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Effect of Gamma Radiation on Genetic Improvement Against Salinity in Catharanthus Roseus Plants

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ABSTRACT: The experiments were carried out during the years of 2013, 2014 and 2015 in the Flowers and Ornamental Plants Research Gardens of the Faculty of Agriculture, Alexandria University, Egypt. The objective of this research was to study the effect of treating the seeds of *Catharanthus roseus* with different gamma rays doses**,** i.e.0, 5, 10, 15 and 20 kr and irrigation with saline water (0,100 and 150 mM) on the morphological characteristics, proline content, alkaloids (vindolen and catharnthine) content and total carbohydrates content in the leaves, variations, mutations and peroxidase isozyme. Data on the effect of gamma radiation, salinity treatments and the interaction between them revealed the followings results.

1- Some variations in the morphological characteristics, such as habit of growth , leaf size, form and colour, stem colour and flower structure and colour**.**
2- Highly significant increases in the proline content.
3a- Significant increases in the leaf vindolen content.
3b- Significant increases in the leaf catharnthine content.
4- No clear effect on the total carbohydrate content.
5- Twelve mutated plants with variation in branching, flowering and salt tolerance.

Key words: Gamma, radiation, genetic, salinity, ornamental, plants.

INTRODUCTION

Catharanthus roseus (L.) G. Don. (Madagascar periwinkle) is a tropical and subtropical ornamental plant and one of the most important medicinal plants (also known as anticancerous drug yield in plant) and also an ornamental bedding plant belonging to the family Apocyanaceae (Jaleel *et al.*,2008).

Catharanthus roseus contains a virtual cornucopia of useful alkaloids, used in diabetes, blood pressure, asthma, constipation, and cancer and menetrual problems. There are about two common cultivars of *C. roseus* which is named on the basis of their flower colour that is the pink flowered “Rosea” and the white flowers “Alba”. *Catharanthus roseus* is found to be a species of *Catharanthus* native and also endemic to Madagascar. The synonyms of the plant name include *Vinca rosea*, *Ammocallis rosea* and *Lochnera rosea*, other English names occasionally used for the plant include Cape periwinkle, rose periwinkle, rosy periwinkle and “old maid”.

Catharanthus roseus is an evergreen subherb or herbaceous plant growing to 1 m. tall. The leaves are oval to oblong, 2.5- 9.0 cm long and 1- 3.5 cm broad, glossy green hairless with a pale midrib and a short petiole about 1- 1.8 cm long arranged in opposite pairs. The flowers are white to dark pink with a dark red center; with a basal tube about 2.5- 3 cm long and a corolla about 2-5 cm diameter with five petal like lobes. The fruit is a pair of follicles about 2-4 cm long and 3 mm broad.

*Catharanthus roseus*posses carbohydrates, flavinoids, saponins and alkaloids. Alkaloids are the most potentially active chemical constituents of *Catharanthus roseus*. More than 400 alkaloids are present in the plant, which are used as pharmaceuticals, agrochemicals, flavor and fragrance ingredients, food additives and pesticides. The alkaloids like actineoplastidemeric, Vinblastin, Vincrestine, Vindesine, Vindeline Tabersonine etc. are mainly present in aerial parts whereas ajmalicine, vinceine, vineamine, raubasin, reserpine, *catharanthine* etc are present in roots and basal stem. Rosindin is an anthocyanin pigment found in the flower of *C. roseus* (Sain and Sharma, 2013).

Aim of the work:

1. Studying the effect of different doses of gamma radiation from cobalt 60 and salt water treatments on the vegetative and flowering growth of *Catharanthus roseus* , as well as on the possibility of inducing mutations , which can resist high salinity or have wider landscape value .
2. Selecting a new strain of *Catharanthus roseus*, with high alkaloid productivity.
3. Using of isozymes techniques (peroxidase enzymes) to find out the genetic relationship among the original mother plant and the mutated plants.

MATERIALS AND METHODS

The experiments were carried out in the Flowers and Ornamental Plants Research Gardens, Department of the Floriculture and Ornamental Horticulture and Landscape Gardening, Faculty of Agriculture, Alexandria University during 2013 – 2015.

Materials

Plant materials

Local cultivar of Madagascar periwinkle or rosy periwinkle (*Catharanthus roseus* (L.) G.Don was used in this study, with purple flowers and cross-pollination. Seeds were obtained from the Flowers and Ornamental Plants Research Gardens of the Faculty of Agriculture, University of Alexandria.

Gamma radiation source

Gamma - rays doses applied in this study were generated from the Cobalt 60 Source, in Gamma – Cell installed in the Irradiation Laboratory at Middle East Regional Radio-Isotope Center for Arab Countries, El-Dokky, and Cairo, Egypt.

Methods

a. Experimental design

The effects of the two factors (irradiation and salinity) on the M_1 - plants were tested in field. The layout of the experiment was designed as factorial layout in Randomized Complete Block Design (RCBD) (Gomez and Gomez, 1984) which contained 5 radiation treatments , i.e. control (0) , 5, 10, 15 and 20 kr.from gamma rays and 3 salinity levels of the irrigation water (0,100 and 150 mM NaCl). One hundred and fifty seeds of *Catharanthus roseus* were used for

every treatment from Gamma rays, One hundred and fifty seeds for every salinity treatment within each gamma rays treatment.

b. Preparing of seeds

Lot of well developed pure seeds from healthy and abundantly fruitful plants of Madagascar periwinkle or rosy periwinkle (*Catharanthus roseus* L.) Local cultivar were collected. The total amount of seeds prepared for gamma ray treatments was divided into five equal portions; the first portion for control, while the other four portions of seeds were, paged equally in four paper bags before exposure to radiation.

c. Gamma radiation practices

On the 18 th and 26 th of March 2013 and 2014 in the first and second seasons; respectively, the dry seeds of *Catharanthus roseus* L.were exposed to four different doses of gamma rays as 5, 10, 15 and 20 kr from Co-60.

d. Soil analyses

Physical and chemical analyses of the used soil were carried out according to the standard methods outlined by Page *et al.* (1982) and are listed in Table (1).

Table (1). Some Physical and chemical characteristics of the used soil during 2013 and 2014.

Parameters	Value	Chemical properties	
Physical properties		**Soluble cations (1:2)**	**(cmol/kg soil)**
Soil texture	Sandy loam	Na^+	20.70
Sand %	75	K^+	0.50
Silt %	8	Ca^{++}	7.40
Clay %	17	Mg^{++}	10.80
		Available K^+	8.76
Chemical properties		**Soluble anions (1:2)**	**(cmol/kg soil)**
pH (1 : 1)	7.82	CO_3^{--}	-
		HCO_3^{--}	3.60
E.C. (dS/m)	3.45	Cl^-	21.00
		$SO4^{--}$	14.80

The experimental treatments consisted of two salinity levels of the irrigation water (100 and 150 mM NaCl) in addition to control (0.0 mM), salinity levels were obtained by addition of appropriate amount of dry NaCl to water. The salinity levels were equivalent to an electrical conductivity of 0.46, 10.9 and 15.9 dSm^{-1}, respectively using a portable EC meter instrument. To avoid an osmotic shock for seedling emergence; the salinized water was used after 45 days of sowing (Gorham and Wyn Jones, 1993).

To prepare the stock solution, a commercial sea salt (sodium chloride) without purification (contents: NaCl 98.5% , Humidity 0.3% and KIO_3 30-70 ppm) produced by Egyptian salt and mineral company (EMISAL) was dissolved in tap water (0.46 dS/m) at (5.85 g salt per liter =100 mM and 8.775 g salt per

liter =150 mM).One month later, complete fertilizer 19-19-19 was top dressed at the rate of 1/2 g /l and this addition was repeated every two weeks.
The plants were irrigated 3 times weekly in summer with 320 ml per pot until the end of the experiment.

Cultural aspects

a. M_1 - Generation

Gamma- rays treated and non - treated seeds were sown on March 20, 2013 in the first season and on March 27,2014 in the second one. The seeds of each treatment were sown in three trays (150 seeds) filled with a mixture of equal parts of sand and clay(1/1).The trays were placed in partial shade according to the factorial experimental layout of the Randomized Complete Block Design and watered daily. On May 3 , 2013 and April 22, 2014 in both seasons , the trays were gradually transferred from shade to open place (sunny place) for one week on May 10, 2013 and April 29, 2014 in the first and second seasons, respectively. Two seedlings were transplanted into 30 cm diameter plastic pot containing sandy loam soil and reached a height of about ten cm. The pots were arranged in the three replicates according to the Randomized Complete Block Design with different numbers of pots in each treatment according to the number of the survived seedlings.

b. M_2 - Generation

For growing the M_2- generation in both seasons , seeds were collected from each treatment on March 20, 2014 and March 23, 2015 in the first and second seasons, respectively, and sown in three trays(100 seeds for each treatment). The trays contained a soil mixture of 1 sand: 1 clay by volume. The trays were placed in partial shade according to the factorial experimental layout of Randomized Completely Block Design with 3 replicates (Gomez and Gomez, 1984).The trays were watered daily. On April 24 , 2014 and April 28, 2015 in the first and second seasons ; respectively , the trays were gradually transferred from shade to sunny place along one week . On April 24, 2014 and April 8, 2015 during the first and second seasons; respectively, every two M_2- seedlings were transplanted into a plastic pot of 30 cm diameter, containing sandy loam soil and reached a height of about ten cm. The pots were arranged according to the experimental design mentioned before.

Experimental Data

The following parameters were recorded in both M_1 - and M_2-generations of the two successive experimental seasons.

1. Morphological characteristics, such as habit of growth, leaf size, form and colour, stem colour and flower structure and colour.
2. Leaf proline content (according to Bates *et al*. 1973).
3. Leaf alkaloids, vindolen and catharanthine contents (after Luo *et al*., 2005)
4. Leaf total carbohydrates content
   Total leaf carbohydrates content was determined colorimetricaly as reported by Loomis and Shull (1937) and Dubios *et al.,*(l956).
5. Variations and Mutations.

All plants of the different treatments in both M_1 and M_2 experiments were examined daily to search for the variation. Changes in the vegetative or flowering growth were recorded. These changes included :

a) Habit of growth.
b) Leaf colour and form.
c) Flower colour and form.

6 .Peroxidase isozyme electrophoresis

The gamma rays and salinity treatments caused variation in the flowers form and tolerance to salinity compared with the control. Leaves were used for the isozymes techniques from the control and the mutated twelve plants. The peroxidase isozymes patterns were examined after the method described by Sabrah and El- Metainy (1985).

RESULTS AND DISCUSSION

1. Effect of gamma radiation and salinity on the morphological characteristics

Some variations in seed germination percentage ,plant height, internode length, stem diameter , number of branches, number of leaves, leaf area, specific leaf weight, total leaf chlorophyll content (a,b and a+b), total carotene, fresh and dry weights of the plants, flowering date ,number of flowers per plant, flowering period, flower length and diameter, pollen viability, survival, fresh and dry weights of the roots, were recorded as a result of different treatments

2. Effect of the gamma radiation and salinity on the leaf proline content

The analysis of variance showed that the effects of the gamma radiation, salinity treatments and interaction between them were highly significant on the leaf proline content in the M_1 and M_2 -generations of the second season.

Data on the effect of gamma radiation and salinity treatments on the leaf proline content of the M_1 and M_2 - generations of the second season are listed in Table 2.

In the M_1 -generation there were highly significant differences among gamma rays treatments. The highest average was at the 20 kr treatment (0.4052 g/100g) and the lowest one was at 0 kr (0.2296 g/100g).By the salinity treatments, there were also highly significant differences. The highest average was at the 150 mM (0.4497 g/100g) and the lowest one was at 100 mM (0.2376 g/100g). The interaction was also highly significant. The 20 kr with 100 mM had the highest proline content (0.7690 g/100g). The lowest one was at the treatment of 20 kr with 0 mM (0.0006 g/100g) (Table 2).

In the M_2 – generation, there were highly significant difference among the gamma rays treatments. The highest average by the gamma rays was at the 20 kr treatment (0.9993 g/100g) and the lowest average was at 5 kr (0.3579 g/100g).The salinity treatments caused highly significant differences. The highest average was at the 150 mM (1.0788 g/100g) and the lowest average was at 0 mM (control) treatment (0.3789 g/100g). The interaction was also

highly significant. The 20 kr with 150 mM treatment had the highest proline content(1.4700 g/100g). The lowest average was at the treatment of 5 kr with 100 mM (0.1818 g/100g).

The results of gamma rays were similar to those reported by Desai and Rao (2014) on *Cajanus cajan* . The results of the salinity treatments were similar to those reported by Zidan and Alzahrani (1994) on *Ocimum basilicum* L. and Heidari and Sarani (2012) on *Matricaria chamomilla*.

Generally, the treatments of gamma rays and salinity caused some increases in proline content in the M_1 and M_2 generation, which is harmony with the results of Nikam *et al.*(2015) on *Saccharum officinarum* L. which can be used for the production of mutants which have the ability for environmental stress tolerance, Desai and Rao(2014).

The results of this work revealed that the dose of 20 kr significantly increased the amount of leaf proline in the irradiated plants comparing with the control in the M_1- and M_2 – generations of the second seasaon. Higher level of proline content in leaves may be due to irradition at 20 kr stimulated the experession of genes encoding enzymes of proline synthesis such as pyrroline -5- carboxylate. Also, irradiation decreased enzymes of proline oxidative such as proline dehydrogenase. This explanation is similar to the opinion mentioned by Amini and Ehasapour (2005).

The results of the M_2 -generation during the second season declared that the doses of 5,10 and 15 kr significantly reduced the amount of leaf proline in irradiated plants as compared to the control.This reduction in leaf proline content could be attributed to the inhibition effect of gamma-rays doses mentioned before on the expression of genes encoding enzymes of proline synthesis and /or enhancing the activity of enzymes of proline oxidative. This declaration is nearly similar to that reported by Amini and Ehasapour (2005).

Table (2). Average values of the leaf proline content of *Catharanthus roseus,* L. as affected by gamma radiation (kr) and salinity levels (mM) treatments in the M_1 – and M_2 generations of the second season.[1)].

Average proline content (g/100g)								
Gamma Rays (Kr)	M_1-2nd season			Average Gam.	M_2-2nd season			Average Gam.
	Salinity Levels (mM)				Salinity Levels (mM)			
	0	100	150		0	100	150	
0.0	0.3810 c	0.1980 d	0.1098 de	0.2296 b	0.4190 de	0.8310 c	1.4200 a	0.8900 b
5.0	0.3620 c	0.1740 de	0.5520 b	0.3626 ab	0.3830 de	0.1818 f	0.5090 d	0.3579 e
10.0	0.3590 c	0.0004 e	0.7030 a	0.3541 ab	0.3690 e	0.2140 f	0.8750 c	0.4860 d
15.0	0.4430 bc	0.0470 e	0.4380 bc	0.3093 b	0.3849 de	0.8650 c	1.1200 b	0.7899 c
20.0	0.0006 e	0.7690 a	0.4460 bc	0.4052 a	0.3390 ef	1.1890 b	1.4700 a	0.9993 a
Average Sal.	0.3091 b	0.2376 c	0.4497 a		0.3789 c	0.6561 b	1.0788 a	
L.S.D.0.05 for A		0.082				0.077		
L.S.D.0.05 for B		0.064				0.060		
L.S.D.0.05 for AB		0.143				0.134		

[1)]Values marked with the same alphabetical letters, within comparable group of means, do not differ significantly, using L.S.D. at 0.05 level of probability.

It is clear that the salinity treatments of 100 and 150mM significantly increased the amount of leaf proline as compared with the control. It has been established that the plants accumulate a variety of osmoregulator soluts including proline as an adaptive mechanism to environmental stress and salinity (Aspinall and Paley,1981). The use of proline as osmoregulator to overcame the bad effects of salinity, which is similar to the effect of seawater on plant growth has been reported by Lin and Kao(1996). Increase in proline content with increasing stress is one of the defense mechanisms which is used by stressed plants to reduce cell osmotic potential which resulted in increasing cell water uptake with concomitant increases in cell turgidity and activity (Khalil and El- Noemani,2012). Stressed plants diminish osmotic potential by accumulating free amino acids,ions,proline,soluble protein and carbohydtaye (Salama *et al.,*1994). These osmolytesmight increase the osmotic pressure of cytoplasm and enhance water flow into the different plant organs and tissues.

3. Effect of radiation and salinity on the leaf alkaloids

3a.Effect of gamma radiation and salinity on the leaf vindolen content

The analysis of variance showed that the effect of the gamma radiation alone and the interaction between gamma radiation and salinity were not significant, but the effect of salinity treatments on the leaf vindolen content was significant in the M_1-generation.

Data on the effects of gamma radiation and salinity treatments on the leaf vindolen content of the M_1 and M_2 –generations in second season are listed in Table 3a.

In the M_2-generation, the effects of the gamma radiation and that of theinteraction between gamma radiation and salinity were highly significant but the effect of the salinity treatments was only significant.

Table 3a presents the mean values of the leaf vindolen content of the different treatments. In the M_1-generation, there were no significant differences between gamma rays treatments. The highest average between the gamma rays was at the 20 kr treatment (1.37 mg/g) and the lowest one was at 0 kr (control) (1.27 mg/g).The effect of the salinity treatments was significant. The highest average between the treatments salinity was at the control treatment (1.66 mg/g) and the lowest one was at 100 mM (0.97 mg/g). The 20kr with 0 mM treatment had the highest leaf vindolen content (2.12 mg/g). The lowest averages were at the treatment of 20 kr with 100 mM (0.86 mg/g).

In the M_2- generation, there were highly significant differences among the gamma rays treatments. The highest average was at the 20 kr treatment (3.35 mg/g) and the lowest one was at 10 kr (2.29 mg/g).The effects of the salinity treatments were significant. The highest average was at the 150 mM (2.94 mg/g) and the lowest one was at 0 mM (control) treatment (2.41 mg/g). The 20 kr with 150 mM treatment had the highest leaf vindolen content (4.20 mg/g).

The lowest average was at the treatment of 15 kr with 0 mM (1.65 mg/g) (Table 3a).

The results of gamma rays were similar to those reported by Abdel-Hady *et al.*(2008) on *Atropa belladonna* and Shaimaa *et al.*(2013)on *Brassica rapa* at gamma rays.

Generally, the treatments of salinity caused some increases in leaf vindolen content in the M_2- generation, which in harmony with the results of Ali (1991) on *Datura*and Heidari and Sarani (2012) on *Matricaria chamomilla*. Also the effect of gamma -rays and salinity on the vindolen was similar to the result reported by Shaimaa *et al.*(2013)on *Brassica rapa*.

Accumulation of alkaloids was considered as an adaptation to the imposed salinity stress because they have an osmoregulatory role (Elhaak and Wegmann, 1997).

William *et al* (1998) reported thatthe increase in the alkaloids content as the influence of NaCl is a combination of an osmotic effect and a specific ion effect. He added that the increase of alkaloids in response to salinity may be due to its role in the plant protection against the salt stress effects.

Table (3a). Average values of the vindolen content of *Catharanthus roseus,* L. as affected by gamma radiation (kr) and salinity levels (mM) treatments in the $M_1 – M_2$ generation of second season.[1)].

Average vindolen content (mg/g)								
Gamma Rays (Kr)	M_1 -2nd season			Average Gam.	M_2 -2nd season			Average Gam.
	Salinity Levels (mM)				Salinity Levels (mM)			
	0	100	150		0	100	150	
0.0	1.51	1.08	1.22	1.27	2.66 bc	2.20 bc	2.89 b	2.58 b
5.0	1.82	1.06	1.11	1.33	2.95 b	2.33 bc	1.91 c	2.39 b
10.0	1.21	0.89	1.82	1.31	2.88 b	1.90 c	2.10 c	2.29 b
15.0	1.63	0.95	1.43	1.34	1.65 c	3.50 ab	3.62 ab	2.92 ab
20.0	2.12	0.86	1.12	1.37	1.94 c	3.91 a	4.20 a	3.35 a
Average Sal.	1.66 a	0.97 b	1.34 ab		2.41 b	2.76 a	2.94 a	
L.S.D.0.05 for A		N.S.				0.445		
L.S.D.0.05 for B		0.485				0.345		
L.S.D.0.05 for AB		N.S.				0.771		

[1)]Values marked with the same alphabetical letters, within comparable group of means, do not differ significantly, using L.S.D. at 0.05 level of probability.

3b.Effect of the gamma radiation and salinity on the leaf catharanthine content

The analysis of variance showed that the effects of the gamma radiation, salinity treatments and the interaction between them on the leaf catharnthine content were highly significant in the M_1-generation in the second season.

Data on the effect of gamma radiation and salinity treatments on the leaf catharnthine content of the M_1 and M_2-generations of the second season are listed in Table (3b).

In the M_2-generations ,the effect of the gamma radiation was not significant,but that of the salinity treatment was significant, while the interaction between them was highly significant.

Table 4 presents the mean values of the leaf catharnthine content of the different treatments. In the M_1-generation, there were highly significant differences among the gamma rays treatments. The highest average was at the 10kr treatment (0.413 mg/g) and the lowest one was at 15 kr (0.104 mg/g).The effects of the salinity treatments were highly significant. The highest average was at the control treatment (0.372 mg/g) and the lowest one was at 100 mM (0.079 mg/g). The 10 kr with 150 mM had the highest leaf catharnthine content (0.890 mg/g). The lowest average was at the treatment of 20 kr with 100 mM (0.002 mg/g).

In the M_2- generation, there were no significant differences among the gamma rays treatments. The highest average between the gamma rays was at the 15 kr treatment (0.186 mg/g) and the lowest one was at 10 kr (0.116 mg/g).The effects of the salinity treatments were significant. The highest average was at the 100 mM (0.177 mg/g) and the lowest one was at 0 mM (control) treatment (0.128 mg/g). The 0 kr with 100 mM treatment had the highest leaf catharnthine content (0.316 mg/g), while the lowest averages was at the treatment of 10 kr with 150 mM (0.080 mg/g).

The results of this work indicated that the gamma doses of 5 and 10kr significantly increased the leaf catharnathine content compared with the control during the M_1-generation of the second season. It was also noticed that the dose of 20kr significantly increased the leaf vindolen content as compared with the control during the M_2-generation of the second season. This means that radiation supported accumulation of alkaloids in the irradiated plants. The respone of plants against radiation induced reproductive and metabolic disorder may be due to the accumulation of several bioactive constituents like alkaloids (Padhya,1986),which may act through different mechanisms such as inhibition of lipid peroxidation (Goel *et al.* 2004).

Alkaloids are end products for the reaction of toxic components in plants and they are harmless for plants (Hossien, 1987). The radiation may stimulate thesereaction which resulted in accumulation of alkaloids in the irradiated plants.

Regarding the salinity treatments, it was noticed that the treatment of 10mM in the M_2-generation of the second season significantly reduced the amounts of leaf catharnathine and vindolen compared with the control. It is known that under stress condiation plants generally shift a major protion of their metabolic activies towards secondary metabolite synthesis, so an increase in alkaloid contents was expected (Ali,1991;Moons *et al.* 1997;Wu *et al.*,2004;Pandey *et al.*, 2007 and Shaimaa *et al.* ,2013).

But in the case of the treatment of 100mM during the M_1-generation the decrease in alkaloids was recorded and it was unexpected.During the M_2-generation of the second season,it was clear that the treatment of 10mM significantly increased the amount of the catharnathine and both treatments of 100 and 150mM significantly increased the amount of leaf vindolen as compared with the control. It has been mentioned before that under stress condition as salinity stress plants generally shift a mojor protion of their metabolic activeties towards secondary metabolite synthesis, as alkaloids (Ali,1991;Moons *et al.*, 1997;Wu *et al.*,2004;Pandey *et al.*, 2007 and Shaimaa *et al.* ,2013). A biotic stresses as salinity stress may result in an increase in the level of endogenous methyl jasmonate, which can stimulate the activity of enzymes involved in the biosynthesis of alkaloids leading to enhanced alkaloids accumulation (Moons *et al.*, 1997).

Table (3b). Average values of the leaf catharnthine content of *Catharanthus roseus,* L. as affected by gamma radiation (kr) and salinity levels (mM) treatments in the M_1 – M_2 generation of second season.[1)].

Average leaf catharnthine content (mg/g)								
Gamma Rays (Kr)	M_1 -2nd season			Average Gam.	M_2 -2nd season			Average Gam.
	Salinity Levels (mM)				Salinity Levels (mM)			
	0	100	150		0	100	150	
0.0	0.326 cd	0.093 e	0.065 e	0.161 bc	0.050 c	0.316 a	0.190 b	0.183
5.0	0.603 b	0.210 de	0.300 d	0.371 a	0.051c	0.130 bc	0.270 ab	0.150
10.0	0.293 d	0.056 e	0.890 a	0.413 a	0.180 b	0.089 c	0.080 c	0.116
15.0	0.183 de	0.036 e	0.093 e	0.104 c	0.210 b	0.170 bc	0.180 b	0.186
20.0	0.453 c	0.002 e	0.103 e	0.186 bc	0.150 bc	0.190 b	0.091 c	0.143
Average Sal.	0.372 a	0.079 b	0.290 a		0.128 b	0.177 a	0.162 ab	
L.S.D.0.05 for A		0.080				N.S.		
L.S.D.0.05 for B		0.062				0.040		
L.S.D.0.05 for AB		0.139				0.090		

[1)] Values marked with the same alphabetical letters, within comparable group of means, do not differ significantly, using L.S.D. at 0.05 level of probability

4. Effect of the gamma radiation and salinity on the total carbohydrate content

The analysis of variance showed that the effects of the gamma radiation, salinity and the interaction between them on the total carbohydrate content was not significant in the M_1-generation in the second season. In the M_2, the effects of the gamma radiation and salinity were significant but the interaction between them was not significant. Table 4 presents the mean values of the total carbohydrate content of the different treatments in M_1-and M_2 of the second season. In the M_1-generation, there were no significant differences among the gamma rays treatments. The highest average was at the 0 kr (control) treatment (5.39 %) and the lowest one was at 20 kr (4.68 %).The effects of the salinity treatments were also not significant. The highest average between the salinity was at 150 mM (5.38 %) and the lowest one was at 0 mM (control) treatment (4.90 %) and the interaction between radiation and salinity was not significant. The 10 kr with 150 mM had the highest total carbohydrate content (6.72 %) and the lowest average was at the treatment of 10 kr with 0 mM (4.04 %) .In the M_2- generation, there was significant difference among the gamma rays treatments. The highest average was at the 15 kr treatment (8.96 %) and the lowest one was at 5 kr (6.50 %).The effects of the salinity treatments were significant. The highest average was at the 100 mM (8.50 %) and the lowest one was at 0 mM (control) treatment (7.10 %). The 15kr with 100 mM and 15 kr with 150 mM treatment had the highest total carbohydrate content(9.50 %). The lowest average was at the treatment of 5 kr with 0 mM (4.70 %).These results were similar to those reported by Rashad (1995) on *Tagest erecta*, El-Sharnouby *et al*. (1997) on *Hibiscus sabdariffia* and Farid *et al*. (1999) on the sweet marjoram. The results of the other workers are not in harmony Kandeel *et al*. (1991) reported on *Ocmium basilicum* that the high gamma dose of 12000 r caused a slight decrease in comparison with the control.These results were similar to those reported by Zidan and Alzahrani (1994) on *Ocmium basilicum*.

The obtained results of salinity treatments during the M_2-generation of the second season indicated that the treatments of 100 and 150mM increased the amount of carbohydrate contents and the increase was significant at the treatment of 100mM compared with the control. Many plants, which are stressed ,by Na Cl salinity, accumulated starch and soluble carbohydrates (Greenway and Munns,1980 and Rathert,1984). This accumulation has been attributed to impaired carbohydrate utilization (Munns and Termaat,1986). Dhanapackiam and Ityas (2010) reported that the soluble and total carbohydrates content in leaves were higher in salt stress plants compared with the control. This is strong evidence that photosynthesis is the main source of accumulating carbohydrates under water stress. The accumulation of organic solutes(soluble and insoluble carbohydrates) might play an important role in increasing the internal osmotic pressure (Zidan and Alzahrani,(1994). This has been widely regarded as response to salinity stress condition. Munns (1993) reported that the concentration of sugars and reserve polysaccharides always rise after plants are exposed to salinity in both growing and fully expanded tissues. This is consistent with a blockage in utilization of sugars in the growing tissues and a subsequent build-up in the rest of the plant.

Table (4). Average values of the total carbohydrates content of *Catharanthus roseus,* L.as affected by gamma radiation (kr) and salinity levels (mM) treatments in the M_1 – M_2 generation of second season.[1)].

Average total carbohydrates content (%)								
Gamma Rays(Kr)	M_1 -2nd season			Average Gam.	M_2 -2nd season			Average Gam.
	Salinity Levels (mM)				Salinity Levels (mM)			
	0	100	150		0	100	150	
0.0	6.53	4.67	4.99	5.39	7.79	7.99	7.40	7.73 ab
5.0	4.79	5.17	5.59	5.18	4.70	7.93	6.88	6.50 b
10.0	4.04	5.13	6.72	5.29	7.60	8.60	7.99	8.06 a
15.0	4.22	4.70	5.47	4.79	7.88	9.50	9.50	8.96 a
20.0	4.92	5.00	4.12	4.68	7.54	8.50	8.20	8.08 a
Average Sal.	4.90	4.93	5.38		7.10 b	8.50 a	7.99 ab	
L.S.D.0.05 for A		N.S.				1.48		
L.S.D.0.05 for B		N.S.				1.15		
L.S.D.0.05 for AB		N.S.				N.S.		

[1)]Values marked with the same alphabetical letters, within comparable group of means, do not differ significantly, using L.S.D. at 0.05 level of probability.

5. Effect of gamma rays and salinity on the induction of variations (Aberrations)(Mutations)

5.1.Growth habit changes

Some treatments caused changes in the habit of growth is some plants resulting in fascinated, dwarfed, creeping and conical forms. Changes in growth habit may be due to the effect radiation on genetic factors controlling the normal growth habit of the plant.The dwarfed growth can be attributed to the effect of radiation on the apical bud which inhibited its growth.It is a fact that most genetical changes in plants result in from chromosome aberrations rather than single gene change (Broertjes *et al.,*1976).

The dwarfed plant lost its ability to grow and was associated with inhibition of flowering. The observed effects in this dwarf plant could be separated as primary and secondary effects. The secondary effects are totally depending upon the primary effects (Donnini *et al.*,1984).
The dwarfed growth in the M_1-generation may be due to physiological damage resulted in the alteration from normal to dwarf growth (Abd El-Maksoud and El- Mahrouk , 1993).

The fascinated growth occurred when a bud had been injured or splitted by radiation,which resulted in many breaks (instead of one break) to come from the apical point. This result is in agreement with that reported by Badr and Etman (1976) and Abdel-Maksoud (1980).

5.2. Leaf changes (shape and colour)

All treatments caused a wdie range of leaf deformities during the M_1-generation of the two seasons. Leaf abnormalities included dwarfing, prolonging, slanting, diminishing. Some leaves were linear, Lanceolate, oblong, elliptic, obovate and spatulate.Other leaves had oblique bases. Some leaves had obtuse, marginate and cuspidate tips. There were changed margins included dentate,undulate, sinuate, incised,lobed and deeply lobed margins. Some plants had curly leaves. Some leaves had the bell- shape. There were some leaves with two midribs. It was noticed in some leaves that the midrib divided the lamina into unequal parts.

The leaf abnormalities were found in the control plants,as well as in the other treatments. In general the frequency of the leaf form changes in the control was leass than that of any other treatment. Selfing was carried out in the plants which had the leaf form changes and the seeds of each plant were sown. The inheritance of these changes were obvious in the M_2- generation and there was a wide range of variation between the M_2- plants.

In this experiment,variation in leaf size and shape suggested that more than one effect may be responsible for the modified leaf patterns. One possible explanation would be the alteration in the ontogeny of leaf tissues through the selective destruction of 1 or more cell layer in the shoot meristem(Skirvin and Janick,1977 and Abdel-Maksoud,1980).Second explanation can be given through genetic changes or chromosomal disturbances, as a result of primary effect of radiation, which may occurred

and caused a decrease in the leaf size in irradiated plants (Kaicher and Swarup,1972 and Evans,1984). Third possibility is that the cell number per unit area and the tength of cells may be altered in the leaf area of irradiated plants as a result of the primary effect of radiation. From the number of cells per unit leaf area and the cell length it could be concluded that broader leaves had a decreased number of cells and /or length of cells.

Some leaf changes, especially those with distorted patterns of development,may be resulted in as induced polyplody which was also reported by love(1966). Also, these changes could be referred to the layer rearrangements as a result of irradiation effect (Kaicher and Swarup,1978 and Abdel-Maksoud,1980 and 1988). These results were in agreement with those reported by Sorour (2011) on *Farfugium japonicum* and Minisi *et al.*(2013) on *Moluccella laevis* at the effect of gamma and Khayamim *et al.* (2014) on sugar beet at the effect of salinity.

The leaf variegation which appeared in the M_2-generation could be attributed to one of the following reasons:

1) The epidermal layer lacked chlorophyll and the internal tissues also showed lack of chlorophyll - because epidermal cells have displaced inner cells in particular regions , the result was creamy green colour.This explanation is supported by those mentioned by Watts(1980),Irvine(1984) and Abdel-Maksoud (1988),who have stated that when the plant is irradiated,the cell layer L_I is easily destroyed and this urges the epidermis or the tissue beneath it to substitute the cell layer L_{II} and then the variegation type appears.

2) The variegation may be caused by gene and / or plastid changes as a results of the irradiation (Borner *et al.*,1976; Walbot and Thompson,1982 and Preil,1985).

Regarding the M_2-generation dwarfed albino plant, it could be concluded that this plant suffered from chlorophyll deficiency which might be due to chromosomal breaks induced by the mutagen (Abd El-Maksoud and El-Mahrouk, 1992).

5.3. Stem colour changes

During the M_1- generation of the first season, one changed plant was found at the combined treatment of 5kr+100mM NaCl. The phenotypic change was restricted in the stem and branches colour. The base of the stem was green, while the rest of the stem had a light purple colour, also,all branches of the plant had a light purple colour.The exact mechanism of the induction of the light purple and green colours cannot be explained with certainly. Both gene and chromosomal structural change has been responsible for the induction of this light purple on the stem of irradiated *Catharanthus roseus* (L) G. Don plant(Sparrow,1961 and Gupta and Shukla,1971).

It is suggested that the appearance of light purple may be due to one or more of the following suggestions:

1. During the biosenthesis of purple pigments, radiation may decrease the methylation of one or more hydroxyl groups by affecting the gene controlling this process,which consequently decreased the purple colour(Wagner,1975).
2. The co-pigmentation may be changed as a result of radiation effect and this may dilute the purple colour and changed it to light purple (De Vries *et al*., 1974 and Chaleff and Torrey,1981).
3. The radiation may affect one of the genes which determine the s quantity of pigments responsible for the purple colour which consequently decreased the quantity of the whole pigments (Wagner,1975).This came to the agreement with that reported by Adachi and Katayama(1970).

The role of salinity in the production of the light purple colour cannot be neglected,where it may be decreased the methylation of hydroxyl groups and /or the degree of co-pigmentation, consequently the appearance of light purple on the stem and branches. According toAdachi and Katayama(1970),the pigment of betacyanin causes the purple in plant. Radiation may reduce the biosenthesis of betacyanin which resulted in appearance of the light purple.

Regarding the appearance of green colour on the base of plant which subjected to the treatment of 5kr+100mM. Scott-Moncrieff (1936) reported that there are intensifying and diluting genes whose action is not effective over the whole, but is restricted to certain areas. It can be suggested that radiation depressed or inhibited the action of the genes which control the purple colour of the stem or determine the extension of purple colour all over the stem. So,the purple colour withdraw from the base of stem while the green colour spread over the stem base.

5.4. Flower changes

5.4.1. Changes in the number and size of petals

The different treatments caused different changes in the number and size of petals. The normal corolla of *Catharanthus roseus*,(L.) G. Don consists of separated and equall five petals. The changes in petal numbers were classified into four types:

Type1.The corolla contained two separated petals and this type was found at the treatments of 5kr+0mM and 10kr+100mM during the M_1- generation of the first season.

Type2. The crolla contained three separated petals and this type was found at the treatments of 15kr+0mM, 5kr+100mM and 20kr+100mM during the M_1- generation of the first season.

Type3.The corolla contained four separated petals (crucifer form). This type was found during theM_1- generation of the first season at the treatments of 5kr+100mM, 10kr+100mM and 15kr+100mM and in the second season at the treatment of 20kr+150mM.Also,this type was found during the M_2- generation of the first season at the treatments of 5kr+0mM,10kr+0mM,15kr+0mM and 20kr+0mM.

Type4.The corolla contained six separated petals. This type was found during the M_2- generation of the first season at the treatments of 5kr+0mM, 10kr+0mM,15kr+0mM and 20kr+0mM.There was one flower with six petals one of them was very small at the treatment of 5kr+0mM.Also, there was one flower with six petals,but one of them was above other petal and this from was detected at the treatment of 10kr+0mM.It was found during the M_2- of the second season some flowers with six separated petals at the treatments of 5kr+100mM,10kr+100mM,15kr+100mM and 5kr+150mM. one flower at the treatment of 15kr+100mM and other one at that of 5kr+150mM had unqual petals.

The flower is a modified stem and the floral whorls are modified leaves and these whorls are appendages similar to the normal leaves in its initiation. Therefore, petal deformities can be attributed to the effect of radiation on flower bud during its initiation. The changes in the number of petals can be postulated that these changes are a result of chromosomal deletion , or changes of the factors govering the normal form or structure , as well as according to the effect of radiation on the ontogeny of flower organ tissues through the selective destruction of one or more cell layer in the apical floral meristem(Abd El -Maksoud , 1980 and 1988).

Bidwell(1979) reported that the initiation and development of flower depends upon the balance of hormones or growth factors.Regarding the type of six petals, it is probably to assume that the gamma- rays had stimulation effect on the initiation and development of petals from the meristematic apex,since gamma doses may affect the balace of growth hormones which in turn may result in an increase in the number of petals.

The reduction in the number of petals(two,three and four petals) could be attributed to the damage effect of gamma-rays and /or salinity on the primordia of petals or on the cells in the shoot growing point,and were later activated and become involved in flowering (Bidwell,1979).
The flowers with changes in the number of petals were selfed. The type 1(two petals) and type 2(three petals) did not form seeds. The types 3 and 4 (four and six petals; respectively) formed seeds and their plants produced normal flowers.

5.4.2. Changes in flower colour

Four types of flower colour changes were observed in the treated *Catharanthus roseus*,(L.) G.Don plants during theM_1- M_2- generations of both seasons (pale(light)purple,white,variegated and striped flowers).
The induced changes at the treatments of 5 kr + 0 mM,10 kr + 0 mM,15 kr + 0 mM and 20 kr + 0 mM were:

1. Pale purple (5 kr + 0mM, 10 kr + 0 mM and 15 kr + 0 mM),
2. Purple variegated with white (15 kr + 0 mM),
3. Purple striped with (15 kr + 0 mM).

These flower colour changes appeared through the M_1- generation of both seasons.

Three types of induced flower colour changes were recognised at different treatments.

1. White flowers (5 kr + 100 mM and 10 kr + 100 mM),
2. Pale (light) purple flowers (5 kr + 100 mM,10 kr +100 mM,15 kr +100 mM and 20 kr + 100 mM),
3. Variegated flowers (5 kr + 100 mM, 10 kr + 100 mM, 15 kr + 100 mM and 20 kr +100 mM)

In the M_2- generation of the second season,there was a new of variegated at the treatment of 15kr+0mM.The flowers were purple variegated with yellow colour and the yellow areas were at the margins of four petals, while on the fifth petal the yellow colour was extended to the flower centre.

In order to give a general interpretation for the appearance of the pale(light)purple flowers,it should be outlined that:

1. Adachi and Katayama (1970) mentioned that betacyanin pigment causes the purple colour.
2. Glycosides of the betacyanins and their co-pigmentation with several other substences are responsible for innumerable variation in the purple colours(Asen *et al.,* 1972 and De Vries *et al.* ,1974).Glycosides type and propably the dgree of methylation are each determined by simple gene (Wagner, 1975).The methylation of one or more hydroxyl groups will increase the colour(Wagner,1975).
3. The different combinations of the pigments are principally responsible for variation in flower colour (De vries *et al*.,1974 and Chaleff and Torrey,1981).
4. The presence of the pigment may be controlled by a single gene, while the quantitative effect of genes in pigment production refers to the effect of multigenes responsible for the amount of pigment in the floral parts(Wagner,1975).

Accordingly it is suggested that the appearance of light purple flowers in *Catharanthus roseus*,(L.)G.Don plants may be due to one or more of the following suggestions:

i. During the biosenthesis of betacyanin,radiation may decrease the methylation of one or more hydroxyl groups by affecting the gene controlling, this process, consequently decreased the purple colour.
ii. The co-pigmentation may be changed as a result of radiation and /or salinity effects and this may dilute the purple colour and changed it to light purple.
iii. The radiation may affect one or more of the genes which determine the quantity of purple pigments which consequently decreased the quantity of the whole pigments. This came to agreement with what was reported by Adachi and Katayama (1970).

These results were in agreement with those reported by Sorour (2011)on *Ligularia japonica*, Minisi *et al.*(2013) on *Moluccella laevis* and Khayamim *et al.* (2014) on sugar beet.

5.5.Mutated plants

The gamma rays and salinity treatments caused branching, flower texture,form and colour and salt tolerance mutations in twelve plants in theM_1compared with the control as follows:

T_0 ⟶ 0 Kr Gama ray + 0 mM salinity (control).
T_1 ⟶ 5 Kr Gama ray + 0 mM salinity (petals texture).
T_2 ⟶ 10 Kr Gama ray + 0 mM salinity (flower form).
T_3 ⟶ 15 Kr Gama ray + 0 mM salinity (flower colour).
T_4 ⟶ 20 Kr Gama ray + 0 mM salinity (little branching).
T_5 ⟶ 0 Kr Gama ray +100 mM salinity (salt tolerate).
T_6 ⟶ 5 Kr Gama ray +100 mM salinity (salt tolerate).
T_7 ⟶ 10 Kr Gama ray +100 mM salinity salt (tolerate).
T_8 ⟶ 15 Kr Gama ray +100 mM salinity (salt tolerate).
T_9 ⟶ 0 Kr Gama ray + 150 mM salinity (salt tolerate).
T_{10} ⟶ 5 Kr Gama ray +150 mM salinity (salt tolerate).
T_{11} ⟶ 10 Kr Gama ray + 150 mM salinity (salt tolerate).
T_{12} ⟶ 15 Kr Gama ray + 150 mM salinity (salt tolerate).

The leaves of the control and mutated plants were used for the isozymes techniques and the separation of the peroxidase isozymes of the control plant and the twelve mutants were carried out.

5.6.Peroxidase isozyme

It is important to notice that isozyme analysis using electrophoresis offers a very well define effective tool for the detection of genetic differences among individuals .This makes electrophoresis a useful tool for plant breeders (Arulsekar and Parfitt,1986) .The study of isozyme electrophoretic patterns can offer a rapid method for the identification of different genotypes without carring out field experiment, which saves time and money (Bailey, 1983). Moreover, the analysis of a protein can be reflected to its gene (Gottlieb, 1977).

The similarity values, (Table 5) showed that the control plants were more genetically distinct to the plants treated with 150 mM NaCl (similarity value equal to 50),while high similarity value (100) was found between the control plants and the plants treated with 5, 10 kr, 5kr+ 150 mM and 15 kr+ 150 mM NaCl (Table 5).

Table (5).Similarity value among the control and all mutants of *Chatharanthus roseus*, L. produced by gamma rays and salinity.

	0	1	2	3	4	5	6	7	8	9	10	11	12
0	100												
1	100	100											
2	100	100	100										
3	66.6	66.6	66.6	100									
4	80	80	80	88.8	100								
5	66.6	66.6	66.6	75	66.6	100							
6	80	80	80	88.8	100	66.6	100						
7	66.6	66.6	66.6	100	88.8	75	88.8	100					
8	66.6	66.6	66.6	50	66.6	75	66.6	50	100				
9	50	50	50	57.1	50	75	50	57.1	85.7	100			
10	100	100	100	66.6	80	66.6	80	66.6	66.6	50	100		
11	88.8	88.8	88.8	75	66.6	75	66.6	75	66.6	57.1	88.8	100	
12	100	100	100	66.6	66.6	66.6	66.6	66.6	66.6	50	100	88.8	100

The separation of the peroxidase isozyme of the control plant and the twelve mutants of *Catharanthus roseus*is illustrated in Figure 1.These results were in agreement with those reported by Jaleel *et al.* (2007)on *Catharanthus roseus*.

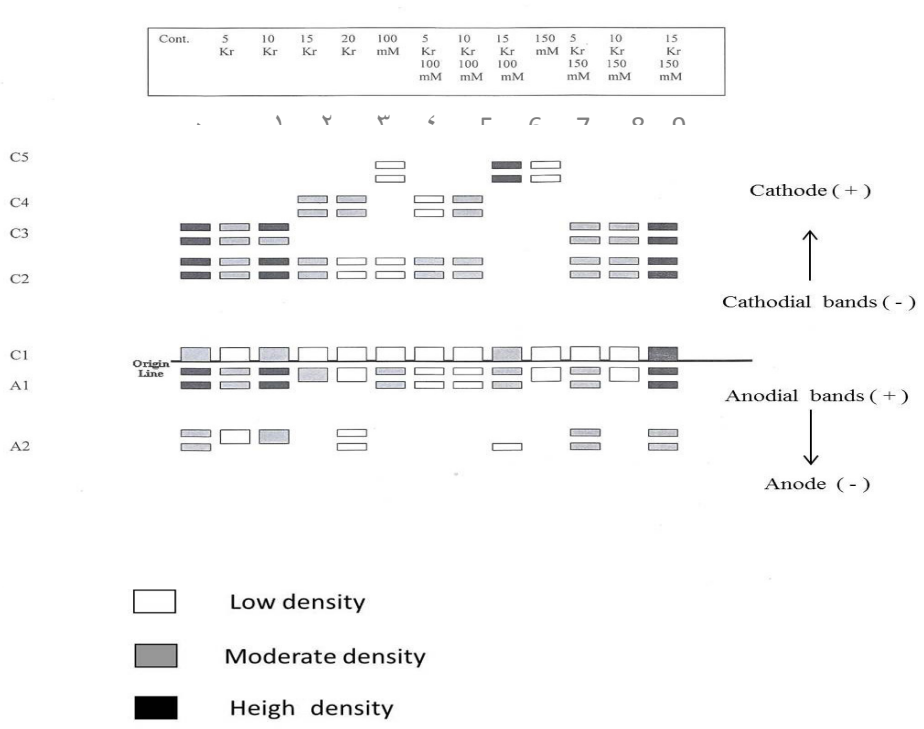

Figure (1). Zymogram of electrophoretic separation samples of peroxidase isozyme of the control and the twelve mutated plants of *Catharanthus roseus*.L.

The electrophoretic banding patterns indicate different profiles among gamma rays doses and salinity concentrations. It can be noticed that a total number of seven loci control the production of peroxidase in the *Catharanthus roseus*. Five bands migrated toward the cathode (-) and designed as C1 to C5, while, two bands migrated toward the anod (+) in the electrophoresis field and were designed as A1 and A2.

The bands of the loci C1 and A1 were presented in all the treatments. Bands of the loci A1 differed in the intensity and homogeneity among treatments. This locus was presented by one homozygous allele in the treatments of 15, 20 kr, 150 mM NaCl and the treatment with 10 kr +150 mM saline water, while this locus showed heterozygous profile in all other treatments. The locus A2 disappeared from the samples treated with 15 kr, 100 mM, 150 mM NaCl and the treatments of 10 kr+150 mM NaCl.

The locus C5 was found only in the samples treated with 100 mM, 150 mM NaCl in low intensity and in the samples treated by 15 kr+ 100 mM in high intensity. The locus C4 was found only in the treatments of 15, 20 kr, 5 kr+ 100 mM and 10 kr + 100 mM NaCl with low intensity. On the other hand the locus C2 was absent in the 150 mM and 15 kr+ 100 mM NaCl treatments.

Phylogenetic tree classified the studied plants into three groups. The control plants (T_0)and the treatments of T_1, $T_2$and T_{12} were classified in cluster I, plants of T_3, T_4, $T_6$and T_7 were classified in the cluster II and plants of T_5, T_8 and T_9 were grouped in the cluster III (Figure 2).

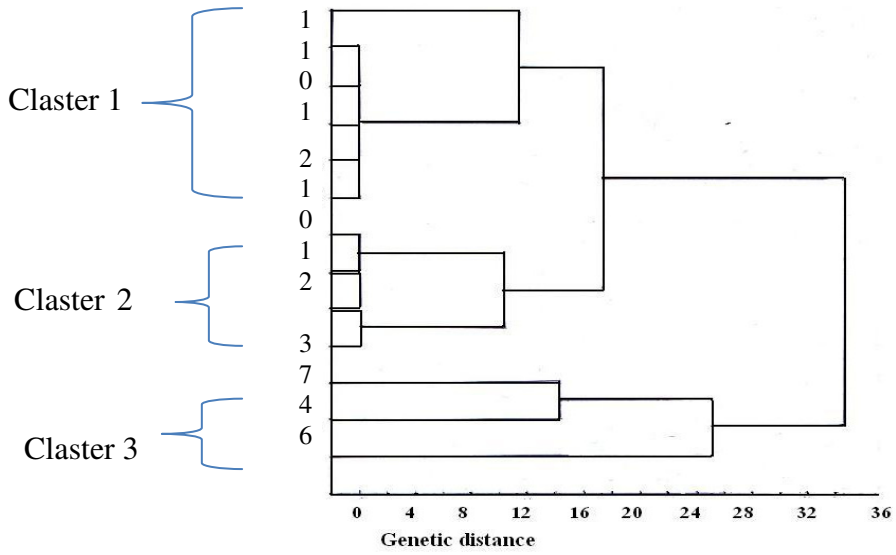

Figure (2). Genetic relationship among the control and the twelve mutants *Catharanthus roseus*, L.based on peroxidase isozymes patterns and similarity values.

CONCLUSION

The obtainedresults indicated that different doses of gamma radiation cause some morphological variations in the vegetative and flowering growth of *Catharanthusroseus* Linn. and induced salt – tolerant plants with high alkaloid content, which can be grown in saline soils.It can be also concluded that peroxidase isozyme could act as a useful biochemical marker in *Catharanthus roseus*,L.to study the genetic relationship between the mother plant and the induced mutations.

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الملخص العربي

تأثير إستخدام أشعة جاماعلي التحسين الوراثي ضد ظروف ملوحة التربة في نبات الونكا

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تم إجراء البحث في حدائق أبحاث الزهورو نباتات الزينة بكلية الزراعة– جامعة الإسكندرية خلال الاعوام ٢٠١٣، ٢٠١٤ ، ٢٠١٥ علي نبات الونكا *Catharanthus roseus*. كان الهدف من البحث هو دراسة تأثير الجرعات المختلفة من أشعة جاما ومعاملات الري بالماء المالح على الصفات الخضرية والزهرية للونكا فضلا عن إمكانية إحداث الطفرات، التي يمكن أن تقاوم الملوحة العالية أو لها قيمة تنسيقية.

هذا وقد تم زراعة البذور المعاملة بأشعة جاما بجرعات صفر، ٥ ،١٠،١٥، ٢٠ كيلو راد وذلك في ٢٠١٣/٣/٢٠ بالنسبة للجيل الأول للموسم الأول و٢٠١٤/٣/٢٧ بالنسبة للجيل الأول للموسم الثاني. وكان تصميم التجربة فى صورة قطاعات عشوائية كاملة بعاملين. مشتملة على ٥ معاملات تشعيع و٣ مستويات ملوحة وخصص لكل معاملة ١٥٠ بذرة في الجيل الأول للموسمين و ١٠٠ بذرة للموسمين من كل معاملة في الجيل الثاني. ويمكن تلخيص اهم النتائج التي تم التوصل إليها فيما يلي:

١ – الصفات الموفولوجية (التغيرات المورفولوجية والإختلافات الظاهرية)

لوحظت تغيرات مورفولوجية في النباتات تبعاً لجرعات اشعة جاما وتركيزات الملوحة في كلا الجيلين والموسمين وذلك في عدة صفات هي :

١. طبيعة النمو (بعض النباتات المتقزمة وعديمة الكلوروفيل).

٢. لون وشكل الورقة (أوراق ذات أشكال غير منتظمة ومصفرة).

٣. طبيعة الساق (سيقان فاتحه اللون).

٤. لون وشكل الزهرة (أزهار قصيرة وأخري مبرقشة وأزهار ذات أعداد بتلات مختلفة).

تقدير البرولين في الاوراق – تقدير القلويدات(محتوي الفاندولين والكاثرانثين) – محتوي الكربوهيدرات – حدوث طفرات– تقدير البيروكسيديز.

٢– محتوي الأوراق من البرولين

وجدت فروق معنوية بين المعاملات في محتوي الاوراق من البرولين (جرام/١٠٠جرام) نتيجه المعاملات بأشعة جاما والملوحة و التأثير المشترك بينهما في الجيل الطفوري الاول ، وكان اعلي تاثير لاشعة جاما عند ٢٠ كيلو راد (٠.٤٠٥٢ جرام/١٠٠جرام) واقل تاثير عند صفر كيلو راد (كنترول) (٠.٢٢٩٦ جرام/١٠٠جرام) ، واعلي تاثير للملوحة

عند ١٥٠ ملي مول (٠.٤٤٩٧ جرام/١٠٠جرام) وللتأثير المشترك بين الملوحة والاشعة عند ٢٠ كيلو راد مع ١٠٠ ملي مول (٠.٧٦٩٠ جرام/١٠٠جرام) كأعلي متوسط واقل متوسط عند ٢٠ كيلو راد مع صفر ملي مول (٠.٠٠٠٦ جرام/١٠٠جرام).

الجيل الطفوري الثاني كان هناك فروق معنوية بين المعاملات في محتوي الاوراق من البرولين بالنسبة لاشعة جاما وتاثير الملوحة و التأثير المشترك بين الملوحة والاشعة وكان اعلي تاثير لاشعة جاما عند ٢٠ كيلو راد(٠.٩٩٩٣ جرام/١٠٠جرام) واقل تاثير عند ٥ كيلو راد(٠.٣٥٧٩ جرام/١٠٠جرام) ، واعلي تاثير للملوحة عند ١٥٠ ملي مول (١.٠٧٨٨ جرام/١٠٠جرام) وللتأثير المشترك بين الملوحة والاشعة عند ٢٠ كيلو راد مع ١٥٠ ملي مول(١.٤٧٠٠ جرام/١٠٠جرام) كأعلي متوسط واقل متوسط عند ٥ كيلو راد مع ١٠٠ ملي مول (٠.١٨١٨ جرام/١٠٠جرام).

3a – محتوي الأوراق من الفندولين

وجدت فروق معنوية بين المعاملات بالنسبة لمحتوي الاوراق من الفندولين (ملجرام/جرام) نتيجة لتاثير الملوحة فقط عند صفر ملي مول (كنترول) (١.٦٦ ملجرام/جرام) في الجيل الطفوري الاول . أما في الجيل الطفوري الثاني فقد كانت هناك فروق معنوية بين المعاملات في محتوي الاوراق من الفندولين بالنسبة لاشعة جاما و التأثير المشترك بين الملوحة والاشعة وكان اعلي تاثير لاشعة جاما عند ٢٠ كيلو راد (٣.٣٥ ملجرام /جرام) واقل تاثير عند ١٠ كيلو راد (٢.٢٩ ملجرام/جرام). اما تاثير الملوحة فقد كان الاعلي عند ١٥٠ ملي مول(٢.٩٤ ملجرام /جرام) والاقل عند صفر ملي مول (كنترول)(٢.٤١ ملجرام /جرام). أما التأثير المشترك بين الملوحة والاشعة عند ٢٠ كيلو راد مع ١٥٠ ملي مول(٢.٤٠ ملجرام /جرام) كأعلي متوسط واقل متوسط عند ١٥ كيلو راد مع صفر ملي مول(١.٦٥ ملجرام /جرام).

3b-محتوي الأوراق من الكاثرانثين

في الجيل الطفوري الاول وجدت فروق معنوية بين المعاملات في محتوي الاوراق من الكاثرانثين (ملجرام/جرام) نتيجة لمعاملات اشعة جاما والملوحة والمشتركة ، وكان اعلي تاثير لاشعة جاما عند ١٠ كيلو راد (٠.٤١٣ ملجرام/جرام) واقل تاثير عند ١٥ كيلو راد (٠.١٠٤ ملجرام/جرام) ، واعلي تاثير للملوحة عند صفر ملي مول (كنترول)(٠.٣٧٢ ملجرام/جرام) والاقل عند ١٠٠ ملي مول (٠.٠٧٩ ملجرام/جرام) و تأثير مشترك بين الملوحة والاشعة عند ١٠ كيلو راد مع ١٥٠ ملي مول (٠.٨٩٠ ملجرام/جرام) واقل تاثير عند ٢٠ كيلو راد مع ١٠٠ ملي مول (٠.٠٠٢ ملجرام/جرام). وفي الجيل الطفوري الثاني لم يكن هناك فروق معنوية بين المعاملات في محتوي الاوراق من الكاثرانثين بالنسبة لاشعة جاما ، لكن تاثير الملوحة كان معنوي عند ١٠٠ ملي مول (٠.١٧٧ملجرام/جرام)وزاد التأثير المشترك بين الملوحة والاشعة معنوياً عند صفر كيلو راد مع ١٠٠ ملي مول (٠.٣١٦ملجرام/جرام) كأعلي متوسط بينما كان اقل متوسط عند ١٠ كيلو راد مع ١٥٠ ملي مول(٠.٠٨٠ ملجرام/جرام).

٤- محتوي الاوراق من الكربوهيدرات الكلية

لم يكن هناك فروق معنوية بين المعاملات لمحتوي الاوراق الكربوهيدرات الكلية (%) في الجيل الطفوري الاول . أما في الجيل الطفوري الثاني فقد كان هناك فروق معنوية بين المعاملات لمحتويالاوراق الكربوهيدرات الكلية بالنسبة لاشعة جاما و تاثير الملوحة ، وكان اعلي تاثير لاشعة جاما عند ١٥ كيلو راد (٨.٩٦ %) واقل تاثير عند ٥ كيلو راد (٦.٥٠ %) ، كما كان اعلي تاثير للملوحة عند ١٠٠ ملي مول(٨.٥٠%) . أما عن التأثير المشترك بين الملوحة والاشعة لم يكن هنالك فروق معنويةبين المعاملات .

٥- إنتاج الطفرات

تم الحصول علي ١٢ نبات مُطَفَّر مقارنة بالنبات الام (المقارنة control) منها ٣ نباتات ذات ازهار مختلفة ونبات ذو تفريع مختلف وثمانية نباتات تتحمل الملوحة وهي

T_0= المعاملة صفر كيلو راد + صفر ملي مول(كنترول).
T_1 = المعاملة ٥ كيلو راد + صفر ملي مول(طفرة ملمس البتلات).
T_2= المعاملة ١٠ كيلو راد + صفر ملي مول(طفرة شكل الزهرة).
T_3 = المعاملة ١٥ كيلو راد + صفر ملي مول(طفرة لون الزهرة).
T_4 = المعاملة ٢٠ كيلو راد + صفر ملي مول(طفرة طريقة تفريع).
T_5= المعاملة ٠ كيلو راد + ١٠٠ ملي مول(طفرة تَحَمّل للملوحة).
T_6 = المعاملة ٥ كيلو راد + ١٠٠ ملي مول (طفرة تَحَمّل للملوحة).
T_7= المعاملة ١٠ كيلو راد + ١٠٠ ملي مول(طفرة تَحَمّل للملوحة).
T_8 = المعاملة ١٥ كيلو راد + ١٠٠ ملي مول(طفرة تَحَمّل للملوحة).
T_9= المعاملة ٠ كيلو راد + ١٥٠ ملي مول(طفرة تَحَمّل للملوحة).
T_{10} = المعاملة ٥ كيلو راد + ١٥٠ ملي مول(طفرة تَحَمّل للملوحة).
T_{11}= المعاملة ١٠ كيلو راد + ١٥٠ ملي مول(طفرة تَحَمّل للملوحة).
T_{12} = المعاملة ١٥ كيلو راد + ١٥٠ ملي مول(طفرة تَحَمّل للملوحة).

٦- إنزيم البيروكسيديز

أظهرت نتائج دراسة المشابهات الإنزيمية لإنزيم البيروكسيديز تحكم سبعة مواقع وراثية في إنتاج إنزيم البيروكسيديز في نبات الونكا . ظهرت خمسة مواقع سالبة متجهة نحو القطب الموجب (الكاثود) وموقعين موجبين متجهين نحو القطب السالب(الانود) . وقد تم التمييز بين الطفرات ومعاملة المقارنة بإستخدام إختبار تحليل المشابهات الإنزيمية لإنزيم البيروكسيديز .كما تم دراسة قيم التشابة بين نباتات المقارنة ونباتات الطفرات الناتجة من المعاملات. وقد امكن وضع المقارنة والطفرات الناتجة في ثلاث مجموعات شملت الاولي منها المقارنة وأربعة طفرات T_4وT_3 وT_2 وT_1 وT_0 والثانية اربع طفرات (T_8وT_7 وT_6 وT_5) والثالثة أربع طفرات (T_{12}وT_{11} و T_{10}وT_9).

Genetic and Horticultural Characterisations of Some Mango Cultivars (*Mangifera indica* L.) Based on Different Markers

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ABSTRACT: Mango (*Mangifera indica* L.) is the most popular fruit crop in the orient particularly in the world. Mango is a diploid fruit tree (2n = 40). The mango is considered as one of the oldest cultivated trees in the world. 28 mango cultivars, different morphological and molecular markers (EST & SSR) were used in the current experiment to identify the genetic relationships with/within cultivars. The results indicated that, high significant variations were observed in the morphological characteristics. Also, the molecular data could be useful tool in calculating the genetic relationship and clustering the recent mango cultivars based on SSR and EST markers. Genetic polymorphism based on different markers were detected.

Key words: Mango, horticulture, molecular, markers

INTRODUCTION

Mango (*Mangifera indica* L.) is one of the most important fruit crops of the Anacardiaceae family (Popenoe, 1920). Mangoes are an important fruit crop in Egypt. Per the latest statistics provided by the Ministry of Agriculture and Land Reclamation of Egypt (20١٥), indicated that, a total of 243028 Feddan is planted by mangoes. Adoption of molecular markers and genomics-based breeding strategies will likely improve predictability and breeding efficiency. In recent years, *Mangifera* germplasm has been collected and analysed using simple sequence repeat (SSR) markers by Duval *et al.* (2006), Schnell *et al*. (2006) and more recently by Dillon *et al*. (2013). The traditional techniques of developing SSR markers are usually time consuming, labor intensive and of low efficiency, Ellis and Burke (2007). However, alternative strategies to identify SSR markers have been developed that use comparative genomics tools such as expressed sequence tags (ESTs) (Wöhrmann and Weising 2011). It is hypothesized that the highly repetitive nature of SSRs makes slippage during replication a common event, leading to the high levels of polymorphism found between populations. A key advantage of EST-SSRs is that they are often more transferable across closely related genera compared to anonymous SSRs from untranslated regions (UTRs) or non-coding sequences e.g., (Pashley *et al*., 2006). This is due to the primer target sequences residing in the expressed DNA regions expected to be relatively well conserved, thereby increasing the chance of marker transferability across species boundaries (Varshney *et al*. 2005). Despite their potential to represent selectively deleterious frame-shift mutations in coding regions, EST-SSRs appear to reveal equivalent levels of polymorphisms compared to SSRs located in UTRs, most likely due to an evolutionary trend towards tri-nucleotide repeats in these coding regions, (Ellis and

Burke, 2007). EST-SSRs are physically linked to expressed genes and therefore represent potentially functional markers. Evaluation of genetic variation within cultivated crop species is central to plant breeding strategies and genetic resource conservation (Dean *et al*., 1999).

One of the many interesting applications of ESTs database (dbEST) is gene discovery where many new genes can be found by querying the dbEST with a protein or DNA sequence. Twenty-two mango cultivars were examined for 40 simple sequence repeat (SSR) anchored primers of 15–18 oligonucleotides which screened by Eiadthonga *et al.* (2005). Microsatellite markers were developed and characterized to assess the genetic diversity among mango cultivars and to test their amplification in closely related species by Kundapura *et al.* (2011). Polymorphic information content values ranged from 0.185 to 0.920 with a mean of 0.687. Dillon *et al.* (2013) a collection of 24,840 expressed sequence tags (ESTs) generated from five mango cDNA libraries was mined for EST-based simple sequence repeat (SSR) markers. Results showed that over 1,000 ESTs with SSR motifs were detected from more than 24,000 EST sequences with di- and tri-nucleotide repeat motifs the most abundant. Twenty-four of the 25 EST-SSR markers exhibited polymorphisms, identifying a total of 86 alleles with an average of 5.38 alleles per locus, and distinguished between all *Mangifera* selections. Private alleles were identified for *Mangifera* species.

Recently, Kundapura *et al*. (2011) studied genetic diversity and population structure of mango cultivars by employing fourteen simple sequence repeat markers, with high polymorphic information content. A set of 387 mango cultivars from different regions of India was used. The main objectives of the present research are to study the molecular and horticultural characterization of some mango cultivars in Egypt from different localities.

MATERIALS AND METHODS

The present experiments were carried out at the Agricultural Botany Department, Faculty of Agriculture, Saba Basha, Alexandria University, Egypt. These studies were conducted during 2014 up to 2016. Twenty eight Mango *(Mangifera Indica* L.) cultivars growing in Egypt have been used for morphological and molecular markers analyses, all of the cultivars were obtained kindly from the Agricultural Research Center, Horticulture Research Institute, (HRI), Giza, Egypt i.e. Shelly, Kensington Bride, Yasmina, Succari, Hindi Besennara, Golek, Alphonso, Piva, R2E2, Zebda, Sabre, Heidi, Osteen, Langra Benersi, Maya, Nam Doc Mai, Princess, Hindi Mloki, Fajri Kalan, Sidik, Joa, Sensation, Tommy Atkins, Kent, Haden, Naomi, Palmer and Lilly.

Eight morphological characters were measured at maturity and harvest stage such as fruit lengths (cm), fruit width (cm), fruit weight (g), peel (%), pulp (%),

fiber length (mm), shelf life (days) and fruit shape. Genomic DNA was isolated from leaves of all varieties using CTAB modified method per Dellaporta *et al.,* (1983). Six SSR specific markers were selected for SSR analysis per the literature of Hameedunnisa *et al*. (2012) (Table 1).

The PCR amplification reactions were performed in 17 µl reaction volume containing 50 ng of DNA, 12.5 µl of Dream Taq master mix (Fermentas co.) and 0.5 µ moles of each primer. The primary program was 6 cycles at 94°C for 1 min, 45°C for 50 seconds decreasing 1°C in every cycle, and 72°C for 1 min, followed by 28 cycles at 94°C for 1 min, 40°C for 1 min and 72°C for 1 min. The previous programs were preceded by a denaturation step at 94°C for 4 minutes and followed by an extension step at 72°C for 7 minutes. The PCR products were separated on 1.5% agarose gel electrophoresis. Seven EST common specific markers (Table 1) were selected to carry out the EST analysis for *Mangifera Indica* L varieties per Dillon *et al*. (2013).

The primary program was carried out for: 7 cycles at 94°C for 1 min, 47°C for 50 seconds decreasing 1°C in every cycle, and 72°C for 1 min. The main programs were carried out for 28 cycles at 94°C for 1 min, 42°C for 1 min and 72°C for 1 min. The previous programs were preceded by a denaturation step at 94°C for 4 minutes and followed by an extension step at 72°C for 7 minutes. The PCR products were separated on 1.5% agarose gel electrophoresis. Morphological data were subjected to analysis of variance (ANOVA) to determine variation among the varieties using SPSS 14 (Statistical Package for the Social Sciences). DNA bands of PCR product were visualized on UV Transilluminator gel documentation system and photographed.

The gel pictures were manipulated using Adope Photoshop 8. The gels were scored for band presence or absence as (1) or (0), respectively. The total number of bands generated from each primer as well as the polymorphic bands number generated from each primer was calculated. The polymorphism percentage of each primer as well as the polymorphic information content (PIC) was also calculated. Similarity coefficient matrices were calculated using the Jaccard similarity algorithm (Jaccard, 1908).

Table (1). Marker names, sequences for SSR and EST used in the current study

Marker	Marker name	Forward and Reverse sequence
SSR	SSR-16	'5-AGCGATGGTGCTCATGCTTA-3' 3'-TCTCTCACGGAATCACATCTT-'5
	SSR-19	'5-TTTCAGCAAACTAGAACCAA-3' 3'-GGCATTCAGTTTTTACCTTGT-'5
	SSR-52	'5-AAAAACCTTACATAAGTGAATC-3' 3'-GAACAGTTGTTTCGTGTCGTA-'5
	SSR-59	'5-GATGTTGTTGGTGTTGTTTA-3' 3'-CAATTAGGAGCAAAATCAGA-'5
	SSR-65	'5-GGTTTTGAATAGAAATGCAA-3' 3'-AAGATGTGTCAATATTGTTTT-'5
	SSR-83	'5-GGCTATTGTCACGAACAAAT-3' 3'-GATTCAGACCCGGATACATT-'5
EST	QGMI-001	'5-GAAAGGCTTGCAGAGACAGG-3' 3'-GTTTCTTCTGTTCGGTGATGGAGGAGT-'5
	QGMI-003	'5-CAGGAATCTTCCCAAACGAA-3' 3'-GTTTCTTTGCCAGTGTCTTCACCTTCA-'5
	QGMI-004	'5-TTCACAACGAGAAGACATGGA-3' 3'-GTTTCTTGGGACCTATTCGATCCCACT-'5
	QGMI-005	'5-TGGAGGAATTGAACCGATTG-3' 3'-GTTTCTTCAGTATCGGAGGCGTCAGTC-'5
	QGMI-010	'5-GGTTTGAGCTTCCAAATTGC-3' 3'-GTTTCTTCCTGGGAAAGTCAACAGCAG-'5
	QGMI-020	'5-GCTCTGACGCGGAGATTC-3' 3'-GTTTCTTGTTGTTTTCCTGGCTGCAAT-'5

RESULTS AND DISCUSSION

a. Morphological variations of *Mangifera Indica* cultivars

Regrading to the data in Table (2) for fruit length (cm) in 28 Mango cultivars, data showed that the highest accession was Fajri Kalan by 16.5 cm and the lowest one was Succari by 9.0 cm. The general average was 12.11 cm for fruit length. Significant variations were observed between the current cultivars with L.S.D.0.05= 2.30. Five cultivars from 28 detected fruit length less than 10 cm such as Alphonso (9.2 cm), Maya (9.5 cm), Princess (9.6 cm), Sensation (9.5 cm) and Haden (10 cm). these values were less than the overall and nearly to the minimum values (Table, 2).Data for fruit width (cm) recorded in Table (1), detected that, the fruit width ranged from 6.3 to 11.5 cm by general average was 10.6 cm. The highest value recorded to R2E3 and the lowest fruit width recorded to Sabre by 6.3 cm. Data showed the different in morphological variations between the 28 mango cultivars with significant values L.S.D.0.05= 3.10. No significant variations were

observed between the maximum and minimum values, while between cultivars there were significantly difference in relation to fruit width (cm).

Concerning to fruit weight (g) high significant variation was observed between all the cultivars (Table, 2). The highest fruit weight was 650 g (Piva accession) followed by 625 g (Hindi mloki accession) then Tommy (615 g). The lowest value was 225 g was recorded to Zebda accession. The general mean was 416. 4 g between thee 28 cultivars with L.S.D.0.05= 114.30. Three different categories were observed for fruit weight, the first group was over than 600 g such as Piva (650 g), Hindi moloki (626 g), Tommy Atkins (615 g). the second group was from 300 to 600 g and this one includes 17 cultivars. Finally, the last one was less than 300 g and that includes 7 cultivars such as Yasmina, Succori, Hindi Besenara, Golek, Zebda, Maya and Joa. Concerning to peel percentage in different mango cultivars, data in Table showed that Succari detect the lowest percent (14%) and it was the shortest fruit also. On the other hand, Tommy Atlins showed the highest peel percentage (34%) flowered by Hindi Mloki by (33%) and it was also the highest fruit weight. While, for pulp %, the data ranged from 16 to 46% the general mean was 23.2%. The highest one was Hindi Besennara (46%) and the lowest one was Tommy (16%) although the fruit weight was high (615 g) as shown in Table 2.

For fiber length (mm), data in Table (2) showed that, values ranged from 6 to 23 mm by general mean 10.9 mm. The lowest cultivars were Princess achieved 6 mm while, the highest was Sabre with 23 mm and the last one showed the lowest fruit width also. Data showed relationship between the fruit width and pulp percentage. Finally, the shelf life for the current accession ranged from 5 to 7 day and the general mean was 6.1 day. Yasmina, Alphonso and Nam Doc Mai showed the lowest values comparing with other cultivars (Table, 2). For fruit shape, data in Table 2 showed different shapes such as cordate, ovate, Cylindrical, Obliqueovate, fusiform, Cylindrical oblique, Rectangular oblique and Oval roundish. Results showed the different morphological variation between the twenty-eight Mano cultivars. The previous data could be reference for the researchers in the future when worked on the mango cultivars in Egypt.

The present results are in consonance with those of Singh *et al*. (2009) who detected prominent variation in the mango cultivar ‘Banganapalli’ based on morphological analysis of 17 fruit characters. The present findings are also in agreement with those of Bally *et al*. (1996), who also observed phenotypic variation in the type of fruit in 15 cultivars of 'Kensington Pride', a polyembryonic cultivar of mango. Conventionally also, the intracultivar heterogeneity of mango has been characterized mostly at the morphological level by several researchers (Gan *et al*., 1981; Naik, 1948; Pandey, 1998; Singh *et al.,* 2009).

Table (2). Morphological characters of twenty-eight mango cultivars

	Fruit length (cm)	Fruit width (cm)	Fruit weight (g)	Peel (%)	Pulp (%)	Fiber length (mm)	Shelf life (days)	Fruit shape
Shelly	12.5	11.0	425.0	25.0	33.0	8.0	6.0	cordate
Kensington Bride	12.6	9.8	400.0	18.0	42.3	11.0	7.0	cordate
Yasmina	11.5	6.7	275.0	17.0	35.0	7.0	5.0	ovate
Succari	9.0	6.5	275.0	14.0	44.0	12.0	6.0	cordate
Hindi Besennara	12.0	6.7	300.0	20.0	46.0	13.0	6.0	Cylindrical
Golek	11.0	7.0	250.0	18.0	29.0	11.0	6.0	Cylindrical
Alphonso	9.2	7.8	500.0	30.0	41.0	7.0	7.0	cordate
Piva	13.7	8.8	650.0	28.0	38.0	8.0	5.0	Obliqueovate
R2E2	13.5	11.5	500.0	23.0	18.0	12.0	7.0	cordate
Zebda	12.5	9.0	225.0	17.0	33.0	13.0	6.0	ovate
Sabre	12.2	6.3	375.0	27.0	39.0	23.0	7.0	Cylindrical
Heidi	11.4	9.5	575.0	17.0	22.0	7.0	7.0	cordate
Osteen	12.9	8.0	400.0	22.0	21.0	16.0	7.0	Cylindrical
Langra Benersi	10.7	8.1	325.0	26.0	28.0	7.0	6.0	ovate
Maya	9.5	8.0	300.0	18.0	25.0	9.0	6.0	cordate
Nam Doc Mai	13.6	7.2	425.0	28.0	21.0	9.0	5.0	fusiform
Princess	9.6	6.9	375.0	24.0	36.0	6.0	5.0	cordate
Hindi Mloki	12.4	7.0	625.0	33.0	33.0	8.0	6.0	Cylindrical
Fajri Kalan	16.5	8.0	500.0	25.0	24.0	8.0	6.0	Cylindrical
Sidik	16.4	7.3	425.0	19.0	28.0	16.0	7.0	Cylindrical
Joa	12.5	7.5	300.0	22.0	35.0	8.0	7.0	Rectangular
Sensation	9.5	7.3	480.0	28.0	41.0	22.0	6.0	Rectangular
Tommy Atkins	12.1	8.8	615.0	34.0	16.0	9.0	5.0	Oval roundish
Kent	11.9	9.7	310.0	22.0	26.0	10.0	6.0	cordate
Haden	10.0	8.5	505.0	26.0	21.0	11.0	6.0	cordate
Naomi	13.5	9.1	455.0	23.0	28.0	8.0	7.0	Rectangular
Palmer	13.0	7.0	490.0	28.0	22.0	15.0	5.0	Cylindrical
Lilly	12.5	8.6	380.0	18.0	18.0	12.0	6.0	ovate oblique
Average	**12.1**	**10.6**	**416.4**	**23.2**	**30.1**	**10.9**	**6.1**	**--**
Maximum	**16.5**	**11.5**	**650.0**	**34.0**	**46.0**	**23.0**	**7.0**	**--**
Minimum	**9.0**	**6.3**	**225.0**	**14.0**	**16.0**	**6.0**	**5.0**	**--**
L.S.D=0.05	**2.30**	**3.1**	**114.30**	**10.50**	**8.2**	**11.5**	**1.6**	**--**

The prime advantages of morphological traits are simplicity and rapid, inexpensive assays, even from herbarium specimens and other dead tissues. Although morphological traits are very useful, they have several disadvantages. They are often limited in number. They suffer from lack of decisiveness. They face heritability problems as they may be controlled by epistatic and pleiotropic gene effects. Morphological characterizations are error prone due to environmental variations affecting expression of these characteristics. In addition, these observations are time consuming and this mode of identification is slow because of long juvenile periods. Thus, these morphological characters may not adequately represent the genetic heterogeneity among cultivars of a cultivar. Hence, characterization of intravarietal heterogeneity based on morphological traits needs complementation with molecular markers as they can contribute greatly to the

utilization of intravarietal heterogeneity through descriptive information of structure of genotypes, analyses of relatedness, the study of identity and location diversity. Assessment of intracultivar diversity of mango has traditionally been made through morphological traits by several researchers such as Naik (1948); Singh *et al*. (2009), where in intracultivar variability was found. Here also, analysis of 8 quantitative fruit traits following descriptive statistics indicated significant variability in fruit morpho-physiology among 28 cultivars of mango under study. In addition, the data on 8 qualitative fruit traits also revealed considerable variation among total sample under study. Overall, morphological analysis indicated considerable variability among the mango trees grown in Egypt. However, assessment of genetic variability based on phenotype has certain limitations, since most of the morphological characters of economic importance are often limited in number; have complex inheritance and dramatically influenced by environmental factors (Tanksley, 1992). These results are suggesting both to focus our attention on the effects of the environment on the genotype and to consider, as a practical consequence, the importance of preserving these cultivars found in different areas to truly preserve the richness of the germplasm of a cultivar.

b. Molecular studies of *Mangifera indica* L.

During the current research thirteen specific markers were used (SSR and EST-PCR) to calculate the genetic variations between 28 mangos (*Mangifera indica)* cultivars. Data in Table (3) and Figure (1) for simple sequence repeat (SSR), the SSR-16 marker produced two alleles and the allele size ranged from 169 to 235 bp. The second marker SSR-19 detected also two alleles by molecular weight ranged from 137 to 173 bp, while SSR-52 and SSR-65 detect one allele with 199 and 154 bp, in respect. Finally, SSR-59 and SSR-83 recorded two alleles with the molecular weight range 145-168 and 157-183 bp, respectively. For SSR markers, the annealing temperature ranged from 52:59 ˚C. The genetic polymorphism (PIC%) ranged from 0.71 to 100% based on the different markers. The data for SSR-52 AND 65 showed 100 PIC flowered by SSR59 by 0.87, SSR19 by 0.83, SSR16 by 0.77 and finally SSR83 by 0.71%. At present, SSRs are the most preferred marker types because they are highly polymorphic even between closely related lines, require low amounts of DNA, can be easily automated and allow high throughput screening, can be exchanged between laboratories and are highly transferable between populations. SSR markers are efficient, time consuming and cost-effective approaches for diversity analysis. Molecular marker analysis is an efficient method of assessing genetic heterogeneity within the cultivars of mango and PCR-based genomic polymorphism has been detected in several cultivars of mango (Bally *et al*., 1996; De Souza and Lima, 2004; Diaz-Matallana *et al*., 2009 and Rocha *et al*., 2012). Intra cultivars study of genomes from different locations can confirm whether there are any genetic differences among the location-specific cultivars or not. In the present study with SSR markers, a total of 190 amplification fragments, ranging from 137-235 bp in length,

were detected at the two microsatellite loci validated in the cultivars. overall, larger intra cultivars variation and significant differentiation in different accession pairs was observed at several loci. SSR analysis is performed by using pairs of specific primers flanking tandem arrays of microsatellite repeats. Microsatellites are abundant in plant systems (Condit and Hubbel, 1991). The first report of length polymorphisms of microsatellites in soybean (Akkaya *et al*., 1992) opened a new source of PCR-based molecular markers for other plant genomes. Microsatellite markers are consistently found to be highly polymorphic, easily visualized, stable, and codominant (McCouch *et al.,* 1997 and Powell *et al.,* 1996). In addition, they have hyper-variability, wide genomic distribution, reproducibility, multiallelic nature, and chromosome specific location. Our results are agreeing with Manchekar (2008) who reported the level of polymorphism present in the microsatellites was variable ranging from 2 alleles (SSR-18, SSR-23 etc.) to 4 alleles (SSR-81) with an average of 2.48 alleles per SSR. The analysis of 23 SSRs revealed that the PCR product size (bp) ranged from 100 (SSR-52) to 310 (SSR20) in 31 cultivars. Polymorphic information content (PIC) value is the reflection of allele diversity and frequency among the cultivars, and varied greatly for all the SSR loci tested and these results were agreeing with our results that showed the PIC values varied widely among loci and ranged from 0.77 (SSR-16) to 100.0 (SSR-52 & 65) with an average of 86.33 per locus (Table 3). These results are in a line with Manchekar (2008) reported that the microsatellites with high PIC values in mango “Beneshan” were (SSR-80, SSR-87, SSR-28, and SSR-89) were found to be more useful in differentiating the ‘Beneshan’ cultivars. Over all, these data extend the knowledge of SSR application as a molecular tool in intravarietal improvement of mango as reported by Bally *et al*. (1996), De Souza and Lima (2004), Diaz-Matallana *et al.* (2009) and Rocha *et al*. (2012), they have used ISSR and RAPD markers for molecular characterization of intravarietal heterogeneity in different cultivars of mango. The present work provides evidence that the SSRs appear to be effective to explore the molecular polymorphism in the mango cultivars.Data in Table (4) and Figure (2) for EST markers showed that all EST markers detect one specific allele except QGMI-001 recorded three alleles with size ranged from 161 to 253 bp. The other primers showed different allele size i.g. 172, 227, 315, 240, 110 and 140 for the flowing primers: QGMI-003, QGMI-004, QGMI-005, QGMI-0010, QGMI-020 and QGMI-023, respectively. Concerning to EST-PCR markers used in our experiment as observed in Table (4) different specific genes were selected to identify he genetic diversity between 28 mangos (*Mangifera indica)* cultivars. The first one was QGMI-001 and the homology traits for this gene were short vegetative phase (controlling flowering time) or floral development. This marker produced three alleles with size range 161 to 253 bp with genetic polymorphism 0.82%; the next six markers gave just one allele and related to different homology traits such as disease resistance gene (defence response), cis epoxy carotenoid dioxygenase 5 (abscisic acid biosynthesis); stress response, WRKY40 (transcription factor); defence response, Carotenoid cleavage dioxygenase 1 (carotenoid biosynthesis), IAA-leucine resistant 3 (transcription factor) and Phytochrome-associated protein 2

(plant development). The alleles size ranged from 110 to 240 bp. Data in Table (4) showed the present and absent amplified fragments for both SSR and EST-PCR markers for 28 mangoes cultivars. Dendrogram illustrating genetic relationships of 28 mango cultivars was generated using an unweighted pair-group method with arithmetic averages (UPGMA) and Jaccard's similarity coefficient. A cluster analysis based on genetic similarity estimates is shown in Figure 3. The dendrogram constructed from the matrix of simple matching coefficients revealed two major clusters with genetic similarity 46%. The first major bifurcation in the dendrogram (Figure 3) separated the 26 cultivars into two major clusters (56%). Cluster-I divided into sub-clusters (74%) includes Shelly, Golek (100%), Succari (87%), Alphonso (82%), Piva & Princess (87%). Cluster II (65%) divided into sub-clusters includes Nam Doc Mai and Sidik in separate sub-cluster (87%), Kent (80%), Hindi Besennara, R2E2, Tommy Atkins, Naomi (88%) and the other sub-cluster (80%) includes Zebda, Fajri Kalan (87%) and Heidi, Joa, Sensation, Lilly (87%). The third sub-cluster (68%) includes Sabre, Haden and Langra Benersi (81%) and Osteen, Maya, Hindi Mloki, Palmer (87%). While Kensington Bride and Yasmina were in separate cluster (74%).

Table (3). Primers, Annealing Temperature, allele's size and polymorphic microsatellite primers used in this study

No.	Primer	Annealing Temperature(℃)	No.of alleles	Allele size range (bp)	PIC
1	SSR- 16	54	2	169-235	0.77
2	SSR- 19	54	2	137-173	0.83
3	SSR- 52	52	1	199	100.0
4	SSR- 59	59	2	145-168	0.87
5	SSR- 65	53	1	154	100.0
6	SSR -83	57	2	157-183	0.71

Table (4). Characteristics of seven EST-SSR markers screened across 28 of *M. Mangifera cultivars*

Marker	GenBank Accession No	Repeat Motif	Homology	No. Alleles	Size Range	PIC
QGMI-001	JZ532296	(CCTTT)5	(floral development)	3	161-253	100
QGMI-003	JZ532319	(CTT)6	(defence response)	1	172	0.89
QGMI-004	JZ532302	(AAG)5	(abscisic acid biosynthesis; stress response)	1	227	0.88
QGMI-005	JZ532303	(AAC)8	(defence response)	1	315	0.75
QGMI-010	JZ532309	(AGG)4	(carotenoid biosynthesis)	1	240	0.80
QGMI-020	JZ532301	(CT)7	IAA-leucine resistant 3	1	110	0.82
QGMI-0023	JZ532311	(AAC)7	Phytochrome-associated protein 2	1	140	0.77

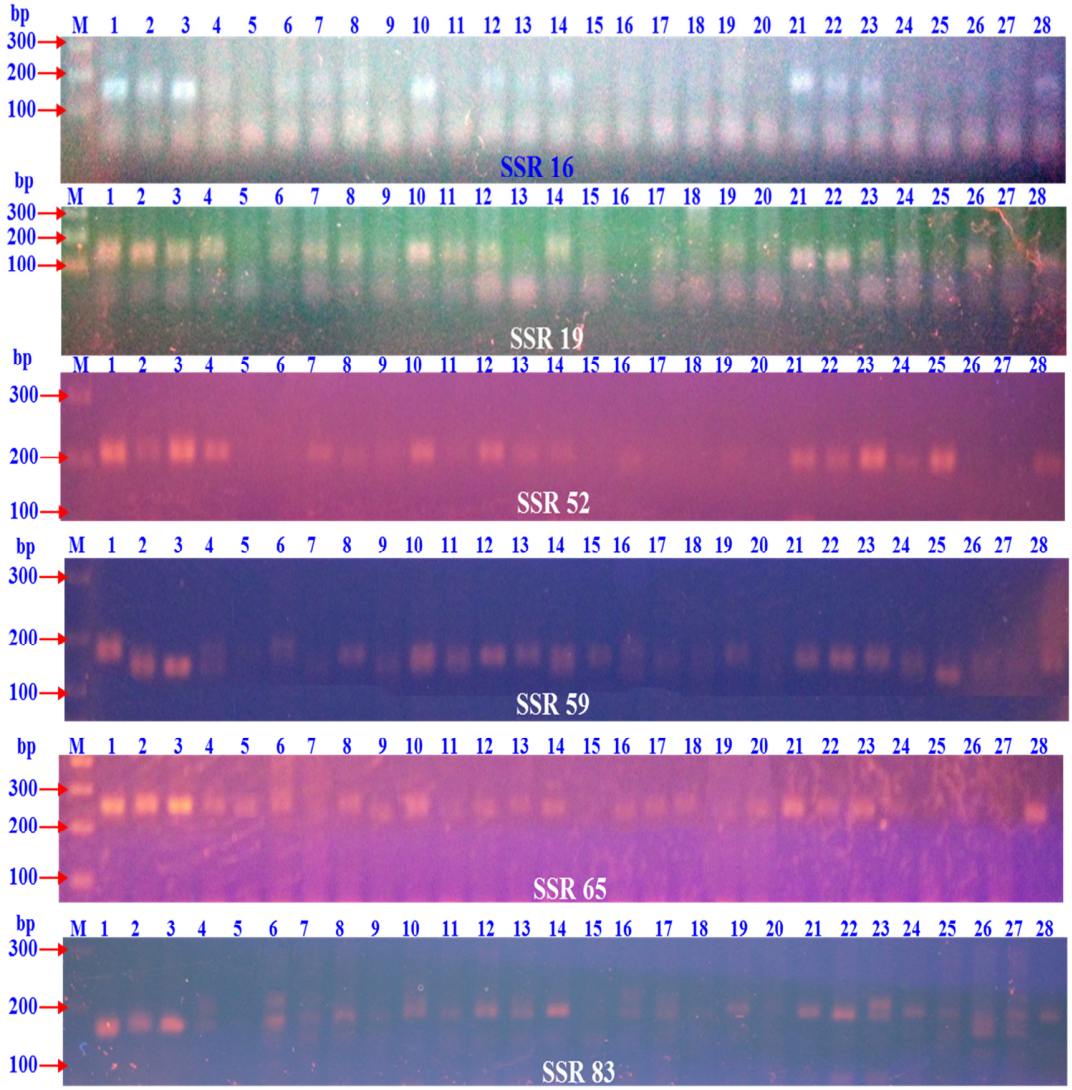

Figure (1). Amplification pattern of 28 mango cultivars generated by SSR-16, 19, 52, 59, 65 and 83 primers. M: Molecular weight marker (200 base pair DNA ladder in left).

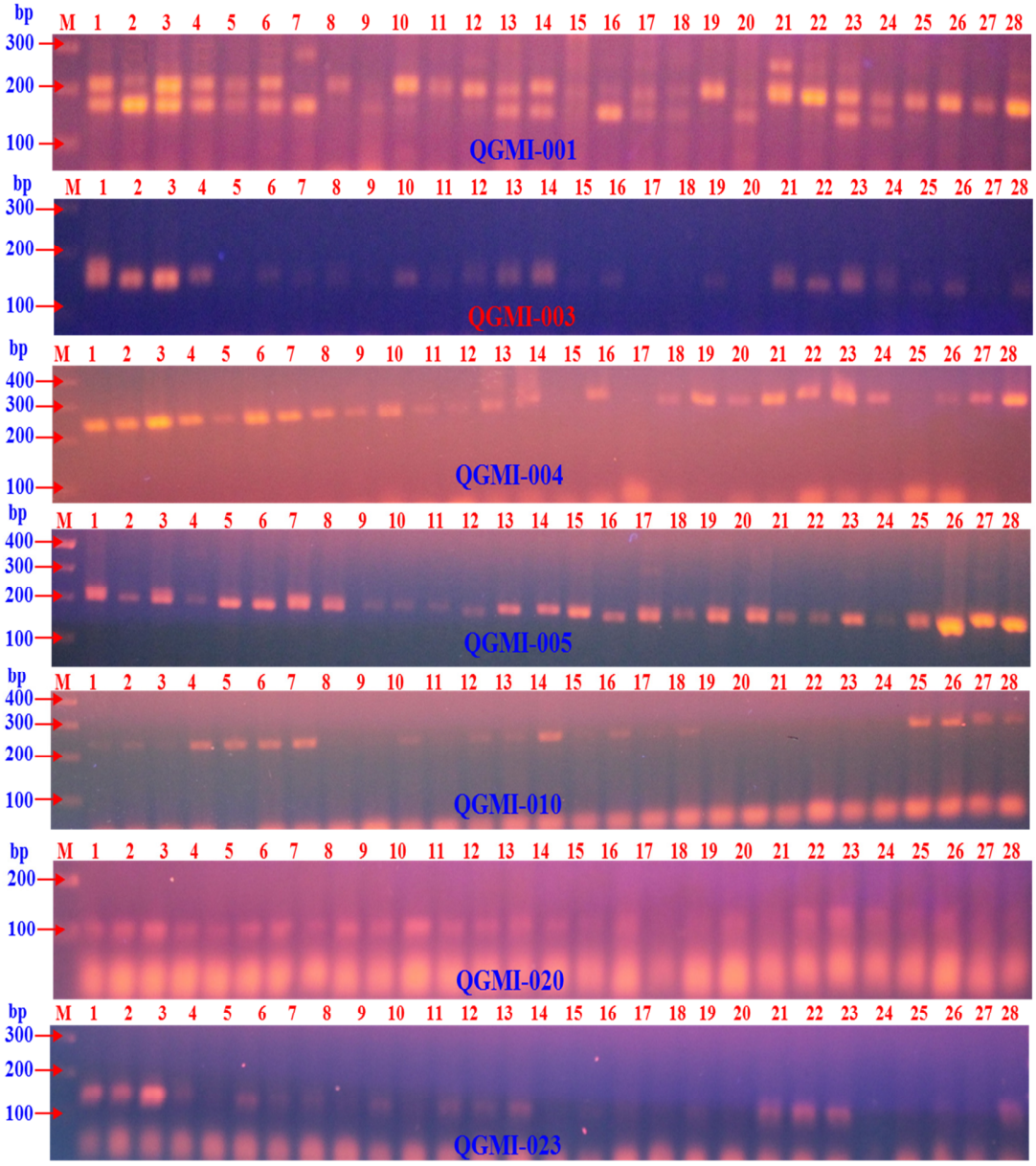

Figure (2). Amplification pattern of 28 mango cultivars generated by EST-01, 03, 04, 05, 10, 20 and 23 primers. M: Molecular weight marker (200 base pair DNA ladder in left).

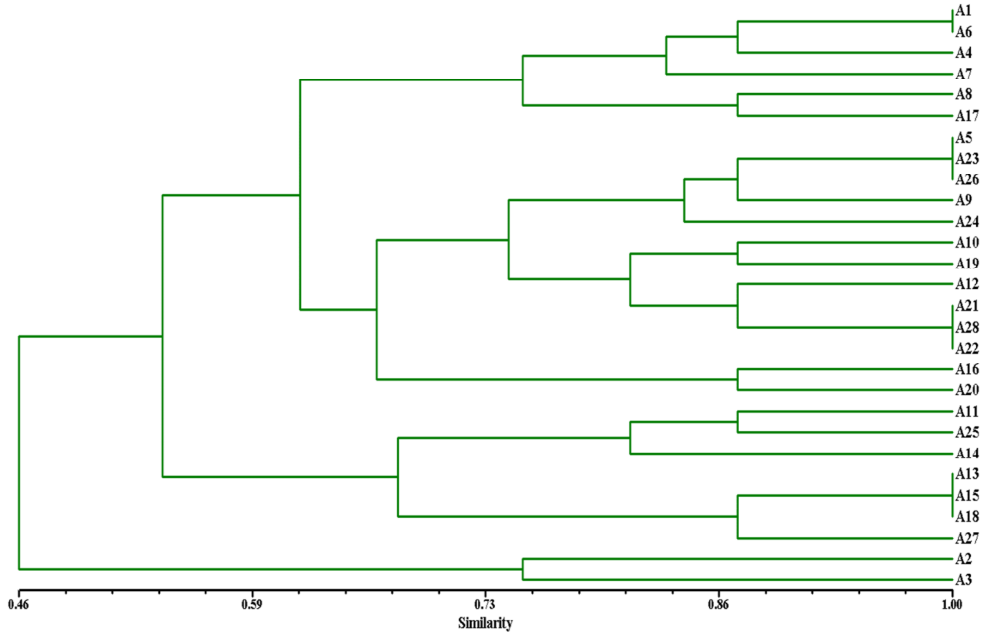

Figure (3). Dendrogram of mango cultivars obtained by UPGMA cluster analysis based on SSR and EST markers

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الملخص العربى

التوصيف الوراثى والبستانى لبعض اصناف المانجو اعتمادا على بعض الواسمات المختلفة

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تعتبر المانجو واحدة من أهم اشجار الفاكهة المنتشرة على مستوى العالم لما تتمتع بة من خصائص عالية وتقبل لدى المستهلك. وتحتوى المانجو على ٢٠ كروموسوم. فى الأونة الاخيرة إنتشرت الأنواع العديدة من المانجو المنزرعة حيث يوجد فى مصر حوالى ثمانية وعشرون نوع مانجو منزرع وذات جودة عالية وعلية كان الهدف من هذة الدراسة وهو دراسة الخصائص البستانية والجزيئية لتلك الانواع المنزرعة فى مصر بغرض إستخدامها فى برامج التربية المستقبلية. استخدمت فى هذة الدراسة ثمان صفات بستانية هامة مثل طول وعرض الثمار ووزن الثمار ونسبة اللب والقشرة وشكل الثمرة كما استخدم ثلاثة عشر واسمة متخصصة من المعلمات المتخصصة وهى SSR & EST لتوضيح مدى التقارب والبعد الوراثى بين تلك الانواع المستخدمة. اوضحت النتائج ان هناك اختلاف معنوى واضح بين تلك الأنواع موضوع الدراسة اعتمادا على خصائصها البستانية كما اظهرت النتائج ان هناك تعدد فى الاشكال المظهرية اعتمادا على معلمات تكرار التراكيب البسيطة والمتخصصة تراوحت من ٧١.٠ الى ١٠٠ %.

الكلمات الدالة: المانجو – الخصائص البستانية – التنوع الوراثى- البصمة الوراثية- الواسمات المتخصصة.

Land Suitability Assessment for Crop Production in Banger Elsoker Region of Egypt

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ABSTRACT: Land evaluation is the process of assessing the possible uses of land for different purposes. Land suitability analysis is a method of land evaluation, which measures the degree of appropriateness of land for a certain use. The present study is a quantitative evaluation of land to determine land suitability in Banger Elsokar district for different crop cultivations based on some pedological variables, as soil salinity, soil depth, soil reaction (pH), calcium carbonate and soil texture that are mandatory input factors for crop cultivation. The studied area was classified on the basis of their capability to the classes C2, C3 and C4. The quantitative approach given by FAO (1976) has been used also to classify the area on the basis of their capability to good capability (5700.2 hectares), poor capability (500.62 hectares) and very poor capability (443.77 hectares). Classifying the land on the basis of their suitability , the ranked classes were S1, S2, S3, S4, NS1 and NS2. This study proposes an integrated methodology for analyzing and mapping of land suitability using the Remote Sensing and GIS techniques. The result indicated that the demarcated areas as highly suitable for crops cultivation were 3785.52 hectares for sunflower, 6635.25 hectares for wheat, 6336.19 hectares for tomato, 6200.82 hectares for watermelon, 2581.24 hectares for olive, 3785.52 hectares for grape and 2196.04 hectares for apple.

Keywords: Land Evaluation, Land suitability, Land Capability, GIS, Overlap

INTRODUCTION

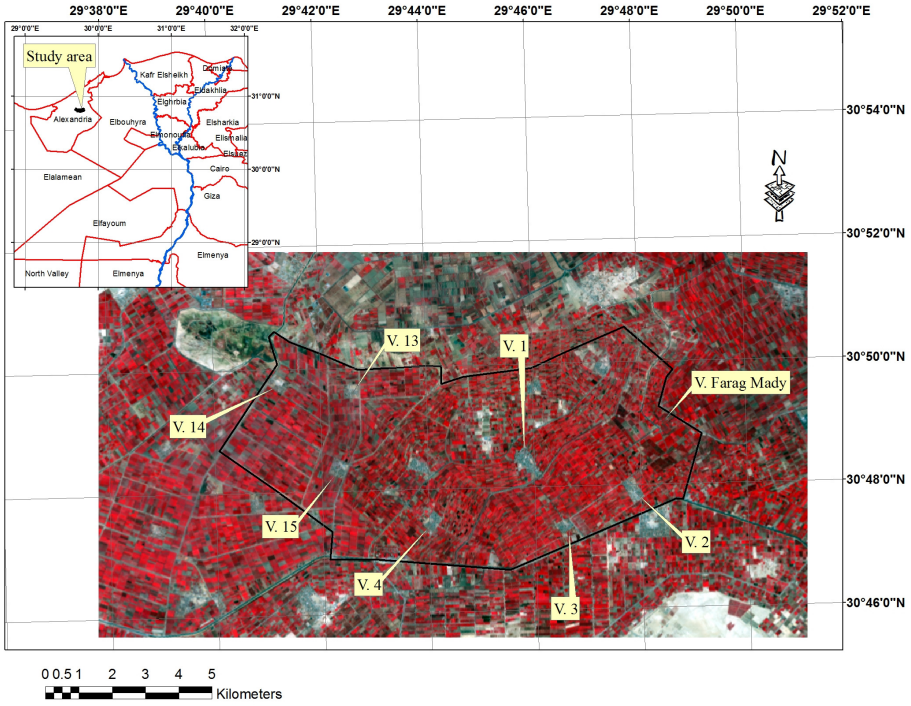
The population of the planet is growing dramatically. However, the potential of the land for crop production to satisfy the demand of the ever increasing population is declining as the result of sever soil degradation. Empirical studies indicate that severe degradation of soils' productive capacity has occurred on over 10% of the Earth's vegetated land as a result of soil erosion, excessive tillage, and overgrazing etc. (Lal, 1994). Considering the rapid growth of the world's population, which is in its turn a limiting factor to the arable lands around the world, the need for effective and efficient application of the croplands have been felt more than ever (Teklu, 2005; Behzad *et al*., 2009). Hence, much attention is given to selection of crop which suits an area the best. The concept of sustainable agriculture involves producing quality crops in an environmentally friendly, socially acceptable and economically feasible way (Addeo *et al*., 2001). Suitability is a measure of how well the qualities of a land unit match the requirements of a particular form of land use (FAO, 1976). The FAO defined that, the suitability is a function of crop requirements and land characteristics and it is a measure of how will the qualities of a land unit match the requirements of a particular form of land use (FAO, 1976). In Egypt, Banger Elsokar region has considerable potential for agriculture activities. Generally, the soil of this region suffers from physical, chemical and fertility implications so land evaluation effort should be done.

The aim of this study was to depict the spatial variability of some soil properties and to evaluate the land capability and suitability for selecting the proper cropping pattern for the different crops commonly grown in the area to overcome the major pedological constraints.

MATERIALS AND METHODS

Study Area

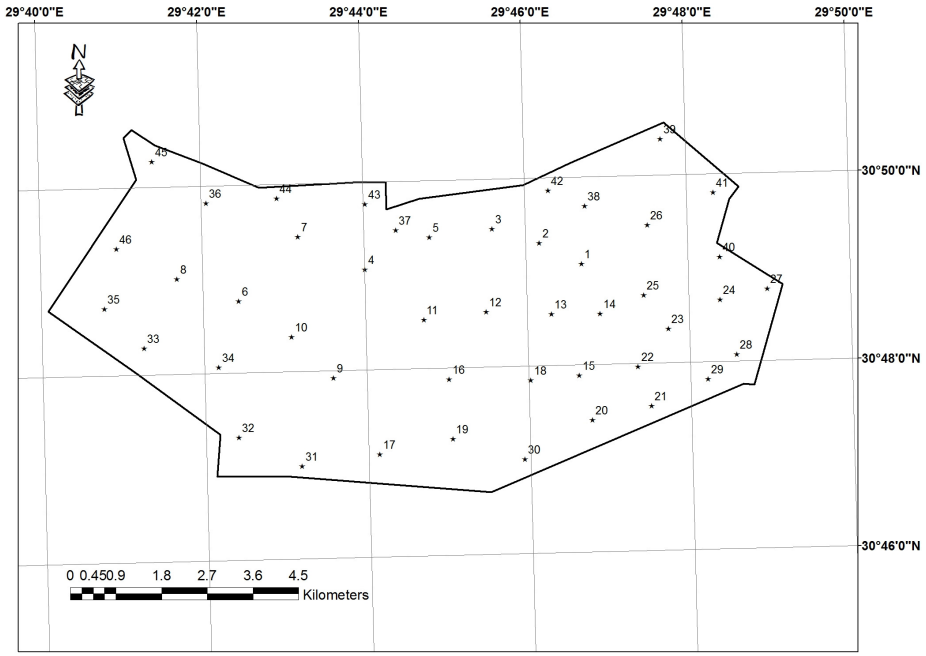
The study area is located between latitudes 30° 46 \ 30 \\ and 30° 50 \ 45 \\ N and longitudes 29° 40 \ 15 \\ and 29° 49 \ 15 \\ E covering area of 7074.34 hectare (16906.86 acres) (map1). The study area includes Bangar El-Sokar Districts, Behira Governorate, Egypt.



Map (1). General location of the study area boundary on the rectified ETM+ Landsat image (2015).

Field and Laboratory work

To characterize the land units for the study area, forty six auger samples were dug using Grid system to cover the area. The location of their augers is shown in map (2).



Map (2). Soil auger samples distribution at study area districts

The soil samples was taken from surface and subsurface layer as wel were air dried and greatly reused with a wooden pestle, sieved though 2 mm sieves and then subjected to laboratory analysis. The soil chemical and physical analysis were carried out according to the methods described in (Page *et al.*, 1982). The tested soil properties were presented in Table(1). Water samples were analyzed in order to characterize the water quality.

Satellite Image

A window of Land sat 8 ETM+ (Enhanced Thematic Mapper plus) image acquired in may. 2015 was selected to represent the study area as shown in map (1).

***Image Registration**

Image registration is the first step to be carried out before proceeding to any further image processing. This step will assign coordinate systems to the image and linked it to its location on the ground. The ETM+ image captured in May. 2015 was geometrically rectified to the digitized topographic maps using image-to-map procedure in ENVI 4.8 software (ENVI, 2008).

***Resolution Merge**

This dialog enables you to integrate imagery of different spatial resolutions (pixel size). Since higher resolution imagery is generally single band (ETM^+ Panchromatic 15 m data), while multispectral imagery generally has the lower resolutions (ETM^+ 30 m). These techniques are often used to produce high resolution, multispectral imagery. This improves the interpretability of the data by having high resolution information which is also in color. Resolution Merge offers three techniques: Multiplicative, Principal Components, and Brovey Transform (ERDAS, 2008).

***Generation of DEM**

The digitized contour lines and spot heights were utilized by Contour Gridder extension to generate the Digital Elevation Model (DEM) within ArcGIS 10.3 environment. The Digital Elevation Model (DEM) is analyzed to generate the degree of slope classes and Aspect.

Descriptive statistical parameters

Minimum, maximum, mean, standard deviation and coefficient of variance were calculated using SPSS software Ver. 12 (2003).

Building up Digital Georeference Database

Data input process is the operation of entering the spatial and non-spatial data into GIS using Arc-GIS 10.3 software. Each soil observation was geo-referenced using the Global Position Systems (GPS) and digitized. The different soil attributes were coded, and new fields were added to the profile database file in Arc/View software. Surface interpolate grid were done for soil salinity, Soil depth, $CaCO_3$ % using module Arc Scripts in ArcGIS 10.3 (ESRI, 2014).

Land evaluation

Land capability and suitability evaluation have been done using ALES-Arid as shown in Fig (1) (Abd El-Kawy *et al*., 2010).

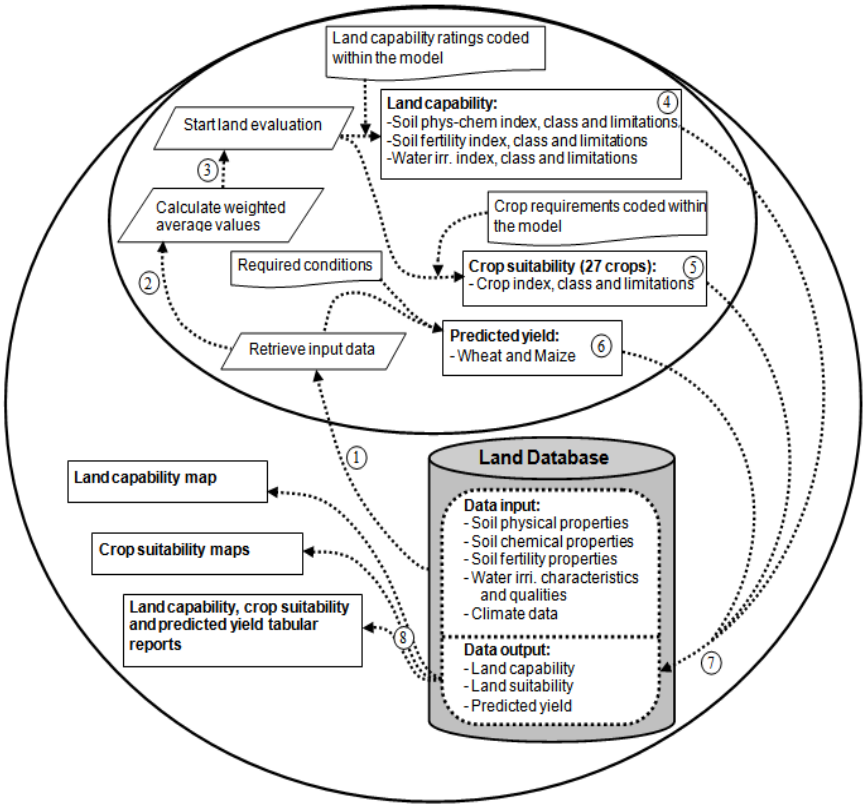


Fig. (1). The structure of ALES arid-GIS. The inner circle shows the model steps (the land evaluation processes) and the outer circle represents the GIS framework (ArcMap platforom).

RESULTS AND DISCUSSION

Characterization of the studied soil profiles attributes

Table (1 and 2) indicates the statistical parameters of the soil profiles for the different soil horizons. The soil depth ranged from 40 cm to 120 cm with median value about 70 cm. The coefficient of variation of the soil depth (0.30) shows that the soil depth was homogeneous in study area. Soil salinity ranged from 0.68 to 14.32 and 0.24 to 5.82 dS/m at surface and sub-surface layer with median 1.46 and 1.48. On the other hand, the coefficient of variation was less in homogeneity for surface soil salinity and sub-surface layer (1.04, 0.56). The homogeneity properties were observed with sand%, clay%, $CaCO_3$ % (0.12, 0.23, 0.16), for surface layer and (0.20, 0.37, 0.17) for sub surface layer, respectively. Other less homogeneity was observed for silt (0.94 and 0.79) for surface and sub-surface respectively.

Table (1). Statistical parameters of soil depth

Properties	Min	Max.	Range	Median	S.E.	S.D.	Var	CV
Soil depth,cm	40	120	80	70	3.495	23.702	561.8	0.30

Table (2). Characteristics and the main statistical parameters of soil profiles samples of the study area

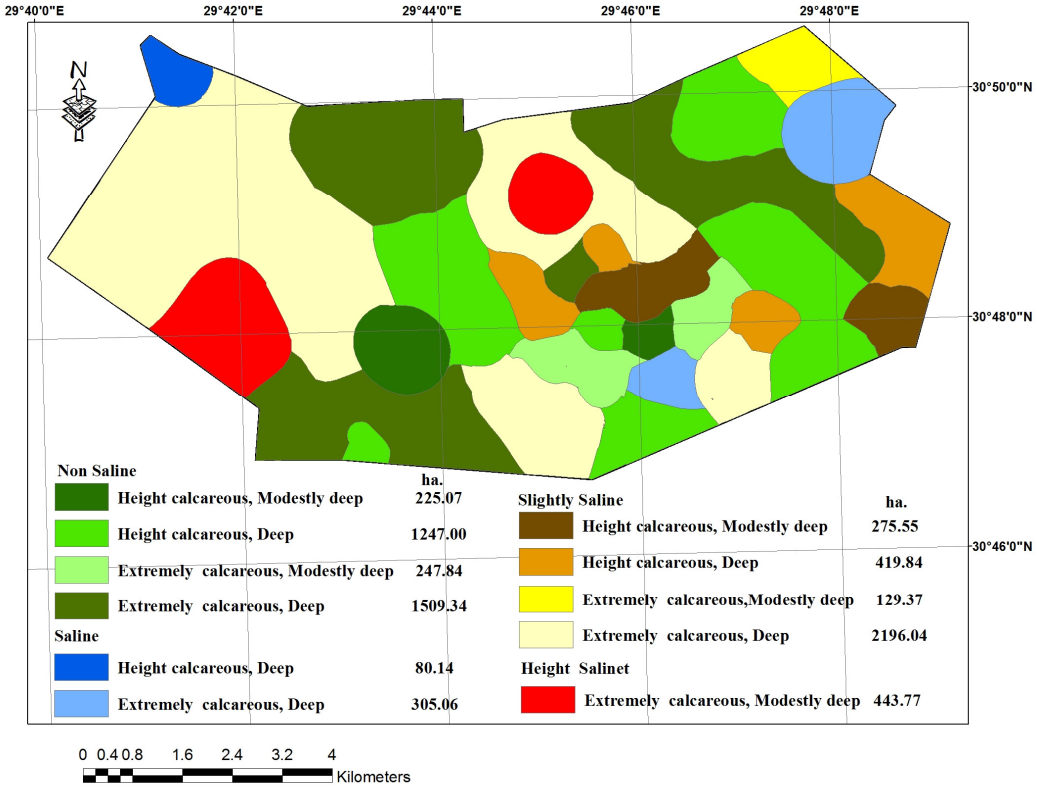
	min	Max	Range	Median	S.E	S.D.	Var.	C.V
Surface layer (0 - 30)								
pH	7.23	8.53	1.30	8.00	0.05	0.34	0.12	0.04
EC, dS/m	0.68	14.32	13.64	1.46	0.36	2.47	6.08	1.04
Ca, meq/l	1.00	20.20	19.20	4.00	0.70	4.76	22.64	0.92
Mg, meq/l	0.70	22.00	21.30	7.00	0.76	5.13	26.31	0.74
Na, meq/l	2.30	125.00	122.70	8.10	2.78	18.83	354.63	1.50
K, meq/l	0.43	6.90	6.47	1.10	0.26	1.75	3.06	0.81
HCO_3, meq/l	1.00	3.00	2.00	2.00	0.08	0.57	0.32	0.34
Cl, meq/l	1.50	34.10	32.60	3.85	0.90	6.08	36.94	1.07
SO_4, meq/l	2.00	110.30	108.30	14.63	2.70	18.30	334.80	0.94
SAR	1.24	44.33	43.09	4.12	0.94	6.39	40.86	1.15
$CaCO_3$, %	20.50	44.00	23.50	30.00	0.73	4.97	24.74	0.16
Clay, %	14.10	36.60	22.50	22.20	0.78	5.30	28.12	0.23
Silt, %	0.50	32.38	31.88	5.50	0.92	6.24	38.94	0.94
Sand, %	45.52	84.80	39.28	71.90	1.25	8.50	72.24	0.12
Sub Surface layer (30 - 60)								
pH	7.56	8.60	1.04	8.05	0.04	0.28	0.08	0.04
EC, dS / m	0.24	5.82	5.58	1.48	0.15	1.00	0.99	0.56
Ca, meq/l	1.20	13.00	11.80	6.00	0.42	2.85	8.11	0.45
Mg, meq/l	0.60	9.00	8.40	2.70	0.26	1.74	3.04	0.65
Na, meq/l	1.65	16.90	15.25	3.39	0.58	3.93	15.45	0.71
K, meq/l	0.28	6.10	5.82	0.78	0.23	1.53	2.35	0.89
HCO_3,meq/l	1.00	3.00	2.00	1.10	0.07	0.45	0.20	0.35
Cl, meq/l	1.00	10.10	9.10	2.00	0.42	2.82	7.94	0.80
SO_4, meq/l	5.40	21.80	16.40	10.65	0.64	4.31	18.56	0.38
SAR	0.64	8.02	7.38	1.60	0.33	2.22	4.91	0.76
$CaCO_3$, %	20.50	45.50	25.00	34.60	0.86	5.82	33.90	0.17
Clay, %	10.00	55.60	45.60	24.60	1.58	10.74	115.42	0.37
Silt, %	0.50	28.30	27.80	5.50	1.01	6.84	46.79	0.79
Sand, %	38.80	80.40	41.60	61.65	1.84	12.46	155.21	0.20

Soil mapping units of the study area were extracted from the overlay of the main soil properties in the Arc-GIS 10.3 such as soil depth, soil salinity and total calcium carbonate Eleven soil units were identified in the studied area as shown in Map (3) and Table (3) included the area in hectars percentage of each soil unit.

Soil units of the studied area

The soils were classified into main four soil units and eleven sub-units based on the diagnostic horizons and variability , soil salinity, calcium carbonate content , soil texture, and profile depth as:

1- Non Saline soil unit was 45.62% and Salin soil unit was 5.44 % of the studied area.
2- Extremely calcareous, Deep soil sub-unit ewas (2196.04 ha) 31.02% and Highly calcareous, Deep soil sub-unit was (80.14 ha) 1.13% as shown in Table (3) and Map (3).

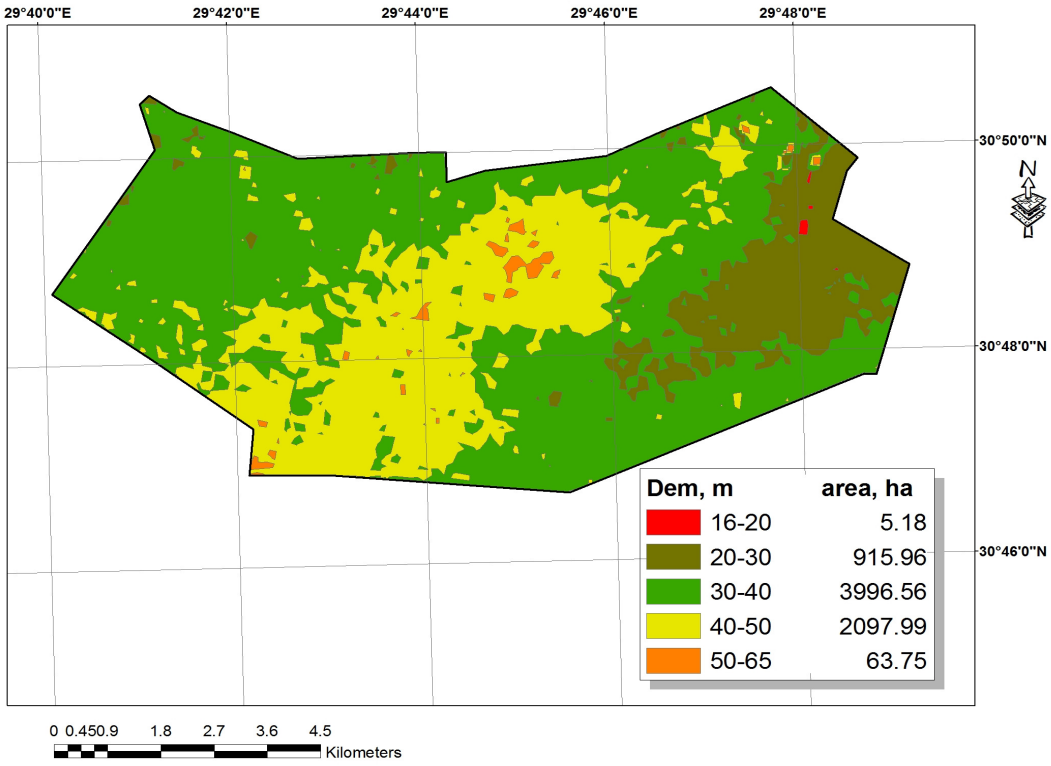


Map (3). Soil mapping units distribution in the study area

Table (3). Soil units of the studied area

Code	Description	Area (hectares)	%
	Non Saline		
1101	Highly calcareous, Modestly deep	225.071	3.18
1102	Highly calcareous, Deep	1247.00	17.62
2101	Extremely calcareous, Deep	1509.34	21.32
2102	Extremely calcareous, Modestly deep	247.84	3.50
Total		3229.251	45.62
	Slightly Saline		
1201	Highly calcareous, Modestly deep	275.55	3.89
1202	Highly calcareous, Deep	419.84	5.93
2201	Extremely calcareous, Modestly deep	129.37	1.83
2202	Extremely calcareous, Deep	2196.04	31.02
Total		3020.8	42.67
	Saline		
1302	Highly calcareous, Deep	80.14	1.13
2302	Extremely calcareous, Deep	305.06	4.31
Total		690.26	5.44
	Highly Saline		
2401	Extremely calcareous, Modestly deep	443.77	6.27

The analysis of Digital Elevation Model (DEM) indicated that the elevations ranged between > 16 m A.S.L. to < 65 m A.S.L. The main elevation from 30 m A.S.L.to 50 m A.S.L. covers an area about of 6094.55 hactares as shown in Map (4).



Map (4). Digital Elevation Model (DEM) of study area.

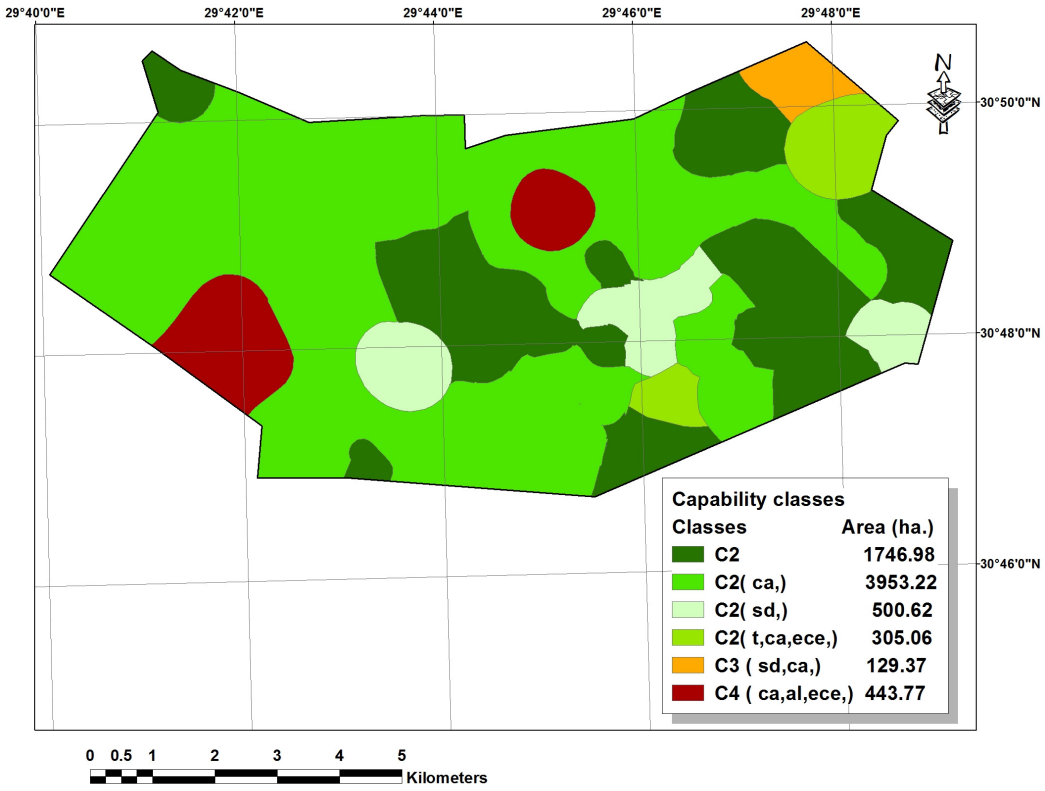
Land capability classes

The ALES Model (Applied Land Evaluation System) provides prediction for general land use capability for a broad series of possible uses. Indicating the limiting factors on the covering area. Map (5) shows the distribution of each land use capability class in the studied area. According to the model prediction, most of the study area was classified as (C2 , C2 (ca)), which indicated good capability with high calcium carbonate percentage as limiting factor which covered about 5700.2 hectares, followed by (C2 (sd)), which indicated very good capability with soil depth class as limiting factor which covered about 500.62 hectares. On the other hand, 443.77 hectares belongs to (C4 (ca, al, ece)), which indicated poor capability with high calcium carbonate percentage, alkalinity and soil salinity as limiting factor.

Land suitability classes for specific land uses

The ALES model was used to predict soil suitability for some common crops cultivated in the study area including: wheat, maize, alfalfa, fababean, onion, tomato, banana, citrus, fig and watermelon. Data of soil suitability class and sub class are presented in the maps (6, 7, 8, 9, 10, 11, 12 and 13) and Table (4) which indicates the distribution of suggested cultivated crops for each soil units in the studied area.

The suitability maps have been proposed acceding to five suitability categories namely; S1, S2, S3, S4 and Ns. From the obtained maps for the different crops, the obtained results can be summarized on follows:



Map (5). Land capability classes for the studied area.

a. field crops:

1-Suitability classes of sunflower were S1(3785.52 ha) (53.38%) and S3(443.77 ha)(6.27%).

2-Suitability classes of wheat were S1(1247.0) (17.62%), S1(t) (5388.25) (76.12%),and S2(ece,t) (433.70 ha) (6.13%).

b. vegetable:

1- Suitability classes of tomato were S1(6330.19 ha) (89.42%), S2 ece (305.06 ha) (4.31%) and S4 (ece, Ca), (443.77 ha) (6.27%).

2- Suitability classes of Watermelon were S1 (6200.82 ha) (87.59%), S2 (129.37 ha) (1.83%), S2(ece)(305.06 ha) (4.31%) and S4(ece)(443.77 ha) (6.27%).

c. Fruit trees:

1- Suitability classes of Banana were S3(t, Ca) (2276.18 ha) (32.15%), S3 (t, Ca, sd) (1509.34 ha) (21.32%), S4 (ece, t, Ca) (305.06 ha) (4.31%), Ns2 (sd) (2544.67 ha) (35.95%) and Ns2(sd, Ca) (443.77 ha) (6.27%).

2- Olive suitability classes were S1 (2581.24 ha) (36.46%), S1 (sd) (1509.34 ha) (21.32%), S4 (ece, sd) (443.77 ha) (6.27%) and Ns2 (sd) (2544.67 ha) (35.95%).

3- Grape Suitability classes were S1 (3785.52 ha) (53.48%), S2 (sd) (1914.68 ha) (27.05%), S2 (ece) (305.06 ha) (4.33%) and Ns2 (1073.76 ha) (15.17%).

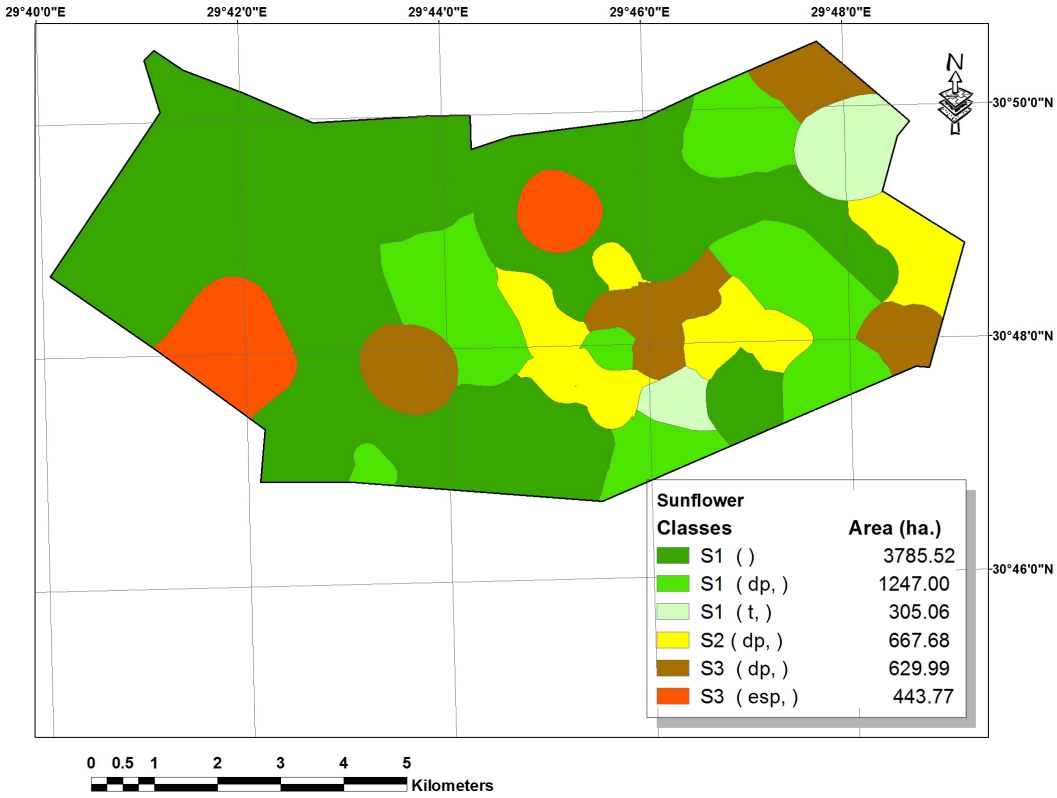
4- Suitability classes of Apple were S1 (2196.04 ha) (31.02%), S2 (80.14 ha) (1.13%), S2 (ece) (305.06 ha) (4.31%) and Ns2 (sd) (2988.44 ha) (42.22%).

Table (4). Land suitability classes for specific uses

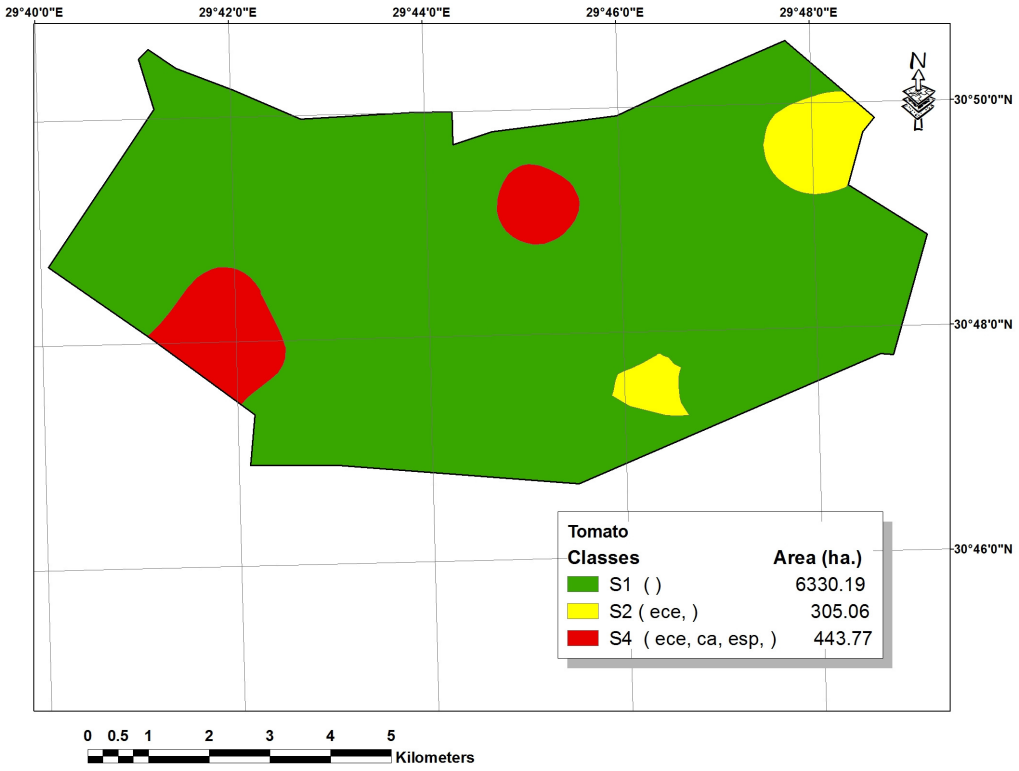
units code	1101	1102	2101	2102	1201	1202	2201	2202	1302	2302	2401
soil _Class	C2(sd)	C2	C2(ca)	C2(ca)	C2(sd)	C2	C3(sd,ca)	C2(ca)	C2	C2(t,ca,ece)	C4(ca,al,ece)
Wheat	S1(t)	S1	S1(t)	S1(t)	S(t)	S1(t)	S1(t)	S1(t)	S1(t)	S1(t)	S2(ece, t)
Barley	S1(t)	S1	S1(t)	S1(t)	S1(t)	S1(t)	S1(t)	S1(t)	S1(t)	S2(t)	S2(t)
Faba_bean	S2	S1	S2	S1	S2	S2	S2	S1	S2(ece)	S3(ece,t)	S4(ece)
Sugarbeat	S1	S1	S1	S1	S1	S1	S1	S1	S1	S2(t)	S3
Sunflower	S3(sd)	S1(sd)	S2(sd)	S1	S3(sd)	S2(sd)	S3(sd)	S1	S1	S1(t)	S2(sd)
Rice	S1(t)	S1	S1(t)	S1(t)	S1(t)	S1(t)	S1(t)	S1(t)	S1(t)	NS2(t)	S3(ece,t)
Maize	S1	S1	S1	S1	S1	S1	S2	S1	S1	S2(ece,t)	S4(ece)
Soyabean	S3(sd)	S2(sd)	S2(sd)	S2	S3(sd)	S2(sd)	S3(sd)	S1	S2(ece)	S3(ece,t)	S4(ece,sd)
Peanut	S3(ca)	S3(ca)	S3(ca)	S3(ca)	S3(ca)	S3(ca)	S3(ca)	S3(ca)	S3(ca)	S4(ece,ca)	S4(ece,ca)
Cotton	S3(sd)	S1(sd)	S2(sd)	S1	S3(sd)	S2(sd)	S3(sd)	S1	S1	S2(t)	S3(sd)
Sugarcane	S3(sd,t)	S2(sd)	S2(sd,t)	S2(t)	S3(sd,t)	S2(sd,t)	S3(sd,t)	S1(t)	S1(t)	S2(t)	S3(ece,sd,t)
Citrus	NS2(sd,ca)	NS2(sd,ca)	NS2(sd, ca)	NS2(ca)	NS2(sd,ca)	NS2(sd,ca)	NS2(sd,ca)	NS2(ca)	NS2(ca)	NS2(ca)	NS2(sd,ca)
Banana	NS2(sd)	NS2(sd)	NS2(sd)	S3(sd,t,ca)	NS2(sd)	NS2(sd)	NS2(sd)	S3(t,ca)	S3(t,ca)	S4(ece,t,ca)	NS2(sd)
Grape	NS2(sd)	S2(sd)	S2(sd)	S1	NS2(sd)	S2(sd)	NS2(sd)	S1	S1	S2(ece)	S4(ece, sd)
Olive	NS2(sd)	NS2(sd)	NS2(sd)	S1(sd)	NS2(sd)	NS2(sd)	NS2(sd)	S1	S1	S1	NS2(sd)
Apple	NS2(sd)	NS2(sd)	NS2(sd)	S2(sd)	NS2(sd)	NS2(sd)	NS2(sd)	S1	S2	S3(ece,t)	NS2(sd)
Pear	NS2(sd)	NS2(sd)	NS2(sd)	S2(sd,t)	NS2(sd)	NS2(sd)	NS2(sd)	S2(t)	S2(t)	S3(ece,t)	NS2(sd)
Fig	NS2(sd)	NS2(sd)	NS2(sd)	S1(sd)	NS2(sd)	NS2(sd)	NS2(sd)	S1	S1	S1	NS2(sd)
Date_palm	NS2(sd)	NS2(sd)	NS2(sd)	S1(sd)	NS2(sd)	NS2(sd)	NS2(sd)	S1	S1	S1	NS2(sd)
Onion	S1	S1	S2	S1	S1	S2	S2	S1	S2(ece)	S3(ece,t)	S3(ece)
Cabbage	S1	S1	S1	S1	S1	S1	S2	S1	S1	S2(ece,t)	S3(ece)
Pea	S2	S1	S2	S1	S2	S2	S2	S1	S2(ece)	S3(ece,t)	S3(ece)
Potato	S3(ca)	S3(ca)	S3(ca)	S3(ca)	S3(ca)	S3(ca)	S3(ca)	S3(ca)	S3(ca)	S3(ece,ca)	S4(ece,ca)
Tomato	S1	S1	S1	S1	S1	S1	S1	S1	S1	S2(ece)	S3(ece)
Pepper	S1	S1	S1	S1	S1	S1	S1	S1	S1	S2(ece)	S4(ece)
Watermelon	S1	S1	S1	S1	S1	S1	S2	S1	S1	S2(ece)	S4(ece)
Alfalfa	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S2(ece)
Sorghum	S1	S1	S1	S1	S1	S1	S2	S1	S1	S2(t)	S4(ece)

(Classes): C1= Excellent, **C2**=Good, **C3**=Fair, **C4**=poor, **C5**=Very Poor, **C6**=Non-agriculture. **S1**=Highly suitable, **S2**=Moderately suitable, **S3**=Marginally suitable, **S4**=Conditionally suitable. **NS1**=Potentially suitable, **NS2**= Actually unsuitable.

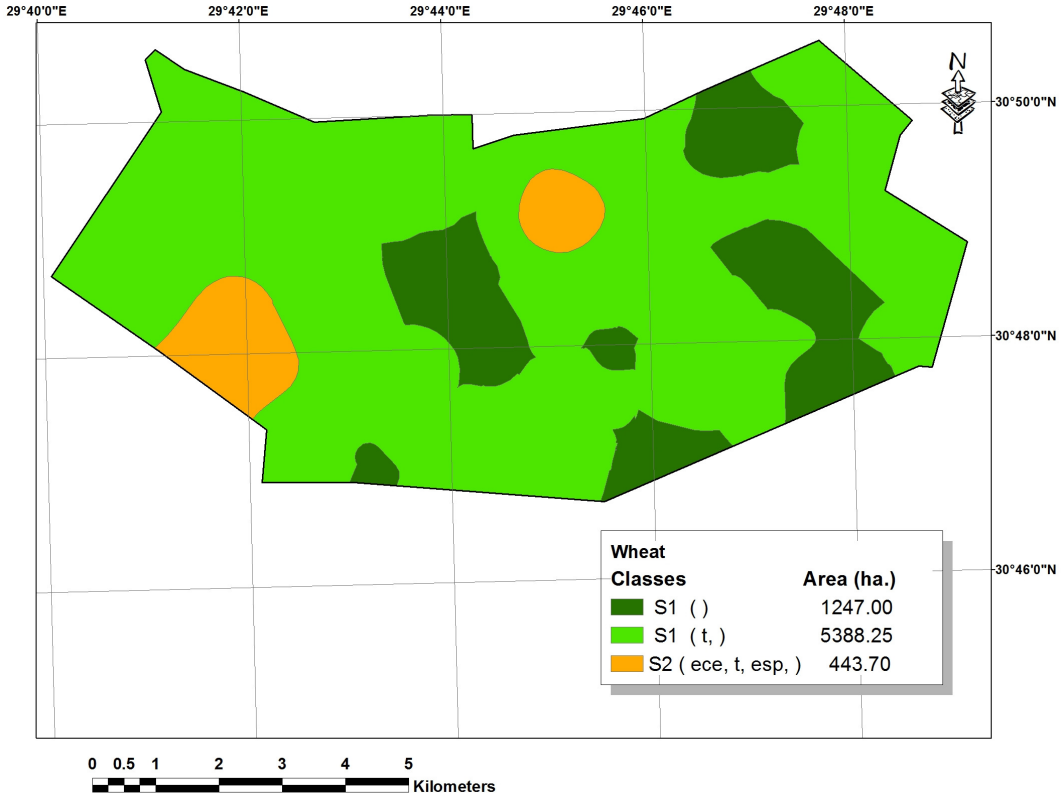
(Soil Sub Classes): t = Clay, **sd**= soil depth, **ca**= $CaCo_3$, **ece** = Soil salinity.



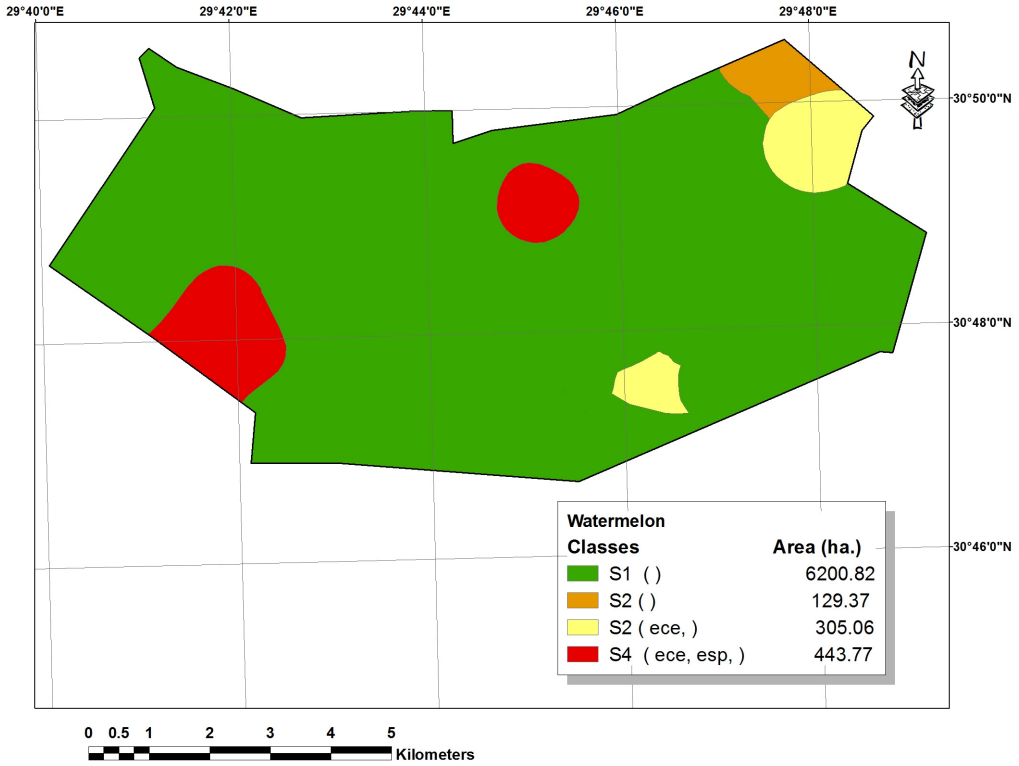
Map(6). land suitability for sunflower.



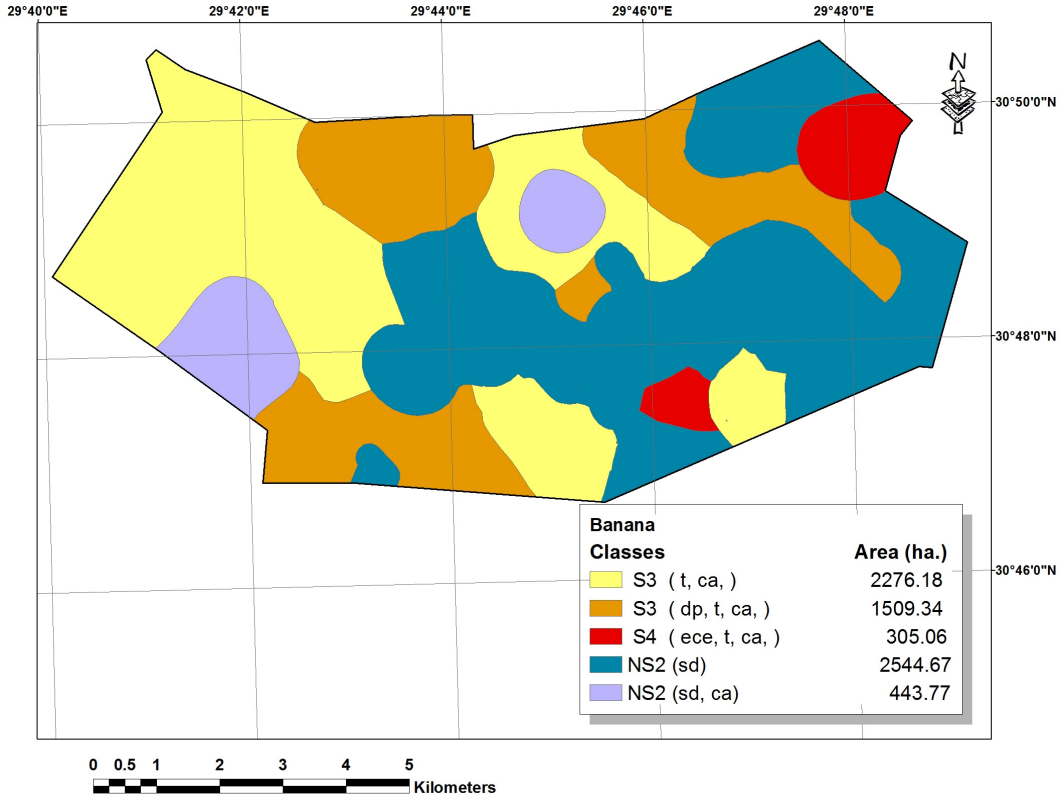
Map(7). land suitability for Tomato.



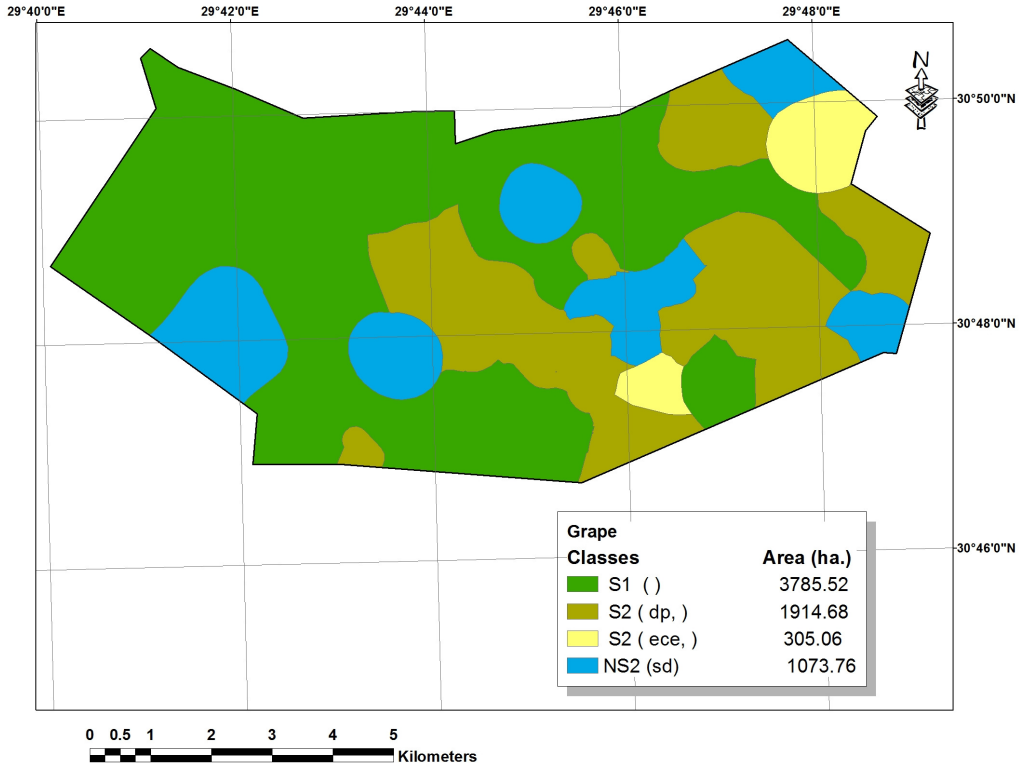
Map(8). land suitability for Wheat



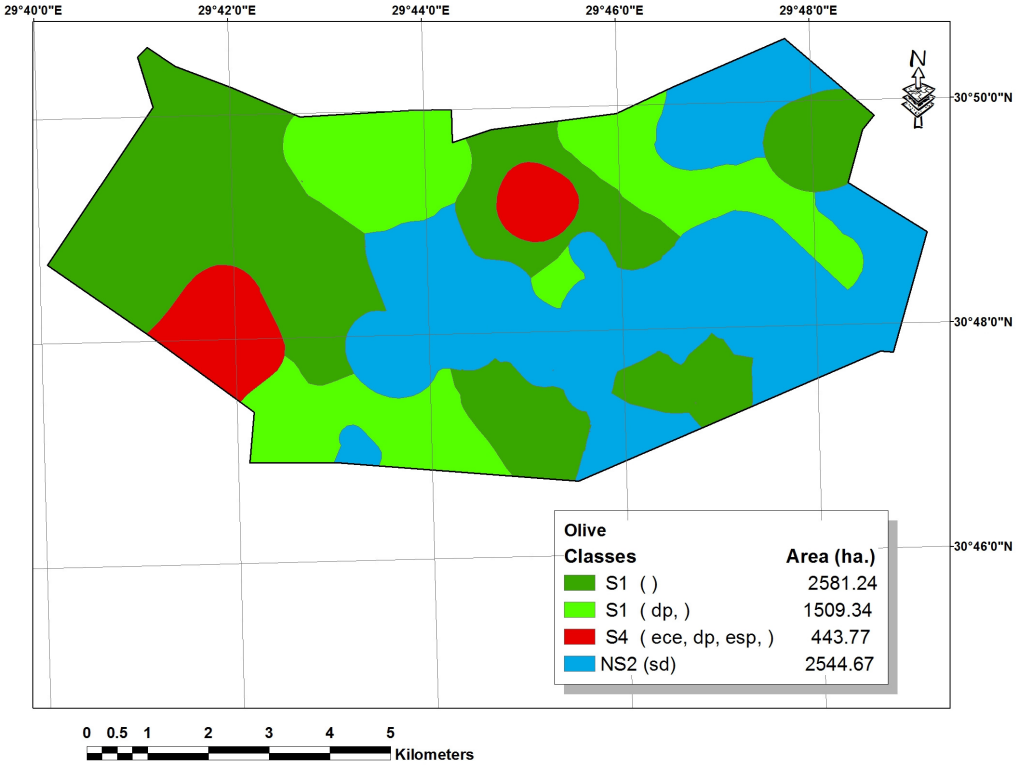
Map(9). land suitability for Watermelon



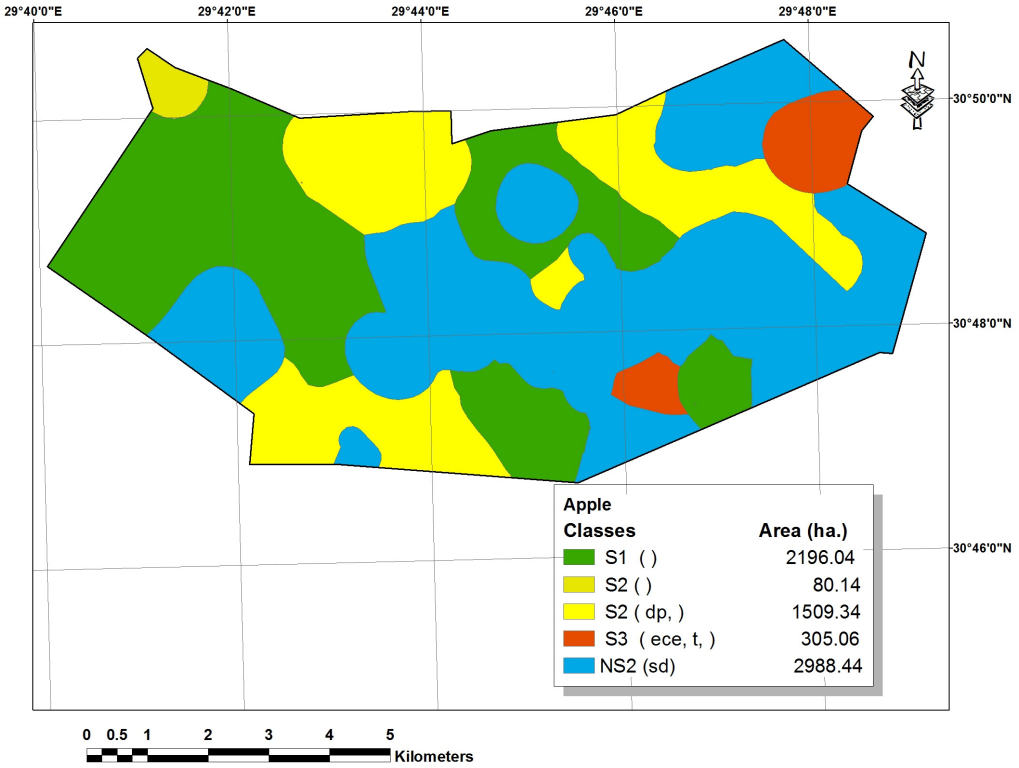
Map (10). land suitability for Banana



Map(11). land suitability for Grape



Map (12). Land suitability for Olive



Map(13). land suitability for Apple

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الملخص العربي

تقييم ملاءمة الأراضي لإنتاج المحاصيل في منطقة بنجر السكر بمصر

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**مختبر بحوث الأراضي الملحية والقلوية – معهد الأراضي والمياه والبيئة بمركز البحوث الزراعية

أجريت هذه الدراسة الحقلية في منطقة بنجر السكر الواقعة في جنوب غرب محافظة الاسكندرية، وعلى بعد ٧٠ كم تقريبا. تهدف هذه الدراسة الى انشاء قاعدة بيانات جغرافية رقمية مسجلة لأراضي المنطقة وحفظ هذه البيانات في الحاسب الالي ثم اجراء تقييم خواص وصفات الارض وذلك للمساعدة في اختيار انسب انواع المحاصيل التي يمكن زراعتها في منطقة الدراسة. وتقييم الأرض هي عملية تقييم الاستخدامات الممكنة من الأراضي لأغراض مختلفة. تحليل ملاءمة الأرض هو وسيلة لتقييم الأراضي، والذي يحدد درجة ملاءمة الأرض لاستخدام معين. هذه الدراسة هي تقييم نوعي للأرض لتحديد مدى صلاحية الأراضي لزراعة المحاصيل المختلفة التي تزرع عادة من قبل المزارعيين في منطقة بنجر السكر. استنادا إلى بعض المتغيرات والعوامل المتعلقة بالتربة مثل ملوحة التربة، وعمق التربة (sd)، درجة تفاعل التربة (pH)، وكربونات الكالسيوم (Ca) وقوام التربة (t) وهي عوامل مساهمة ضرورية لزراعة المحاصيل. وقد صنفت منطقة الدراسة على أساس قدرتها للانتاج الزراعي الى (C4, C3, C2). تم إعداد تقييم الأراضي وفقا لمبادئ تقييم الأرضي حسب منظمة الأغذية والزراعة (١٩٧٦). أيضا لتصنيف المنطقة على أساس قدرتها على أنتاج المحاصيل فكانت قدرة أنتاجها جيدة (٥٧٠٠,٢ هكتار)، ومتوسطة القدرة الأنتاجية (٥٠٠,٦٢ هكتار)، وقدرة انتاجية فقيرة (٤٤٣,٧٧ هكتار).وتم تصنيف الأراضي على أساس مدى ملاءمتها للمحاصيل الزراعية، فكانت تصنيفها على سبيل المثال (S1، S2، S3، S4، NS1، NS2) في هذه الدراسة، تم استخدام نظم المعلومات الجغرافية كأداة لتوقيع تقييم مدى ملاءمة الأرض للزراعة وملائمتها لأنواع مختلف من المحاصيل . وأشارت النتيجة أن المناطق المناسبة جدا لزراعة المحاصيل كانت ٣٧٨٥,٥٢ هكتار لعباد الشمس، ٦٦٣٥,٢٥ هكتار للقمح، ٦٣٣٦,١٩ هكتار للطماطم، ٦٢٠٠,٨٢ هكتارللبطيخ، ٢٥٨١,٢٤ هكتار للزيتون، ٣٧٨٥,٥٢ هكتار للعنب و٢١٩٦,٠٤هكتار للتفاح.

Effect of Dual Inoculation with Rhizobium Bacteria, A- Mycorrhizal Fungi and Micronutrients on Productivity of Egyptian clover

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ABSTRACT: Two field experiments were conducted at the Experimental station Farm of Facility of Agriculture (Saba- Basha). Alexandria University. Egypt. During 2014/2015 and 2015/2016 growing seasons. The objective of this study was the investage the effect of dual inoculation with Rhizobium & A- mycorrhizal fungi and micronutrients on productivity and quanty of Egyptian clover (Trefolim alexandrinum, L.) (cv. Giza 6). The obtained results recorded that summarized as follows. Application foliar micronutrient (Ca +B) at two times sprays gave the highest significantly effect on growth characters i.e. (plant height, number of nodules and dry weight of nodules/10 plants) at all sampling dates and fresh and dry yield (ton)/fed. Also, quantitatetraits (Crude protein (CP %) crude fiber (CF), water soluble carbohydrate (WSC %) ether extract (EE) and natural detergent fiber (NDF %) in both seasons.Inoculation Dual (Rhizobium + A- mycorrhizal gave the highest values of growth, yield and quantitative traits of clover plants in both seasons. The effective treatments for growth characters fresh and dry yield (ton)/fed, as well as quantitative treatments were obtained from applying foliar micronutrient spraying at two times with dual inoculation (Rhizobuim + A- mycorrhizal)
Keywords: Egyptian clover, micronutrients, dual inoculation, growth, yield, quality characters

INTRODUCTION

Egyptian clover (Triflouim alexandrinum, L.) is the most important forage crops in Egypt, it is cultivated in about 2.5 million feddan and used as animal feed and soil improvement. Forage quality is the most important character of feed staff producing and feeding the highest quality forage possibly increases animal performances reduces feeding costs and ultimately results in an increased return on time and money invested in forage production (Abdel-Sattar et al., 1996, Abdel-Halim et al., 1993 and Abdel – Gawad, 2003).

The foliar spray is more essential than soil application due to higher utilization which makes the nutrients more efficient. It can, also, be used to satisfy a cut- need of macro, micronutrients. Moreover, some soil fertilization problem can early to solve by foliar spray application. It acts as micronutrient on one hand and environmental toxic factor on the other hand and is known to affect nodulation and nitrogen fixation (Gaure et al., 2012), successful development of nodules by rhizobial species at many different stages of development (Brewin, 1991).

Rhizobial surface component play an important role in deciding the host compatibility and abringing about the infection leading to nodulation and nitrogen fixation (Swamynthan and Singh, 1995).

Mycorrhizal are multifunction organisms in agro ecosystems that improve soil physical, chemical and biological properties by developing mycelium, increasing nutrients absorption and soil nutrients (Cardoso and Kuyper, 2006). Chaicki et al. (2015), reported that dry matter of berseen clover (triflouim alexandrinum, L.) inoculation with mycorrhizal was significantly more

than control treatment. According to the same report co- inoculation by Rhizobium bacteria and Mycorrhizal fungi increased clove shoot dry weight and leaf area index compared by control. Therefore, the objective of the research is to study the effect of dual inoculation with rhizobium & A- mycorrhizal fungi and micronutrients on productivity of Egyptian clover.

MATERIALS AND METHODS

Two field experiments were carried out at the Experimental Farm of Faculty of Agriculture (Saba Basha), Alexandria. University, at Abees region Alexandria, Egypt, during the two growing seasons of 2014/2015 and 2015/2016 to study the effect of dual inoculation with Rhizobium & A-mycorrhizal fungi and micronutrients on productivity and quantitative traits of Egyptian clover.

The experiment was designed in as split plot with three replicates. The main plots were allocated to the calcium and micronutrient B at 100 g/fed for foliar spray (untreated, one spray and two spray), the four dual inoculation i.e. (uninoculation, Rhizobium, A-mycorrhizal and mixture Rhizobium + A-mycorrhizal) were allocated randomly to the sub plots. Analysis of chemical and physical properties of the experimental soil (0 to 30 cm) is shown in Table (1) according to methods reported by Page et al. (1982).

Table (1).The physical and chemical properties of the experimental soil during 2014/2015 and 2015/2016 seasons

Soil properties	2014/2015	2015/2016
A- Mechanical analysis		
Sand	13.90	14.80
Clay	44.00	43.00
Silt	42.10	42.70
Soil texture	Sand clay	
B- Chemical analysis		
pH (1:1)	7.80	7.90
EC (1:1) dS/m	3.40	3.45
1- Soluble cations (1:2) (cmol/kg soil)		
K^+	1.53	1.55
Ca^{++}	1.95	1.90
Mg^{++}	18.5	18.4
Na^{++}	13.50	13.8
2- Soluble anions (1:2) (cmol/kg soil)		
CO^-_3+ HCO^-_3	2.90	2.80
CL^-	20.4	18.80
SO^-_4	12.50	12.80
Calcium carbonate (%)	7.60	7.50
Organic matter (%)	0.90	1.00
Total nitrogen (%)	0.44	0.48
Available Phosphorus (mg/kg)	10.8	11.3
Available K (mg/kg)	123.60	118.70

The plot area was 10.5 m^2 (1/400 feddan) and seed were broadcasted at the rate of 20 kg/fed. (Variety Giza 6). All plots received 30 kg P_2O_5/fed, prior to planting date (Oct. 10^{th} and Oct 12^{th} first and second seasons).Berseem seed was inoculated prior to sowing with Rhizobium legumonsarumbiovartrifolii. The rhizobia strains were provided by the biofertilizer production unit. Soil. water and Enviromental Research institute. ARC. Vie ARC 101 (RE1) isolated from nodulated between (*Triflouim alexandrinum,* L.) root plants isolation and purification were done according to the method described by Vincent (1970). Apeat – based inoculum containing ≥ 10^8 cell/g was used in seed inoculation.

A-mycorrhizal fungi (*Glomusm acrocarpuim*) strain was obtained from Department of Plant Production, Faculty of Agriculture (Saba Basha), Alexandria. University, at the rate of 2550 spores was mixed with seeds and decating technique as described by Radwan (1996) three cuts were taken through the growing period of both seasons. Cutting was done when the stand of plots was about 40- 50 cm height and the stubble height was about 6 cm from the surface. Plant samples were taken on 45 days after sowing to determine the following parameters:

A) Growth and yield characters:

1. Plant height at three cutting.
2. Number of nodules
3. Dry weight of nodules (g/10 plants).
4. Fresh and dry yield (ton/fed).

B) Quantitative traits

Plant samples were collected from each plot at each cutting weighted dried and ground in a grinding mill to pass through a 1mm seive. Samples of each cut were analyzed for forage quality properties. Crude protein (CP), crude fiber (CF),water soluble carbohydrate (WSC%), Ether extract (EE), Ash and digetative dry matter (DOD) according to A. O. A. C. (1990) and natural detergent fiber (NDF%) collected according to Mcdonald *et al.* (1978)

Statistical analysis

The obtained data were statistically analyzed for ANOVA and LSD values were calculated to test the differences between the mean values of the studied treatments according to Gomez and Gomez (1984).

RESULTS AND DISCUSSION

A- Growth characters and yield:

The obtained results given in Tables (2, 3, 4 and 5) clearly showed that the application foliar micronutrients at two times exhibited a significant effect on growth characters and yield i.e. plant height, number of nodules, dry weight of nodules/10 plants, fresh and dry yield forage (ton)/fed in both seasons. Application foliar at two sprays of some micronutrients significantly increased the growth characters at all sampling and fresh, dry yield (ton)/fed during both seasons. These results may be due to the effect of calcium and Boron on stimulation physiological processes plant photosynthetic carbohydrate and

protein accumulation, as well as sugar translocation in plant. Similar results were reported by Mohamed and Helal (1999), Nadian (2004) and Dheri *et al*. (2007).

Data in the same Tables show the effect of dual inoculation Rhizobium & A- mycorrhizal on growth characters (plant height, number of nodules and dry weight of nodules/10 plant) at all sampling and fresh and dry yield (ton)/fed, in both seasons. Growth characters and yield were improved by the dual inoculation (Rhizobium & A-mycorrhizal) which caused significant increase in growth character and yield in both seasons.

Rhizobium + A-mycorrhizal increase the ability of host plant to uptake soluble nutrient, particulary phosphorus and some micronutrients (Shabani *et al*., 2011). Also, Nadian *at al.* (1998) reported that dry matter of berseem clover (*Triflouim alexandrinum,* L.) inoculated with mycorrhizalwas significantly more than control treatment.

The interaction between application of some micronutrients and dual inoculation was significant for growth characters (plant height, number of nodules and dry weight of nodules/10 plant) at all sampling and fresh and dry yields (ton)/fed in both seasons. Tables (2, 3, 4 and 5).

Table (2). Plant height (cm) as affected by micronutrients and dual inoculation (Rhizobuim, Mycorrhizal) at three cuts of T. alexandrinum during 2014/2015 and 2015/2016 seasons

Treatments	2014/2015 Days after sowing			2015/2016 Days after sowing		
	Cut1	Cut2	Cut3	Cut1	Cut2	Cut3
A) Micronutrients						
Control	30.71c	32.12c	33.17c	26.79c	27.79c	29.65c
One spray	32.44b	33.94b	35.96b	28.13b	29.75b	31.74b
Two spray	34.12a	35.48a	36.99a	30.46a	32.53a	34.65a
L0.S.D. (0.05)	**0.85**	**1.00**	**1.00**	**0.90**	**1.02**	**1.05**
B) Dual inoculation						
Uninoculation	23.87d	25.03d	26.07d	23.57d	25.73c	26.97
Rhizobium	32.75c	33.83c	35.71c	25.77c	27.47	29.53e
Mycorrhiza	34.09b	36.67b	38.46b	30.46b	32.13b	34.18b
Dual (Rhiz + Mycor)	38.18a	39.84a	41.23a	34.02a	35.36a	37.37a
L.S.D. (0.05)	**1.20**	**1.25**	**1.30**	**1.05**	**1.30**	**1.40**
Interations						
AxB	*	*	*	*	*	*

Mean values in the same column marked with the same letter are not significantly differed at 0.05 levels of probability

* significant at 0.05level of probability

Table (3). Number of nodules as affected by micronutrients and dual inoculation (Rhizobuim, Mycorrhizal) at three cuts during 2014/2015 and 2015/2016 seasons

Treatments	2014/2015			2015/2016		
	Cut1	Cut2	Cut3	Cut1	Cut2	Cut3
A) Micronutrients						
Control	113.75c	115.71	118.18c	1296.85c	128.38c	129.25c
One spray	122.59b	124.67b	126.63b	134.42b	136.00b	137.25b
Two spray	133.67a	135.75a	137.20a	144.99a	146.53a	147.88a
L0.S.D. (0.05)	**3.50**	**3.70**	**3.90**	**4.20**	**4.40**	**4.40**
B) Dual inoculation						
Uninoculation	110.67d	112.83d	115.20d	125.44d	126.63d	128.07d
Rhizobium	126.89b	128.93b	130.50b	137.44b	139.03b	139.67b
Mycorrhiza	117.11c	119.11c	121.17c	130.66c	132.33c	133.83c
Dual (Rhiz + Mycor)	138.67a	140.72a	142.63a	148.17a	149.89a	150.77a
L.S.D. (0.05)	**3.70**	**4.00**	**4.20**	**3.80**	**3.90**	**4.20**
Interations						
AxB	*	*	*	*	*	*

Mean values in the same column marked with the same letter are not significantly differed At 0.05 levels of probability

* Significant at 0.05 level of probability

Table (4). Fresh and dry yield (ton)/fed as affected by micronutrients and dual inoculation (Rhizobuim, Mycorrhizal) during 2014/2015 and 2015/2016 seasons

Treatments	Fresh yield 2014/2015		Dry yield 2015/2016	
	2014/2015	2015/2016	2014/2015	2015/2016
A) Micronutrients				
Control	36.33c	33.58c	3.89c	3.79c
One spray	42.30b	36.25b	4.91b	4.67b
Two spray	44.40a	41.88	5.19a	4.98a
L0.S.D. (0.05)	**1.70**	**1.90**	**0.20**	**0.25**
B) Dual inoculation				
Uninoculation	33.42d	31.06d	3.25d	3.37d
Rhizobium	39.91c	34.89c	4.27c	3.94c
Mycorrhiza	43.89b	40.00b	5.19b	4.56b
Dual (Rhiz + Mycor)	47.32a	43.00a	5.96	5.25a
L.S.D. (0.05)	**2.10**	**2.50**	**0.25**	**0.30**
Interations				
AxB	*	*	*	*

Mean values in the same column marked with the same letter are not significantly differed at 0.05 levels of probability

* Significant at 0.05 level of probability

Table (5). Dry weight of nodules (g/10 plants) as affected by micronutrients and dual inoculation (Rhizobuim, Mycorrhizal) at three cuts during 2014/2015 and 2015/2016 seasons

Treatments	2014/2015			2015/2016		
	Cut1	Cut2	Cut3	Cut1	Cut2	Cut3
A) Micronutrients						
Control	108.75c	110.38c	112.28c	121.75	123.13c	125.00c
One spray	116.33b	118.25b	120.25b	128.92	130.75b	132.75b
Two spray	128.09a	129.25a	130.88a	139.58	141.25a	143.25a
L0.S.D. (0.05)	**3.50**	**3.70**	**3.80**	**3.80**	**3.90**	**4.20**
B) Dual inoculation						
Uninoculation	104.00d	105.83d	107.86d	120.76d	122.33d	124.33d
Rhizobium	122.55b	123.83b	125.33b	131.44b	133.33b	135.33b
Mycorrhiza	110.89c	112.33c	114.50c	125.33c	128.83c	128.67c
Dual (Rhiz + Mycor)	133.45a	135.17a	136.83a	142.78a	144.33a	146.33a
L.S.D. (0.05)	**3.30**	**3.50**	**3.60**	**3.50**	**3.70**	**3.90**
Interations						
AxB	*	*	*	*	*	*

Mean values in the same column marked with the same letter are not significantly differed at 0.05 levels of probability

* Significant at 0.05 level of probability

B- Qualitative traits or quality:

The results recorded in Tables (6 and 7) showed that quantitative traits i.e. crude protein (CF %), crude fiber (CF%), water soluble carbohydrate (WSC%), ether extract (EE), ASH%, natural detergent fiber (NDF%) and Degeative dry matter (DMD%) for the two seasons, were significantly affected by some micronutrients. Foliar application at two spraying significantly increased qualitative traits in both seasons. It could be concluded that the using micronutrients led to active indol acetic acid and then this acids makes amino acids to qualitative traits through this clover quality increase and by using micro and macronutrients, dry yield by of clover plant in will increased. Similar results were reported by Ali *et al.* (2012), Bhat (2013) and Bhatte *et al*. (2016).

Chemical constituents, crude protein (CF), crude fiber (CF), Ether Extract (EE), water soluble carbohydrate (WSC %), ASH%, natural detergent fiber (NDF %) and Digestive dry matter (DMD %) (Yield (ton)/fed) area shown in Table (6). Dual inoculation (Rhizobium + A-mycorrhizal) gave highest values of chemical constituents with compared to uninoculation (control) treatment in both seasons. This results could be explained by beneficial effects of fertilizer inoculation (Rhizobium + A-mycorrhizal) which led to increase nutrient supply, improve photosynthesis and ultimately provide the better qualitative characters (Gholamhosiane *et al*., 2012). Similar results were reported by Zeidi *et al*. (2004), Canbolat *et al*. (2006), Blaise *et al*. (2006) and Abo Taleb *et al*. (2008).

The interaction between application of micronutrients and dual inoculation was significant for quantitative traits during both seasons Table (6). The highest values of quantitative traits were recorded for application of micronutrients at spray with dual inoculation (Rhizobium + A-mycorrhizal) in both seasons.

It was concluded that dual inoculation with (Rhizobium + A-mycorrhizal) increased growth, yield quantity and quality of Egyptian clover (Giza 6). Thedual inoculation led to significant decrease in production cost and guaranteed more beneficial effects on social and environmental health.

Table (6a).Crude protein (TCP %), Crude fiber (CF %),Total soluble carbohydrate (WSC %) Ether extract (%), ASH (%), Natural d tergeant fiber (NDF %) andDegeative dry matter (DMD %) as affected by micronutrients and dual inoculation (Rhizobuim, Mycorrhizal) in 2014/2015 season

Treatments	Crude protein (TCP %)	Crude fiber (CF %)	Total soluble carbohydrate (WSC %)	Ether extract (%)	ASH%	NDF%	DMD%
	2014/2015	2014/2015	2014/2015	2014/2015	2014/2015	2014/2015	2014/2015
A) Micronutrients							
Control	19.58c	24.67c	10.00c	14.33c	7.76c	47.33c	44.05c
One spray	22.17b	26.88b	10.42b	16.50b	8.26b	44.67b	47.17b
Two spray	23.63a	28.42a	11.00a	17.80a	8.44a	53.00a	49.66a
L0.S.D. (0.05)	**0.80**	**1.60**	**0.35**	**0.90**	**0.15**	**1.90**	**2.10**
B) Dual inoculation							
Uninoculation	18.89d	25.00d	9.78d	14.78c	7.50d	46.55d	44.06d
Rhizobium	21.21c	26.00c	10.22c	15.89bc	8.09c	49.33c	46.67c
Mycorrhiza	23.12b	27.44b	10.78b	17.00ab	8.35b	51.33b	48.22b
Dual (Rhiz + Mycor)	23.95a	28.17a	11.11a	17.78a	8.62a	52.78a	48.89a
L.S.D. (0.05)	**0.70**	**0.60**	0.30	**1.65**	**0.20**	**1.30**	**0.52**
Interations							
AxB	*	*	*	*	*		*

Mean values in the same column marked with the same letter are not significantly differed at 0.05 levels of probability

* significant at 0.05 level of probability

Table (6b).Crude protein (TCP %), Crude fiber (CF %), Total soluble carbohydrate (WSC %) Ether extract (%), ASH (%), Natural detergent fiber (NDF %) Degeative dry matter (DMD %) as affected by micronutrients and dual inoculation (Rhizobuim, Mycorrhizal) in 2015/2016 season

Treatments	Crude protein (TCP %)	Crude fiber (CF %)	Total soluble carbohydrate (WSC %)	Ether extract (%)	ASH%	NDF%	DMD%
	2015/2016	2015/2016	2015/2016	2015/2016	2015/2016	2015/2016	2015/2016
A) Micronutrients							
Control	19.85c	25.09c	10.21c	14.50c	7.03c	45.75c	44.83c
One spray	22.64b	27.00b	10.48b	15.67b	7.48b	48.25b	46.75b
Two spray	23.93a	28.92a	11.20a	17.09a	7.87a	51.50a	48.75a
L0.S.D. (0.05)	**0.90**	**1.70**	**0.22**	**0.80**	**0.20**	**2.00**	**1.50**
B) Dual inoculation							
Uninoculation	19.19d	25.49d	9.82d	14.11d	7.06d	44.89d	44.33d
Rhizobium	21.75c	26.56c	10.44c	15.33c	7.38c	47.44c	46.33c
Mycorrhiza	23.54b	27.56b	10.89b	16.33b	7.60b	49.56b	47.55b
Dual (Rhiz + Mycor)	24.10a	28.44a	11.50a	17.22a	7.81a	51.78a	48.75
L.S.D. (0.05)	**0.45**	**0.80**	0.23	**0.70**	**0.19**	**1.75**	**1.20**
Interations							
AxB	*	*	*	*	*		*

Mean values in the same column marked with the same letter are not significantly differed at 0.05 levels of probability

* significant at 0.05 level of probability

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الملخص العربى

تأثير التلقيح المزدوج الرايزوبيم وفطر الميكوريزا والعناصر الصغرى على الإنتاجية للبرسيم المصري

فتحي إبراهيم رضوان ، محمود عبد العزيز جمعة ، عصام اسماعيل قنديل ، محمود الحجاجي موسى

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أجريت تجربتان حقليتان بمزرعة كلية الزراعة (سابا باشا) – جامعة الإسكندرية – مصر خلال موسمي الزراعة ٢٠١٤/٢٠١٥، ٢٠١٥/٢٠١٦ لدراسة تأثير التلقيح المزدوج الرايزوبيم وفطر الميكوريزا والعناصر الصغرى على إنتاجية وجودة البرسيم المصري صنف (حـ٦).

ويمكن تلخيص أهم النتائج فيما يلي:

إضافة (اليورون + الكلسيوم) مرتين رشاً أعطى أعلى تأثير معنوي للصفات الخضرية مثل طول النبات، عدد العقد، الوزن الجاف للعقد/١٠ نباتات) عند جميع نباتات العينات ومحصول الوزن الطازج ومحصول الوزن الجاف (طن)/فدان وأيضاً صفات الجودة والنسبة المئوية للبروتين الخام الألياف الخام، والكربوهيدرات الذائبة مستخلص الاثير، والرماد. أدى التلقيح المزدوج (الرايزوبيم + الميكوريزا) للحصول على أعلى قيم صفات المجموع الخضري والمحصول والجودة للنباتات البرسيم في كلا الموسمين.المعاملة المؤثرة على صفات المجموع الخضري والمحصول الطازج والجاف (طن)/فدان وأيضا صفات الجودة تم الحصول عليها من الإضافة رشاً بخليط الكالسيوم واليورون مرتين مع التلقيح المزدوج الرايزوبيم+ الميكوريزا.

In Vitro Propagation of Volkamer Lemon using Nodal Cutting Segments

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ABSTRACT: Citrus is one of the most important commodity worldwide, owing to its tremendous nutritional value, and acceptable as fresh edible food. This study was conducted at the Desert Research Center (DRC) in Cairo, Egypt, during the period 2013-2017. An efficient in vitro propagation system for Volkamer lemon (Citrus volkameriana) was established. The effect of various combination of two plant growth regulators (cytokinin and auxin) was evaluated on the proliferation efficiency of citrus plant via in vitro propagation technique. The sterilized stem nodal segments of the given species were planted vertically on MS culture medium augmented with various combinations of BAP at 0.0, 0.5, 1.0, 1.5, 2.0, 2.5, and 3.0 mg/l and NAA at 0.0, 0.1, and 0.2 mg/l, and especially at BAP×NAA at 2.0 ×0.1 mg/l respectively proved to be the best for bud induction. The survival percentage of stem node segment frequency was 100%, especially when MS medium was supplemented with BAP in a range 1.0- 3.0 mg/l. The best shoot initiation was obtained on MS medium augmented with BAP and NAA at 2.0 and 0.1 mg/l, each in turn, which recorded the highest mean value (3.99 shoots/ explant). Higher number of elongated shoots was obtained on MS medium with BAP and NAA at 3.0 and 0.1 mg/l, in order. The higher multiplication rate was recorded on MS medium containing BAP and NAA at either 2.0 or 2.5 mg/l for the former and 0.05 mg/l for the latter. The shoots were then rooted on MS medium containing IBA and NAA at 1.5 and 0.2 mg/l consecutively, with high rooting percentage (100%). The plantlets survival ex vitro swas (80%) when plantlets were transferred to plastic pots containing a mixture of sand and peatmoss (1:1). In conclusion, this study provides reproducible technique for micropropagation of Volkamer Lemon.

Keywords: Citrus volkameriana, plant tissue culture, initiation stage, multiplication stage, rooting and acclimatization stage

INTRODUCTION

Citrus volkameriana, is a member of Rutaceae family and it is commonly known as Volkamer lemon. Citrus is considered as the number one fruit of the world due to its high nutritional value, great production potential and preparation of large number of fruit products from them. Citrus species are cultivated in most tropical and subtropical regions of the world (García-Luis et al., 2006). Volkamer lemon (Citrus volkameriana) is a commonly used as a rootstock in Egypt and it is an excellent rootstock for warm, humid areas with deep sandy soils (García-Luis et al., 2006). Volkamer Lemon being polyembryonic in nature, give rise to several vigorous and virus free nucellar seedling which are difficult to differentiate from zygotic seedling and are ,also, difficult to isolate from zygotic seedling, which necessitate the application of in vitro micropropagation, therefore, very little work has been carried out on the tissue culture of this plant (Ali and Mirza, 2006). Likewise, in vitro propagation is a techno-economically viable and eco-friendly approach to produce disease free planting material on a large scale, utilizing relatively small space and time. Hence, rapid and cost effective in vitro methods of reproducing this rootstock would ensure bulk production of true- to -type and disease- free- planting material. Therefore, the present study was undertaken to standardize the protocol for in vitro propagation of this commercially important Volkamer Lemon.

MATERIALS AND METHODS

Plant materials:

This study was achieved through the period from year 2013 until 2017 in the Tissue Culture Laboratory, Desert Research Center (DRC), and Cairo, Egypt.

The plant materials of citrus rootstock (Volkamer) explants were collected from a private farm located at 70 km Cairo-Alexandria desert road. Actively growing shoots with terminal buds were collected, moistened, wrapped and placed into ice-box container. In the laboratory, the explants were washed under running tap water for 4 hours and the healthy ones were chosen to verify their response to the in vitro propagation procedure. The latter procedure was performed as the following system:

Stage 0 (selection the mother plant and explants sterilization):

Vigours and healthy plants of Volkamer Lemon were selected from the above-mentioned private farm, to collect the explants nodal segments.

Explants sterilization:

Surface sterilization of the given explants was carried out under complete aseptic conditions in the Laminar Air Flow Hood. The explants were subjected to different sterilization treatments using commercial Clorox containing 5.25% sodium hypochlorite (NaOCl) at 1.25% for 20 minutes. After each treatment, the explants were rinsed thoroughly with double distilled sterilized water for 4 times to remove all traces of the disinfectant, with continuous hand shaking agitation in each of the previous steps. Finally, nodal segments were trimmed at both ends to 0.5 - 1cm in length using forceps and scalpel to be ready for culturing.

The basic nutrient medium and culture conditions:

Stem nodal segments were cultured vertically on solidified basal Murashige and Skoog (MS) medium adopted by Murashige and Skoog (1962) supplemented with 100 mg/l myo-inositol and 30 g/l sucrose (3%), which augmented with growth regulators such as benzyl amino purine (BAP), at different concentrations, either independently as 0.0, 0.5, 1.0, 1.5, 2.0, 2.5 and 3.0 mg/l or in combinations with β–naphthalene acetic acid (NAA) which was added at 0.0, 0.1and 0.2 mg/l. The pH of the nutrient media was adjusted to 5.7 ± 0.1 with adding few drops of either 0.1N Hydrochloric acids (HCl) or 0.1N Sodium hydroxide (NaOH) prior to addition of 2.7g/l phytagel to solidify the liquid media. Fifteen ml of media were dispensed into culture tubes 25×150 mm long or 30ml volume into 350 ml jars. Then, closed with polypropylene caps and autoclaved at 121℃ under a pressure of 1.1kg/cm² for 20 min, then left to cool, and media were stored at room temperature a day before being used.

Initiation stage

Effect of different growth regulator combinations on the initiation (establishment) stage:

The induction of shoots from the nodal segments was attempted with full strength of solid MS medium supplemented with 100 mg/l myo-inositol, 30 g/l sucrose, 2.7g/l phytagel, 40 mg/l adenine sulphate, 100mg/l glutamine, 1mg/l FeSO4.7H2O and 500mg/l malt extract. Different growth regulators combinations of BAP (0.0, 0.5, 1.0, 1.5, 2.0,2.5 and 3.0 mg/l) individually or in

combination with 0.0, 0.1and 0.2 mg/l NAA were added to the media to obtain the highest percentage of growth induction comparing to MS medium free of growth regulators (as a control). The freshly sterilized explants were cultured into tissue culture tubes or jars and each treatment was represented by 3 replicates.

Multiplication stage:

Established explants (outcomes of initiation stage) were multiplied on MS media for Volkamer Lemon containing different concentrations of BAP (2.0 and 2.5 mg/l) with NAA at 0.05 mg/l for shoots multiplication. As reported above explants were cultured in tissue culture tubes or jars and each treatment was represented by 3 replicates. The explants were subcultured for seven consecutive subcultures on the best-defined multiplication medium using large jars to obtain stock materials to be used for the following experiments.

Rooting stage:

Shoots derived from multiplication stage (ca. 3-5 cm long) were transferred to half strength MS salts with vitamins containing 1g/l activated charcoal (AC), in addition to 100mg/l myo-inositol and 30 g/l sucrose. For rhizogenesis, two types of auxins were tested, viz., IBA at five concentrations (0.0 [nil], 0.5, 1.0, 1.5, and 2.0 mg/l) in combination with NAA at four concentrations (0.0 [nil], 0.2, 0.5 and 1.0 mg/l). The tested media were solidified with 2.7g/l phytagel. Cultures were incubated under the same conditions that used for shoot propagation. The incubation condition was, in general, as 16-hr photoperiod+ 8hr darkness, at 25±2 oC and light intensity of 3000 Lux.

Acclimatization stage:

The obtained plantlets (rooted shoots) were washed, thoroughly, with running tap water to discard media residues, and treated with 0.2 % (w/v) Mon cut 25% (a, a, a-trifluoro-3- isopropoxy-o-Toluanilid) solution as a fungicide for 30 sec., then they were transplanted ex vitro in plastic pots (8 cm in diameter) containing soil potting mix of peat-moss and sand (1:1 v/v). Pots were covered with transparent polyethylene bags and placed in a greenhouse. One week later, the covers were removed, and the plantlets started to acclimatize for one month. The percentage of survived transplants (%) was recorded.

Statistical analysis:

All the experiments carried out during this study were designed as factorial experiments layout in completely randomized design (Gomez and Gomez, 1984). Recorded data were analyzed statistically using analysis of variance technique (ANOVA) Steel et al. (1997). The means significance was compared by applying the least significant difference (L.S.D.) test at 5%level of probability.

RESULTS AND DISCUSSIONS

Initiation stage:

Effect of BAP, NAA (mg/l) and their combinations on the given traits of citrus rootstock "Volkamer Lemon" during initiation stage:

Survival percentage of stem explants:

Data presented in (Table 1) declare the effect of both BAP and NAA (mg/l) and their combinations that augmented to MS medium on survival percentage of stem node segment explants during initiation stage. The main effect of BAP showed that BAP exerted highly significant ($P \leq 0.01$) effect on the given trait, whereas, augmenting MS medium with at the range 1-3.0 mg/l and 0.1 mg/l NAA; brought about the highest survival percentage (100%). This finding could be attributed to the mode of action of both BAP and KIN as cytokinins on the stimulation of both cell division and growth promotion of axillary shoots in plant tissue culture as reported previously by Trigiano and Gray (2000) and George et al. (2008). On the other hand, the shoot proliferation depends upon the balance of cytokinins and auxins. The addition of lowest levels of NAA used affected well the initiation of citrus in vitro (Usman et al., 2005).

The mean number of neoformed shoots/explant

Data illustrated in (Table 2) exhibited that tested MS media supplemented with various levels of BAP, NAA, and their combinations on the characteristic. The main effects of BAP, NAA and their combinations, showed a very highly significant effect ($P \leq 0.001$) on the given trait. The highest mean values (3.99) were obtained when MS medium was supplemented with 2.0 mg/l BAP in combination with 0.1mg/l NAA. This finding could be taken place due to the accurate balance between both growth regulators as exogenous application and those of endogenous biosynthesis, which resulted in the best genes expression and subsequently the growth (George et al., 2008).

In this respect the high BAP level compare to NAA level considers as in favor of stimulation cell division, morphogenesis (shoot initiation/bud formation) in tissue culture process, and break of apical dominance and release growth of lateral buds (Raven et al., 1992; Salisbury and Ross, 1992; Davies, 1995) and their combinations exerted highly significant effects on the initiation stages characters of rootstocks, where stem node segment as explants were grown in vitro for 30 days. Further, the obtained results in this study cope with those of Upadhyay et al. (2010) and Marques et al. (2011) who advised to add lower level of NAA to affect the initiation of citrus in vitro and found that the high rates of bud initiation and shoot development were obtained both with BA supplemented medium, in range from 1mg/l to 3 mg/l and with 0.1 mg/l NAA supplemented medium.

Table (1). Effect of different levels of both BAP and NAA (mg/l) and their combinations added to MS culture medium on survival percentage of stem node explants during initiation stage of Volkamer (Citrus volkameriana).

NAA (mg/l)	BAP (mg/l)							Mean NAA	Significance		
	0.0	0.5	1.0	1.5	2.0	2.5	3.0		BAP	NAA	BAP × NAA
	MS medium										
0.0	65	30	80	80	100	100	100	79.28	**	ns	ns
0.1	50.2	50.2	90	90	100	100	100	82.91			
0.2	50.2	30	48	90	100	100	100	74.02			
Mean (BAP)	**55.13**	**36.73**	**72.66**	**86.66**	**100**	**100**	**100**				
L.S.D.									**23.2**	**15.2**	**40.3**

Table (2). Effect of different levels of both BAP and NAA (mg/l) and their combinations added to MS culture medium on mean number of neoformed shoots/explant for stem node segment during initiation stage of Volkamer (Citrus volkameriana).

NAA (mg/l)	BAP (mg/l)							Mean NAA	Significance		
	0.0	0.5	1.0	1.5	2.0	2.5	3.0		BAP	NAA	BAP × NAA
	MS medium										
0.0	0.11	0.11	0.33	0.66	1.88	1.22	0.44	0.67	***	***	***
0.1	0.11	0.11	0.33	1.11	3.99	2.44	0.99	3.02			
0.2	0.11	0.00	0.22	0.44	0.44	0.44	0.33	0.36			
Mean (BAP)	**0.11**	**0.07**	**0.29**	**0.73**	**2.28**	**1.36**	**0.58**				
L.S.D.									**0.27**	**0.18**	**0.48**

L.S.D. = Least significant difference test at 0.05, 0.001 level of probability. **, ***, ns = high significant, very highly significant, not significant, respectively.

NAA concentration above 1 mg/l significantly reduced bud initiation and shoot elongation. The highest mean values were obtained on MS medium supplemented with 2.0 and 2.5mg/l BAP in combination with 0.1mg/l NAA for "Volkamer". Furthermore, Upadhyay et al. (2010) mentioned that 2.0 mg/l BAP + 0.1 mg/l NAA was found to be the best treatment for establishment medium of "Sweet orange" , with respect to maximum sprouting, minimum days taken for sprouting with highest number of shoots/ explants. Hence, 2mg/l BAP or 1.0 mg/l KIN + 0.1 mg/l NAA was observed to be the best treatment for multiplication medium with maximum shoot length and highest number of leave.

The mean shoots length (cm)/explant.

Data illustrated in (Table3) exhibited the effect of various levels of BAP, NAA, and their combinations added to the MS medium on the defined characteristic of the mean shoots length of neoformed per culture explants. The main effect of BAP disclosed that it exerted a very highly significant effect (P≤ 0.001) on the given trait, especially when MS culture medium was augmented with BAP at 3.0 mg/l and NAA at 0.1 mg/l, which recorded the highest mean length of shoots (2.01 cm). These results are in agreement with those obtained by Tapati et al. (1995) and Moreira et al. (2001) who found that BAP has been

reported to be the most commonly used cytokinin in citrus tissue culture media, which enhanced culture establishment and minimized the time elapsed to be bud sprouted or outgrowth. This finding may be taken place due to the balance between endogenous and exogenous PGRs (George and Sherrington, 1984; and George et al., 2008) whereas, auxins are capable to control various distinctive processes such as promotion of stem elongation and growth and they are not effective against shoot proliferation (George et al., 2008; Goussard, 1981).

Multiplication stage:

Effect of BAP with NAA and their combinations on the multiplication of Volkamer axillary shoots during 7 successive subcultures

Data in Table (4) and Plate (1) display that the effect of augmenting MS medium with BAP and NAA at best given levels on percentage of explant forming growth, mean number of axillary shoots, and mean length of axillary shoots/ propagule during seven successive subculture of Volkamer rootstock. Whereas, MS medium supplemented with BA at 2.0 or 2.5 mg/l and NAA at 0.05 mg/l; achieved such significant effect on the given traits. The multiplication rate was gradually, increased until the fifth subculture, then declined at the sixth and seven subcultures; especially mean numbers of shoots.

As for the percentage of explant forming out growth, the main effect of BAP and NAA, showed no significant effect on the given trait. For instance, the mean number of shoot formed/ propagule, upon fortifying MS medium with BAP and NAA at either 2.0 or 2.5 and 0.05 mg/l, respectively, showed a significant effect on the given trait, which recorded the highest mean value of the defined character (4.68 or 4.43, each in turn), during the fifth subculture, whereas, after sixth subculture it declined (2.67 or 2.23, serially). On the other hand, augmenting MS medium with BAP and NAA at 2.5 and 0.05 mg/l showed a significant effect on given trait, which recorded the highest mean length of shoots/ propagule (1.75cm).

Table (3). Effect of different levels of both BAP, NAA (mg/l) and their combinations added to MS culture medium on mean shoots length (cm)/explant for citrus rootstocks" Volker" stem node segment during initiation stage.

NAA (mg/l)	BAP (mg/l)							Mean NAA	Significance		
	0.0	0.5	1.0	1.5	2.0	2.5	3.0		BAP	NAA	BAP × NAA
	MS medium										
0.0	0.16	0.33	0.91	1.08	1.23	1.23	1.75	0.95	***	ns	ns
0.1	0.16	0.50	1.83	1.38	1.42	1.42	2.01	1.19			
0.2	0.16	0.00	1.00	1.25	1.66	1.66	1.50	0.96			
Mean (BAP)	**0.16**	**0.27**	**1.24**	**1.23**	**1.17**	**1.37**	**1.75**				
L.S.D.									**0.39**	**0.25**	**0.67**

L.S.D. = Least significant difference test at 0.05, 0.001 level of probability. **, ***, ns = high significant, very highly significant, not significant, respectively.

Table (4). Effect of given levels BAP with NAA on same multiplication traits of Volkamer Lemon axillary shoots during seven successive subcultures.

Genotypes	Volkamer Lemon					
Growth regulators	2.00 mg/l BAP+ 0.05 mg/l NAA			2.50 mg/l BAP + 0.05 mg/l NAA		
No. of subculture	Survival %	Mean number of shoots	Mean length of shoots (cm)	Survival%	Mean number Of shoots	Mean length of shoots(cm)
1_{st} subculture	100^{a}	0.63^{d}	1.52^{a}	100^{a}	0.55^{d}	1.75^{a}
2_{nd} subculture	100^{a}	0.88^{cd}	1.49^{a}	100^{a}	1.12^{d}	1.47^{abc}
3_{rd} subculture	100^{a}	1.12^{cd}	1.39^{a}	100^{a}	2.12^{c}	1.26^{bc}
4_{th} subculture	100^{a}	1.83^{bc}	1.37^{a}	100^{a}	3.22^{b}	1.19^{bc}
5_{th} subculture	100^{a}	4.86^{a}	1.24^{a}	100^{a}	4.43^{a}	1.07^{c}
6_{th} subculture	100^{a}	2.67^{b}	1.38^{a}	100^{a}	2.23^{c}	1.34^{abc}
7_{th} subculture	100^{a}	0.86^{cd}	1.62^{a}	100^{a}	0.96^{d}	1.58^{ab}

Plate (1). Multiplication stage of Volkamer Lemon, when cultured on MS media and the best combination 2.0 mg/l BA with 0.05 mg/l NAA.

In this respect, cytokinins, together with auxin, take part in regulation of the cell cycle in plant cells (i.e. stimulation of cell division, break apical dominance, enhance axillary shoot proliferation, and adventitious, inhibition root formation). Also, the interaction between auxin and cytokinis or their ratio between other represents an important signal in the formation of cell phenotype and in the onset and maintenance of the process of cell division (Stickens et al., 1996). In the same line, Kumar et al. (2001) mentioned that the plantlets were regenerated by direct organogenesis from epicotyls segments of in vitro germinated nucellar seedlings of sweet orange cultivars. When epicotyls segments (1.0-1.5 cm long) were cultured on MS medium supplemented with BA and NAA, in Mosambi; the highest number of explants showed shoot proliferation (14.33) and the highest number of shoot (2.06) and leaves (4.56) were obtained upon using 1.0mg/l BA. In Jaffa, 2.0mg/l of BA; gave the highest number of explants showing shoot proliferation. Likewise, Upadhyay et al. (2010) mentioned that 2.0 mg/l of BAP + 200 mg/l of casein hydrolysate was found to be the best treatment for establishment medium for sweet orange , with respect to maximum sprouting, minimum days taken for sprouting with highest number of shoots/ explants. It was observed that augmenting the culture medium with 2.0mg/l BAP + 1.0 mg/l KIN + 0.1 mg/l NAA; was recorded to be the best treatment for multiplication medium with maximum shoot length and highest number of leave. In vitro organogenesis of citrus was studied by Schinor et al. (2011) for the micropropagation of genotype Citrus sinensis cv. Natal, C. limonia, C. volkameriana and C. aurantium, with the use of epicotyls segments –derived explants, and cultured in MT medium supplemented with different concentration of BAP and NAA. For the recalcitrant genotypes C. limonia and C. aurantium the in vitro organogenesis was, also, studied with intermodal segments, cultured in MT medium supplemented with BA ad NAA. In the same year, the factors affecting in vitro adventitious shoot formation on internode explants of Citrus aurantium L. was recorded by Marques et al. (2011) and found that the high rates of bud initiation and shoot development were obtained due to supplementing the culture medium with BA, in range from 1.0 mg/l to 3.0 mg/l and with 0.1 mg/l NAA. Notably, NAA concentration above 1.0 mg/l; significantly reduced bud initiation and shoot elongation.

Rooting stage (Rhizogenesis)

Effect of IBA, NAA and their combinations (mg/l) on percentage of rooted shoots /propagule during rooting stage of citrus rootstock " Volkamer".

Data tabulated in Table (5) display the effect of various level of both applied growth regulators viz, IBA, NAA and their interactions on percentage of rooted shoots/ propagule of the tested rootstocks "Volkamer Lemon" during rooting stage. As for, the main effects of IBA, NAA in addition to their combinations, generally, they exerted very highly significant effect ($P \leq 0.001$) on the given trait. For instance, augmenting MS medium with IBA, NAA and IBA× NAA at 1.5, 0.2 and 1.5×0.2 mg/l; resulted in the highest percentage values as 49.75, 46.60 and 100%, consecutively.

Effect of NAA, IBA and their combinations (mg/l) on mean number of roots formed/explant during rooting stage of citrus rootstocks'' Volkamer ''.

Results outlined in Table (6) and Plate (2) disclosed the effect of IBA, NAA (mg/l) and their combinations on mean number of roots formed/ shoot of Volkamer Lemon during rooting stage. Whereas, IBA at 1.5, NAA at 0.2 mg/l and their interaction at 1.5×0.2 mg/l, in series, have very significant effects ($P \leq 0.001$) of the given trait, which recorded the highest mean values as 1.27 for IBA, 1.15 for NAA and 2.44 for interaction.

The obtained results could be explained on the bases that auxin induced number of responses which involved cell division, cell enlargement, protein and nucleic acids syntheses which are concomitant of auxin-induced growth and changes in wall plasticity of plant cell and increase the apical dominance as there are essential and rapid processes involved in growth and elongation (Wilkins, 1989). The use of auxins and many other factors and changes in the rooting environment have been described in order to enhance the rooting of microcuttings (Brand and Lineberger, 1986). Similarly, in a previous study on in vitro rooting of cv. "Pinot noir" microshoots (Heloir et al., 1997), where it was shown that IBA is a suitable auxin, while other types of auxins (e.g., NAA) may lead to callus formation. Jaskani et al. (2008) reported that media having 10µM (2.0mg/l) IBA proved to be the best for root formation in microshoots while its absence shoots of vitis showed complete failure in root formation. Hicks and Dorey (1998) also reported that roots at high frequency was achieved on MS medium plus IBA but level of IBA was different than the treatments in the present study which may be due to different varietal response. These results are close to those of HuXinXI et al. (2007) who indicated that about 97.7% of the adventitious shoot from Citrus sinensis was rooted on 1/2 MS medium + 3% sucrose + 0.7% agar + 2.0 mg/l IBA, pH 5.8. Also, Upadhyay et al.(2010) reported that IBA (2.0 mg/l) + NAA (0.1 mg/l) + activated charcoal (500mg/l) was found to be significantly superior over all other treatments with respect to maximum root initiation percentage, days spanned to root initiation , highest number of roots and length for nodal and intermodal segments of C. sinensis. Alemow and "Cleopatra" mandarin shoot were rooted well using these plant growth regulators.

Table (5). Effect of IBA, NAA and their combinations (mg/l) on percentage of roots /propagule during rooting stage of citrus rootstocks" Volkamer ".

NAA(mg/l)	IBA (mg/l)					Mean NAA	Significance		
	0.0	0.5	1.0	1.5	2.0		IBA	NAA	IBA×NAA
0.0	0.00	22.0	44.0	44.0	0.00	22.00	***	***	***
0.2	0.00	0.00	100	100	33.0	46.60			
0.5	0.00	0.00	0.00	55.0	33.0	17.60			
1.0	11.0	0.00	0.00	0.00	44.0	11.00			
Mean (IBA)	2.75	5.5	36.0	49.75	27.5				
L.S.D.							8.0	7.0	17.0

L.S.D. = Least significant difference test at 0.05,0.001 level of probability.
*, ***, ns significant, very highly significant, not significant, respectively.

Table (6). Effect of IBA, NAA and their combinations (mg/l) on mean number of roots formed/explant during rooting stage of citrus rootstocks "Volkamer ".

NAA (mg/l)	IBA (mg/l)					Mean NAA	Significance		
	0.0	0.5	1.0	1.5	2.0		IBA	NAA	IBA×NAA
0.0	0.00	1.66	1.16	1.17	0.00	0.79	***	ns	***
0.2	0.00	0.00	2.33	2.44	1.00	1.15			
0.5	0.00	0.00	0.0	1.50	1.00	0.50			
1.0	0.66	0.00	0.00	0.00	2.00	0.53			
Mean (IBA)	0.16	0.41	0.87	1.27	1.00				
L.S.D.							0.40	0.36	0.80

L.S.D. = Least significant difference test at 0.05,0.001 level of probability.
*, ***, ns = significant, very highly significant, not significant, respectively.

Likewise, NAA/IBA combinations; produced higher rooting percentages than did the IBA/ IAA combinations, and in sour orange nearly 100%of explants developed roots. Regenerated shoots of Citrus limon L. showed root induction on MS medium containing 1.0 mg/l IBA which was recorded by Goswamiet al. (2013). Root initiation commenced within 12 days, and after three weeks, vigorous roots could be seen on each plantlet they were, successfully, acclimatized and transferred to the glasshouse.

Acclimatization stage:

Effect of acclimatization mixture on plantlets survival, during plantlets acclimatization stage of citrus rootstocks.

Data presented in Table (7) and Plate (3) demonstrated the ex vitro successful acclimatization of neoformed plantlets of citrus rootstocks" Volkamer ". A high percentage of "Volkmer" plant survival (80%) was achieved by transplanting of plantlets in pots containing peatmoss and sand at ratio of 1:1(v/v). Generally, the well- defined mixture declared mixture the best mixture of growing "Volkamer" plantlets. As well as, no significant difference was dectected regarding plant survival observed between all mixtures. The number of newly formed leaves (true leaves) of "Volkamer", especially the highest mean number value were achieved due to the mixture ratio above-mentioned of

peatmoss: sand (1:1) and the lowest mean value was recorded with the ratio of peatmoss and sand (1:2). While, the plantlets length of 'Volkamer" was, significantly promoted by the effect of physical and chemical properties of acclimatization mixture which resulted in (9.5cm), but the lowest height was 3.4 cm which was recorded owing to the mixture from the sand: peatmoss (1:2).

Table (7). Effect of acclimatization mixture on plantlets survival, during plantlets acclimatization stage of Citrus Volkameriana.

Acclimatization mixture	Volkamer		
	Plant survival %	Number of newly leaflets	Shoot length (cm)
Sand+ Peatmoss 1:2	40	3.4	5.6
Sand + Peatmoss 2:2	40	3.9	7.5
Sand + Peatmoss 1:1	80	5.8	9.5
Sand + Peatmoss 2:1	60	3.7	5.6
L.S.D.	40.561*	0.868***	1.545***

L.S.D. = Least significant difference test at 0.05,0.01,0.001 level of probability.
*, **,***, ns= significant, high significant, very highly significant, not significant, respectively.

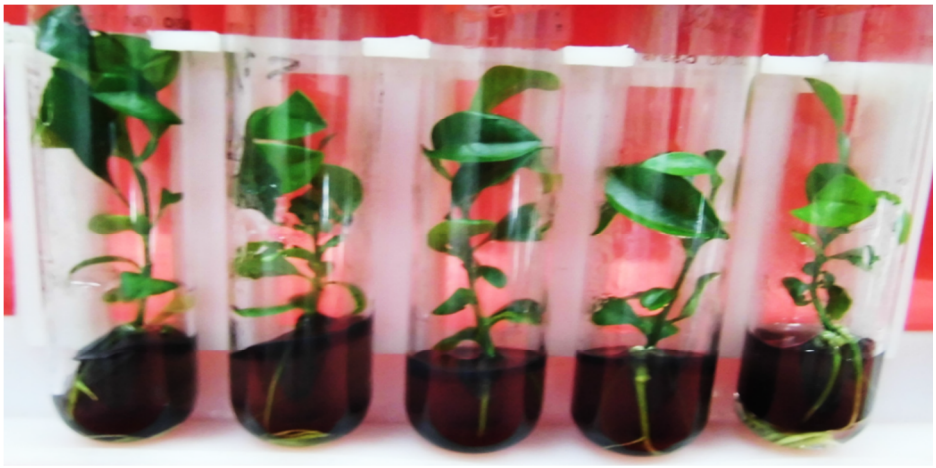

Plate (2). Rooting stage of Volkamer using MS medium containing 2.0 mg/l IBA and 0.2 mg/l NAA.

Plate (3). Acclimatization stage of Volkamer.

In this context, Kumar et al. (2001) found that the complete plantlets survival rate of regenerated were obtained with the highest survival rate of 68.8% due to transfer the neoformed plantlets to pots containing sand and soil (2:1) was 66.02% in Mosambi and 67.5% in Jaffa. Usman et al. (2005) found that Kinnow explants registered the highest rooting percentage (91%)and recorded the highest number of root per shoot (1.3). the plantlets were grown in the greenhouse on mould, sand, peat moss, and loam, then transplanted into the field after 2-3 month. Prez-Tornero et al. (2010) reported that the success during the acclimatization was close to 100% and the plantlets exhibited normal growth in soil under greenhouse condition. In addition, Roussos et al. (2011) claimed that the rooted explants were successfully acclimatized under mist (85%). Also, Khalil et al. (2011) noticed that the regenerated plantlets of C. senensis were successfully acclimatized when planted in jiffy pots containing sterilized soil mixture of sand, silt and clay in 1:1:1 ratio to study their response to in vivo condition.

In conclusion, the stem node segment was the best of the citrus " Volkamer Lemon" explant showed the maximum shoot initiation on MS medium supplemented with BAP at 2.0 and NAA 0.1 mg/l each in turn. While, MS medium containing BAP at 2.0 or 2.5 and NAA at 0.05 mg/l; brought about the highest multiplication rate of the given traits. Whereas, the maximum rooting was obtained on MS medium augmented with IBA 2.0 mg/l + NAA at 0.2 mg/l. Generally, the mixture ratio of sand: peat moss (1:1) was the best mixture of growing "Volkamer Lemon" plant on the given trait.

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الملخص العربي

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تعتبر الموالح من أهم محاصيل الفاكهة حول العالم لما لها من قيمة غذائية عالية وايضا مقبولة كغذاء طازج. تم تنفيذ هذه الدراسة في مركز بحوث الصحراء–القاهرة–مصر خلال الفترة من ٢٠١٣ الى ٢٠١٧. لقد تم إيجاد بروتوكول كفء ويعتمد عليه للإكثار المعملي الدقيق لأصل ليمون الفولكامر. لقد تم تقييم تأثير توليفات مختلفة من أثنين من منظمات النمو (سيتوكينين وأوكسين) على كفاءة تكاثر هذا النوع من الموالح من خلال تقنية الإكثار المعملي الدقيق. تمت زراعة البراعم رأسياً على بيئة موراشيج وسكوج MS المزودة بتوليفات مختلفة من السيتوكينين بنزيل أمينو بيورين بتركيزات صفر، ٠,٥، ١,٠، ١,٥، ٢,٠، ٢,٥، ٣,٠ ملجم/ لتر) وكذلك الأوكسين نفثالين حمض الخليك بتركيزات صفر، ٠,١ و ٠,٢ ملجم/لتر، وأثبت التفاعل بين البنزيل أمينو بيورين× نفثالين حمض الخليك عند ٢,٠×٠,١ ملجم/لتر على التوالي هي التوليفه الأفضل لأستحثاث نمو البراعم المنزرعة. كانت النسبة المئوية لحياة الأجزاء الساقية البرعمية ١٠٠% خاصة عندما زودت بيئة موراشيج وسكوج بمدى من البنزيل أمينو

بيورين يتراوح بين ١,٠ الى ٣,٠ ملجم. كان أفضل تنشئة للمجاميع الخضرية قد تم الحصول عليه عندما زرعت الأجزاء النباتية على بيئة موراشيج وسكوج المزودة بنزيل أمينو بيورين ونفثالين حمض الخليك عند ٢,٠ كذلك ٠,١ ملجم / لترعلى التوالي، والتي سجلت أعلى قيمة متوسطية (٣,٩٩) مجموع خضرى لكل جزء نباتى. ولقد تم الحصول على مجاميع خضرية طويلة عندما زرعت تلك المجاميع الخضرية على بيئة موراشيج وسكوج المزودة بنزيل أمينو بيورين ونفثالين حمض الخليك عند٣,٠ كذلك ٠,١ ملجم على التوالي. أما اعلى معدل تضاعف لتلك المجاميع الخضرية كانت قد لوحظت عندما زرعت تلك المجاميع الخضرية على بيئة موراشيج وسكوج المزودة بنزيل أمينو بيورين ونفثالين حمض الخليك عند أما٢,٠ أو ٢,٥ ملجم/لتر بالنسبة للأول وكذلك ٠,٠٥ ملجم/لتر للأخير. تم تجذير المجاميع الخضريةعلى بيئة موراشيج وسكوج المزودة بالأوكسين أندول بيوترك حمض الخليك ونفثالين حمض الخليك عند ١,٥ كذلك ٠,٢ ملجم/ لتر على التوالي مع أعلى نسبة مئوية للتجذير والتي كانت ١٠٠%. كان معدل حياة النبيتات ٨٠% عندما تم نقلها الى أصص بلاستيكية تحتوى على خليط من الرمل والبيتموس (١:١). ولهذا فالدراسة الحالية تقدم تقنية يمكن الأعتماد عليها للإكثار المعملى الدقيق.

Soil Resources Potentialities of Some Areas Adjacent to Bani Mazar-El-Boiety Road, West of El-Minia, Egypt

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ABSTRACT: The present study is concerned with assessment of land potentiality of an area locating at Bani Mazar's Western Desert fringe, that is bounded by longitudes 30° 09` and 30° 30` E and latitudes 28°30` and 28° 35` N, covering an area of approximately 82883 acres. The area could be distinguished, on basis of remote sensing as well as GIS facilities, into eleven (11) landforms; i.e. three different tablelands (TL), in terms of topography (almost flat TL, gently undulating TL, undulating TL); depression; plateau foot slope; major and minor escarpments; hills; hill foot slope; denuded hills and sand dunes. Twenty two (22) soil profiles, representing the tableland, depression, and plateau foot slope were morphologically described, their physical and chemical properties were determined; and their diagnostic characteristics were assessed. Data indicated that soils generally belong to the order *Entisols* and could be place, at sub-group level, to *Typic Torriorthents* and *Typic Torripsamments.* In addition, there is a relatively limited area belonging to *Lithic Torrorthents*. Based on CERVATANA model, around 61.9 % of the area is moderately capable for agricultural production (S3), whereas 13.93 % is non-productive and the rest of the area (24 %) is associated with sand dunes, hills and escarpment landform units. At subclass level, there are S3r, referring to moderate capability with slight constraint severity and S3lr specifying those affected by severe soil constraints and erosion risk. In terms of ALMAGARA model, related to the suitability of soil for crop cultivation, tested crop could be arranged as olive > sugar beet > alfalfa > peach > citrus > wheat > maize > melon > potato > sunflower. It is also indicated that about 2.75 % of the acreage area are suitable for peach, citrus and olive, whereas 25.23 % is moderately suitable, 14.36 % is marginally suitable and 33.36 % is not suitable for the selected crops.

Keywords: El-Minia Governorate, Soil characteristics, Micro LEIS, Land capability, Land Suitability, Remote Sensing, and GIS.

INTRODUCTION

Egypt has experienced a rise and the prevalence of combined food insecurity and income poverty to 17.2% (an estimated 13.7 million people) in 2011, up from 14% of the population in 2009. The increasing population and limited cultivated land, combined with land degradation and desertification pose significant challenges for production. Between 2010 and 2011the total cultivated area in Egypt decreased by about 1 percent, associated with encroachment of aeolion sand on agricultural land (World Food Program, 2013), which necessitates the need for exploring the desert land around the old cultivated area in Egypt to find out the suitable soils for agriculture and reasonable sustainable way. Agricultural expansion, on scientific basis, is considered the mainstay of Egypt's national economy to take up and cope with the current economic chalenges.

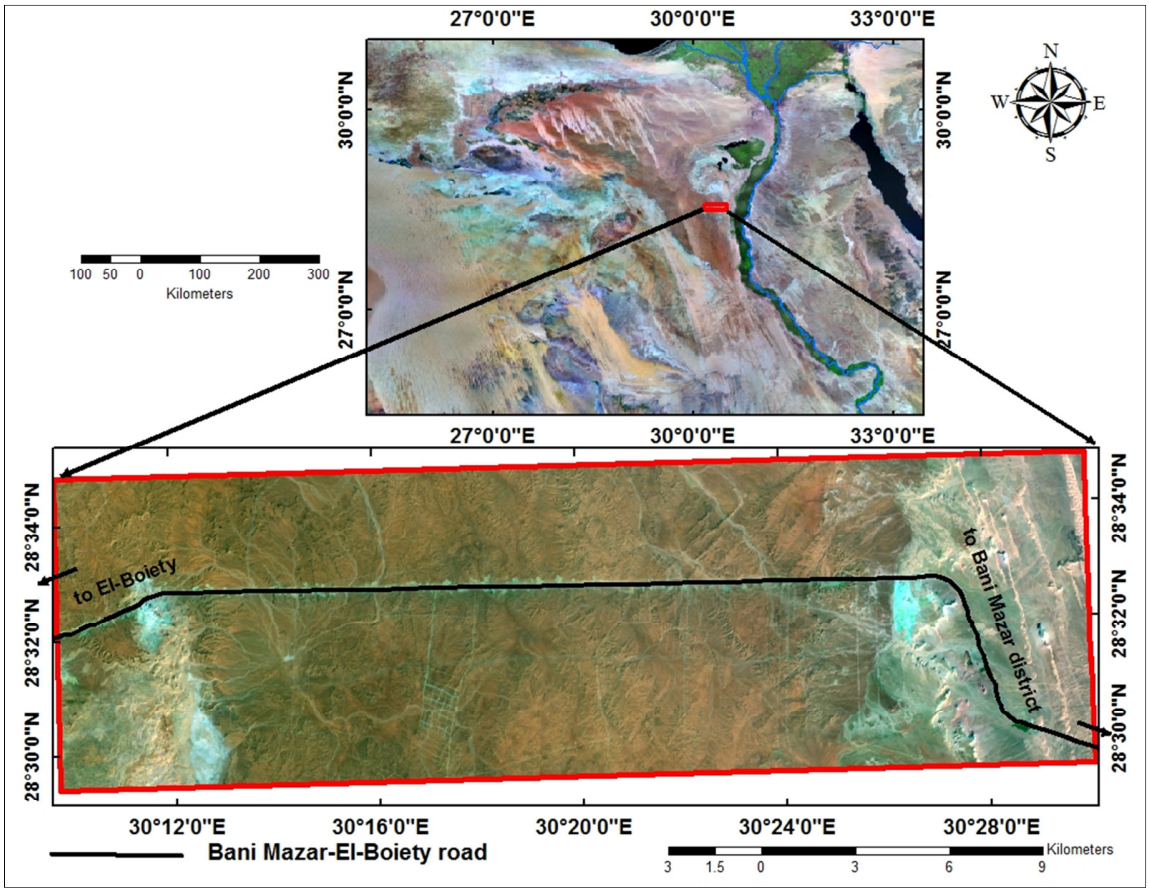
The full understanding of the geological, geomorphological and pedological, as well as chemical and physical properties of soils is considered as the fundamental base for a successful reclamation plan in Egypt. Land evaluation is the process of estimating the potentials of land for alternative kind of use.

According to Dent and Young (1981), it includes productive uses, such as arable farming, livestock production and forestry, together with the uses that provide services or other benefits, such as water catchment's area, recreation, and tourism and wildlife conservation.

Remote sensing techniques have been utilized in soil science for many years as a tool for soil surveyors, reducing the time and expense for sampling (Palacios-Orueta and Ustin, 1998). Geographic information system plays a major role in spatial decision-making. The collected information for the suitability analysis for crop production should present both opportunities and constraints for the decision maker (Ghafari *et al*., 2000). The ultimate aim of GIS is to provide support for spatial decision making process (Foote and Lynch, 1996). Spatial analysis can be defined as the analytical technique associated with the study of geographic phenomena locations together with their spatial dimensions and their associated attributes (ESRI, 2010).

The present investigation deals mainly with the geomorphologic setting, soil condition and its classification in order to evaluate the potentialities of some soil resources adjacent to Bani Mazar-El-Boiety Road, West of El-Minia in terms of land capability and land suitability for the horizontal agricultural expansion and their optimum agricultural use based on remote sensing data, GIS facilities, selected soil-sites characteristics and physical and chemical characteristics of the different soil units.

The area under investigation is located in the west of El-Minia Governorate, adjacent to Bani Mazar-El-Boiety Road with about 33.5 km in length. It is bounded by longitudes 30^{o} 09` and $30^{o}$ 30` E and latitudes $28^{o}30$` and $28^{o}$ 35` N, covering an area of approximately 82,883 acres, (Map 1). Said (1993) mentioned that in the western side of the Nile valley, the middle Eocene formations are covered by Oligocene gravel and cobbles. The Eocene limestone may crop to the surface locally. The main geological deposits in the study area are Nile deposits, sand dunes, aeolian deposits, gravel and basalt, (EGPC - Conco Coral Staff, (1987). According to Abu El-Izz (2000) the investigated area is built of recent alluvium sediments belong to Pleistocene, and Pliocene periods. The area is characterized by arid climate as the total rainfall is 7.8 mm/year. The dryness is prevailing most of the year and the wet periods are comparatively short. Based on the Egyptian Meteorological Authority data (2009) and Soil Taxonomy System (USDA Soil Survey Staff, 2014a), the soil temperature regime of the studied area is defined as Thermic, and the soil moisture regime as Torric. Ground water is considered the main source of irrigation water in the study area.



Map (1). Location of the investigated area at the west of El-Minia.

MATERIALS AND METHODS

A Landsat-8 Operational Land Imager (OLI) data covering the investigated area acquired in 2016 (path 177 / row 40) was employed in this study. It was merged and processed with Digital Elevation Model (DEM), (Fig. 1), which has been generated from the vector contour lines, and prepared in ERDAS Imagine 9.3 software (2010) to identify the different landforms of the study area. The OLI data were classified using the ISO-DATA classification technique (Map. 2) to produce unsupervised soil map for the resultant landforms (Lillesand and Kiefer, 2000).

A rapid reconnaissance survey was made throughout the investigated area in order to identify and verify landforms and to gain an appreciation of the broad soil patterns and landscape characteristics of the investigated area. The primary mapping units were verified based on the field interpretation and the information gained during the field work. Twenty two soil profiles were dug (note: soil profiles No. 1 & 16 not represented on the soil profile location map) to represent

unsupervised soil mapping unit within the resultant landforms and to fulfill the requirements of the digital soil maps, in addition to some testing auger observations for the purpose of recognizing the boundaries among the different mapping units. A detailed morphological description of soil profiles was recorded on the basis of guidelines for soil description, FAO (2006).

The collected soil samples from genetic horizons/layers of the profile pits were subjected to some physical and chemical analyses using soil survey laboratory methods manual, USDA Soil Survey Staff (2014). Soil characteristics values were recalculated over a certain depth, some of them by using weighting factors for the different profile sections, Sys *et al*. (1991a). Soil classification was carried out according to the USDA Soil Taxonomy, USDA Soil Survey Staff (2014).

A land capability and suitability evaluation were applied using CERVATANA and ALMAGRA models constituent of MicroLEIS DSS respectively. These two models were designed by De la Rosa *et al.* (1992) and modified for computing purpose by De la Rosa *et al.* (2004). Following the generally accepted norms of land evaluation (Klingebiel and Montgmery, 1961; FAO, 1976; Dent and Young, 1981; ONERN, 1982; Verheye, 1986), the CERVATANA model forecasts the general land use capability or suitability for a broad series of possible agricultural uses. That model works interactively, comparing the values of the characteristics of the land-unit to be evaluated with the generalization levels established for each Use Capability Class. The prediction of general land use capability is the result of a qualitative evaluation process or overall interpretation of the following biophysical factors: relief, soil, climate, and current use or vegetation. Following the procedure of maximum limitation method, four capability classes are determined: Class S1-Excellent, Class S2-Good, Class S3-Moderate, and Class N-Marginal and Nule. Four subclasses are also defined according to the most limiting land qualifies.

While the second Model, ALMAGRA model, fits the types of biophysical evaluation that use as diagnostic criteria those soil characteristics or conditions favorable for crop development in function of productivity. The soil characteristics considered in this model are: limit of useful depth, useful depth, stoniness, texture, drainage, carbonates content, salinity, sodium saturation, and degree of development of the profile. For each soil characteristic, it was established a gradation matrix which relates the soil characteristic value with the corresponding soil crop requirements. Following the procedure of maximum limitation, five relative suitability classes are determined: Class S1-Highly suitable, Class S2- Suitable, Class S3-Moderately suitable, Class S4-Marginally suitable, and Class S5- Not suitable. The subclasses are indicated by the letters corresponding to the main limiting soil diagnostic criteria. Ten land uses were tested for their suitability in the investigated area, namely: traditionally crops wheat (T), maize (M), melon (Me), potato (P), sunflower (G) and sugar beet (R) as annuals; alfalfa (Af) as semiannual; and peach (Me), citrus fruits (C) and olive (O) as perennials. The requirements of each kind of land use are obtained according to Sys *et al.,* (1993).

The tested crops were chosen on basis that several problems are facing the decision makers which are: low quality soil resources, shortage of available irrigation water and low quality of the available water.

Geomorphologic, soil, land capability and land suitability maps were spatially generated by using Arc GIS software, ESRI (2010).

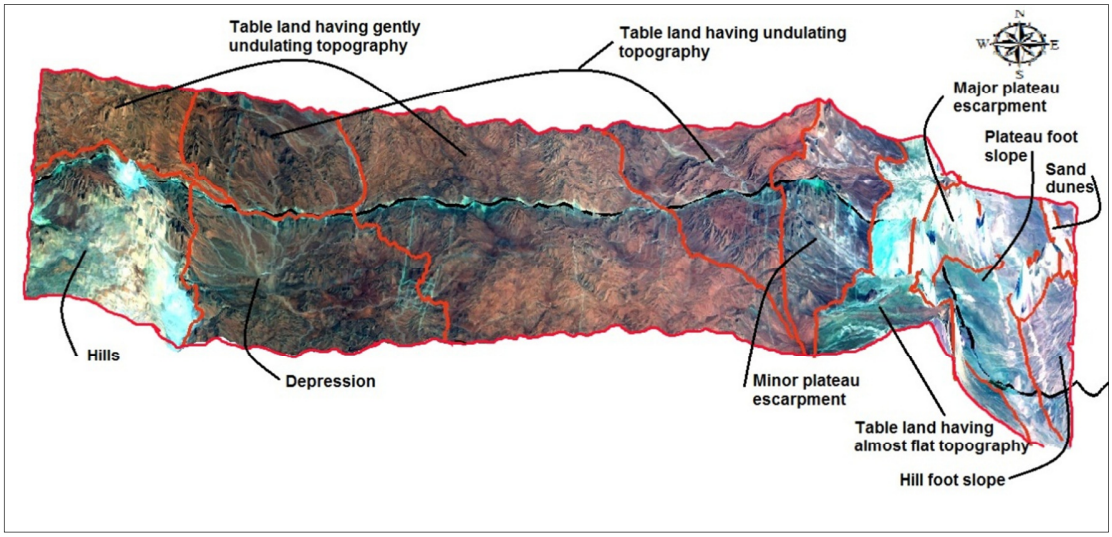
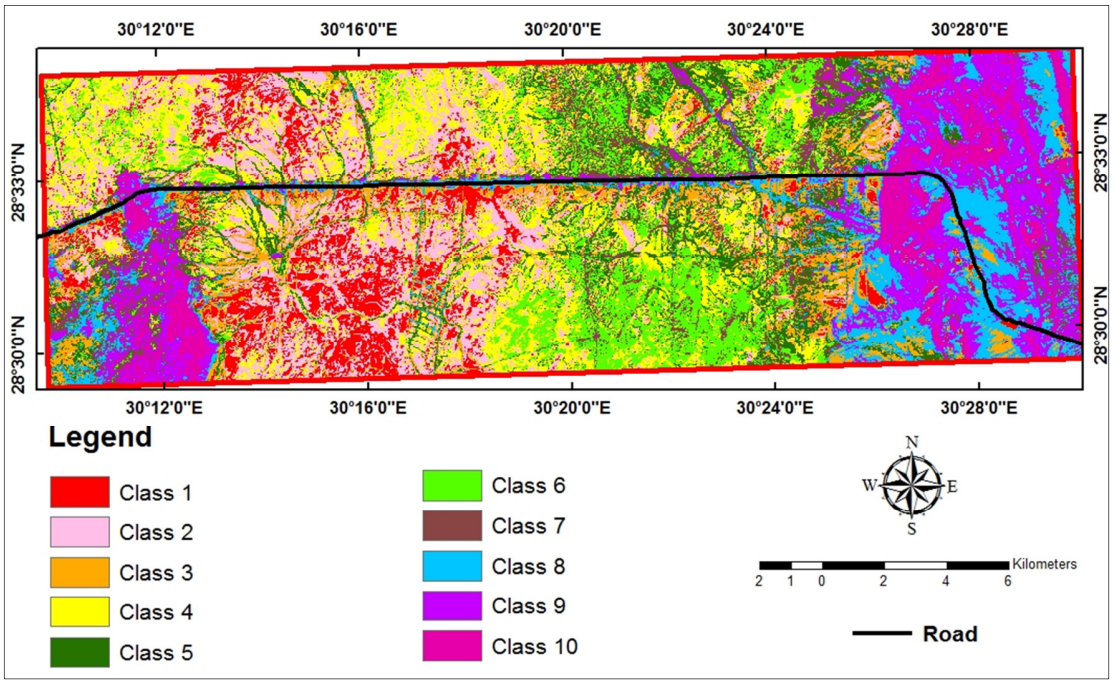


Fig. (1). 3D view of the investigated area showing the main landforms.

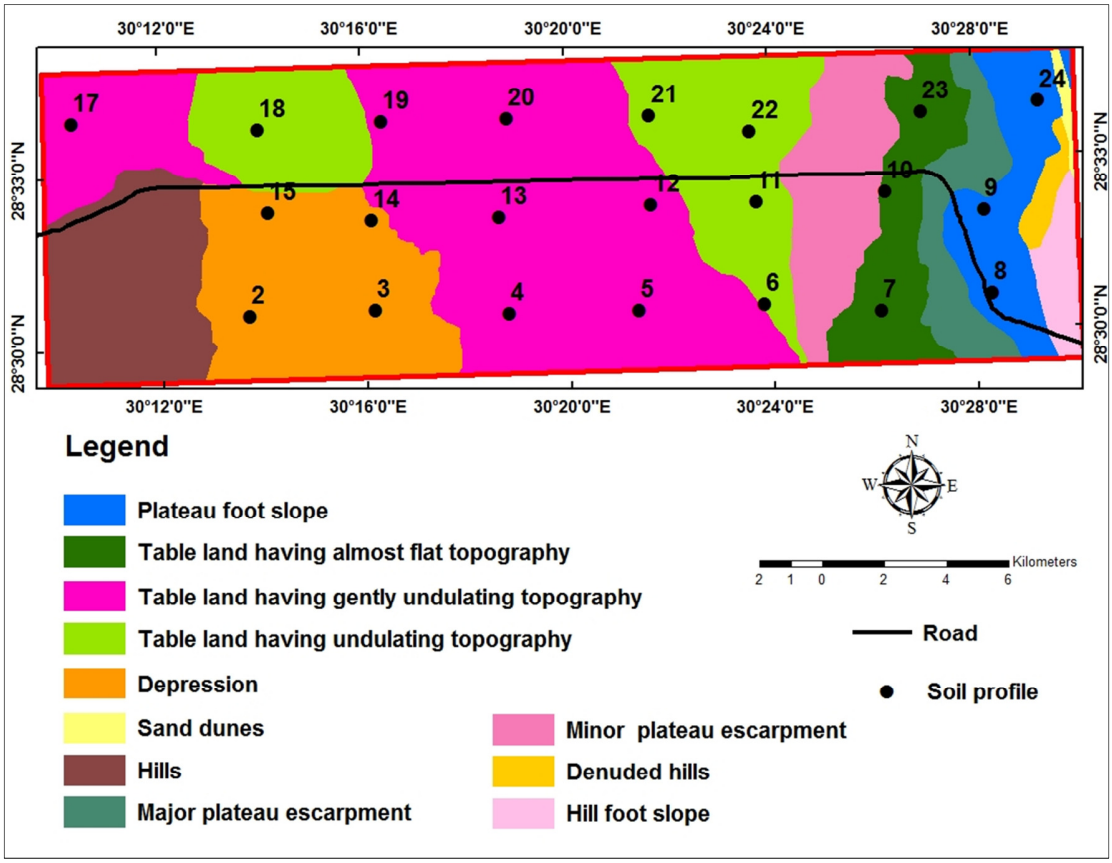


Map (2). Unsupervised classification of the investigated area.

RESULTS AND DISCUSSION

A- Geomorphology of the investigated area

The results showed that viewing a remotely sensed image merged with Digital Elevation Module (DEM) can often lead to get the better understanding of the patterns in the image and how they relate to the shape of the earth's surface. And based on the visual and digital interpretation of merged Digital Elevation Module (DEM) with Landsat-8 OLI image together with knowledge drawn from the geological map (Egyptian General Petroleum Corporation Conco Coral Staff, 1987), topography map, ground truth data and soil survey of the study area, the geopedological approach (Zinck, 1989) is adopted to produce the physiographic map, (Map 3). The combination among landscape, lithology, morphology of the terrain surface, and the photo mapping units are shown in Table (1). Landforms map was considered a Geo- database map over which the representative soil profiles were spatially distributed.



Map (3). Main landforms of the investigated area represented by soil profiles.

Table (1). Physiographic legend, proportions of each landform and associated soil profiles of the study area.

Landscape	Relief [1]	Lithology/Origin [2]	Landform	Mapping unit symbol	Representative Soil profiles	Elev. (m)	Area (Acre)	Area (%)
Plateau Pu	Almost flat 0.5 - 2% Pu 2	Wadi Rayan formation Pu 23	Plateau foot slope	Pu 231	8, 9 and 24	90 – 120	5011	6.04
			Table land having almost flat topo	Pu 232	7,10 and 23	120 - 130	5304	6.4
	Almost flat 0.5 - 2% Pu 2	Oligocene to Pleistocene Pu 24	Depression	Pu 241	2, 3,14 and15	140 - 160	10871	13.11
	Gently undulating 2-5% Pu 3	Oligocene to Pleistocene Pu 34	Table land having gently undulating topo.	Pu 341	4,5,12,13,17,19 and 20	150 - 170	28103	33.9
	Undulating 5-10% Pu 4	Oligocene to Pleistocene Pu 44	Table land having undulating topo.	Pu 441	6,11,18,21 and 22	145 - 175	13476	16.25
	Rolling 10 – 15% Pu 5	Quaternary Pu 55	Sand dunes	Pu 551		90 - 100	335	0.4
	Hilly 15-30% Pu 6	Minia formation Pu 61	Hills	Pu 611		160 - 230	8041	9.7
	Steeply dissected 30 - 60% Pu 7	Wadi Rayan formation Pu73	Major plateau escarpment	Pu 731		120 - 150	3438	4.14
			Minor plateau escarpment	Pu 732		140 - 170	5921	7.15
Hilland Hi	Hilly 15-30% Hi 6	Samalut formation Hi 62	Denuded hills	Hi 621		110 - 140	699	1
			Hill foot slope	Hi 622		100 - 130	1588	1.91
Total							82883	100

1- The relief indicated by an Arabic number in sequence of decreasing slope gradient as follows:
1 Flat, 2 Almost flat, 3 Gently undulating, 4 Undulating, 5 Rolling, 6 Hilly, 7 Steeply dissected, and 8 Mountainous.
2- The lithology/ origin indicated by an Arabic number in sequence of old age to recent age.

B- Soils of the investigated area

The results showed that the area under investigation has different morphological, physical and chemical characteristics according to the studied soil profiles representing the different unsupervised soil mapping units of the resultant landforms. Tables (2 and 3) show values of soil attributes of some potential landform units which could be discussed and classified according to Soil Taxonomy (Map 4), (USDA Soil Survey Staff, 2014) as the following:

1- Soils of plateau foot slope (Pu 231)

Soils of this unit were formed at the down of a major rock escarpment of the limestone plateau landscape in the eastern part of the study area, formed from Wadi Rayan formation dated back to middle Eocene age. They occupy an area of about 5,011 acre covering 6.04 % of the total area and represented by soil profiles No. 8, 9 and 24. The surface is almost flat, sloping towards the east, and covered with many fine gravel. Surface runoff and associated hazard of water erosion are slight due to dominant very gentle slope. The data show that, because of the erosional and depositional process, soil profiles are either moderate (< 100 cm) or deep (> 100 cm) and lack any evidence of development. Characteristics of soils formed on it are mainly related to the local lithology.

Soil texture is sand throughout the different layers of representative soil profiles. Calcium carbonate content ranges between 10.7 and 29.92% with a general trend to increase in the profile bottoms reflecting the calcareous parent materials nature in the representative profile. Gypsum content is recorded among the studied soil samples and ranges from 1.76 to 4.01%. Secondary formations of carbonates and gypsum in detectable amount were identified throughout the layers without any diagnostic horizons. Soil-pH is slightly alkaline (pH 7.4-7.7), ESP values indicate low sodium hazard (ESP 4.74-9.88%), and soil salinity varies from moderately to extremely saline (EC 9.03-50.2 dSm^{-1}). The vertical distribution of salts shows gradual homogenity with depth. The soils of this unit are classified as *Typic Torripsamments.*

2- Soils of tableland having almost flat topography (Pu 232)

This unit is a part of the plateau landscape located between the major escarpment in the east and the minor escarpment in the west at the eastern part of the study area; formed from Wadi Rayan formation dated back to middle Eocene age. They occupy an area of about 5304 acre covering around 6.4 % of the total area and represented by profiles No. 7, 10, and 23. The surface is almost flat and covered with much fine gravel. The hazardous effect of water erosion is slight as surface runoff is very slow due to slight slope class. Because of the erosional and depositional process or due to limitation by a lithic contact, soil profiles are either shallow depth (< 50 cm) or moderately deep (50 - 100 cm) and lack any evidence of development. Characteristics of soils formed on it are mainly related to the local lithology.

Data in Table (3) show that soils have coarse texture and are generally strongly to extremely calcareous ($CaCO_3$ % 18.93 – 66.34 %), moderate in gypsum content (1.71 – 4.5), and considerably varied salinity level are obtained (EC 3.88 – 29.17 dS/m). In representative profile No. 10, the salinity increases with depth reflecting the Eocene marine nature in the profile bottoms (Wadi Rayan formation). Values of pH (7.8 – 8.1) and ESP (16 -21%) show that the soils are saline-alkaline except soil profile-10 which has pH and ESP ranging from 7.4 – 7.9 and 8.5 – 10.5 %, respectively is saline. The soils of this unit are classified as *Typic Torripsamments* (profile-10) and *Lithic Torriorthents* (profiles-7 and 23).

3- Soils of depression (Pu 241)

Soils of this unit cover an area of about 10,871 acre, representing 13.11 % of the total area and are represented by soil profiles No. 2, 3, 14, and 15. They are formed in the low-lying lands existing in the Oligocene to Pleistocene plateau surface which is located at south west of the study area. The surface is almost flat, very gently sloped towards the center of this unit, and is covered with many varysized gravel. The hazardous effect of water erosion is slight as surface runoff is very slow due to slight slope class. Data in tables (2 and 3) show that soils represented by profiles 2, 3 and 14 are moderately deep while profile 15 is deep and all are characterized by sandy to gravelly sand texture, moderately well to excessively drainage and devoid of any sign of horizon development. Total carbonates are moderate ($CaCO_3$ % 4.49-10.51%), gypsum content is present as traces, soil-pH is slightly too moderately alkaline (pH 7.6-8.1), ESP values indicate low sodium hazard (ESP 5.11-13%), and soil salinity varies widely from very slightly to moderatley saline (EC 2.2-14.5 dSm^{-1}). Based on analytical data and field studied soils of depression are classified as *Typic Torripsamments* (profiles-3, 14, and 15) and *Typic Torriorthents* (profile- 2).

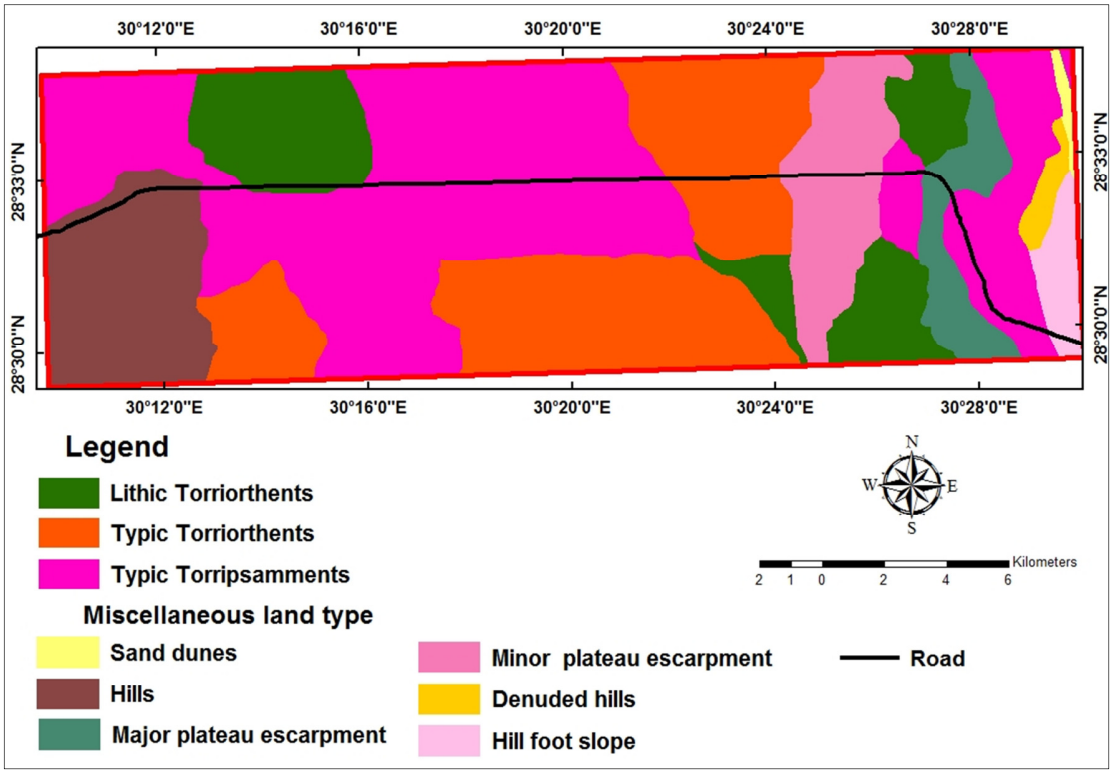
4- Soils of tableland having gently undulating topography (Pu 341)

These soils dominate the plateau surface of the study area occupying an area of about 28,103 acre representing 33.9% of the total area. They are developed from the formations dated back to Oligocene to Pleistocene ages. They are formed from sandy to gravelly sand soils. Surface is gently undulating and covered with gravel associated with desert varnish which minimizes surface runoff with slight hazard of water erosion. Soils of this landform were examined through profiles 4, 5, 12, 13, 17, 19, and 20. They are excessively and/or moderately well drained and characterized by deep to moderately deep profile. Very wide variation in total carbonate content are recorded among the representative soil profiles and ranging between 3.29 and 35.56 % due to the nature of parent material which consists essentially of sandy and gravelly sediments, while gypsum content is present as trace. Secondary formations of carbonates and gypsum in detectable amount were identified throughout the layers without any characteristics of diagnostic horizons. Soil reaction is slight tending to moderately alkaline range where pH values fluctuate between 7.4 and 8.4. Soils have wide range of salinity with EC values ranging between 4.07 and 27.25 dSm^{-1}. Values of ESP (from 6.5 to 14.5 %) indicate with values of EC and pH that those soils are saline. Hence, soils are

classified as *Typic Torriorthents* (Profiles-4 and 5) and *Typic Torripsamments* (profiles-12, 13, 17, 19 and 20).

5- Soils of tableland having undulating topography (Pu 441)

Soils of table land having undulating topography cover an area of 1,3476 acre representing 16.25 % of the total area. The surface is undulating and covered with many varysized gravels. They are represented by soil profiles No. 6, 11, 18, 21 and 22. These soils are characterized by shallow or deep gravelly sand profile with excessively drained (profiles-11, 21 and 22) and poorly drained (profiles-6 and 18) status. Secondary formations of carbonates and gypsum in detectable amount were identified throughout the layers with no any characteristics of diagnostic horizons. The electrical conductivity values revealed that soil salinity varies widely from very slightly saline (EC ≈ 3.16 dS/m) to extremely saline (EC ≈ 20.6 dS/m). The higher figures of salinity are mostly concentrated in the middle layers of profiles- 11, 21, and 22 as its EC values vary from moderately (EC ≈ 12.3 dS/m) to extremely saline (EC ≈ 20.6 dS/m). The soil-pH values vary from slightly (pH ≈ 7.6) to moderately alkaline (pH ≈ 8.3). ESP values (from 2.5 to 16.24 %) indicating with the other parameters (pH and EC) that these soils are mostly slightly saline – slightly alkaline. Hence, they are classified as *Typic Torriorthents* (Profile-11, 21and 22) and *Lithic Torriorthents* (profiles-6 and 18).



Map (4). Soil classification of the investigated area.

Table (2). The main morphological features of representative soil profiles in the investigated area.

Profile No.	Lat. N Log. E	Topography, Slope, Surfac cover	Erosion	Drainage	Depth (cm)	Soil colour		Consistency*
						Dry	Moist	
Plateau foot slope (Pu 231)								
8	28°30'36.21" 30°28'18.87"	Almost flat, Nearly level, Many fine gravel	Slight	Excessive	0-30	10 YR 6/6	10YR 5/8	LO
					30-90	10 YR 6/6	10YR 5/8	HA
					90-105	10 YR 6/8	10YR 5/8	HA
					105-120	10 YR 6/8	10YR 5/8	EHA
9	28°32'3.73" 30°28'11.52"		Slight	Moderately well	0-30	10 YR 8/2	10YR 7/2	SO
					30-60	10 YR 8/3	10YR 7/4	HA
					60-90	10YR 8/3	10YR 7/4	HA
24	28°33'54.78" 30°29'18.07"		Slight	Excessive	0-30	10 YR 6/6	10YR 5/8	LO
					30-90	10 YR 6/6	10YR 5/8	HA
					90-105	10 YR 6/8	10YR 5/8	HA
					105-120	10 YR 6/8	10YR 5/8	EHA
Tableland having almost flat topography (Pu 232)								
7	28°30'21.14" 30°26'7.60"	Almost flat, Nearly level, Many fine gravel	Slight	Poor	0-30	7.5YR 8/4	7.5YR 7/4	SHA
10	28°32'24.69" 30°26'15.32"		Slight	Moderately well	0-35	10YR 7/4	10 YR 6/6	LO
					35-55	10YR 7/4	10 YR 6/6	SO
					55-90	10YR 7/4	10 YR 6/6	HA
23	28°33'40.43" 30°26'16.42"		Slight	Poor	0-30	10YR 8/3	10YR 7/6	SHA

* Consistency: LO - Loose, SO - Soft, SHA - Slightly Hard, HA - Hard

Table (2). Cont.

Profile No.	Lat. N Log. E	Topography, Slope, Surfac cover	Erosion	Drainage	Depth (cm)	Soil colour Dry	Soil colour Moist	Consistency*
Depression (Pu 241)								
2	28°30'32.53" 30°13'42.99"	Almost flat, Very gently sloping, Many varysized gravel	Slight	Moderately well	0-25	10YR 7/6	10 YR 6/6	LO
					25-65	10 YR 6/6	10YR 5/8	SHA
					65-90	7.5YR 6/6	7.5 5/8	HA
3	28°30'35.11" 30°16'10.81"		Slight	Moderately well	0-30	10YR 7/4	10YR 5/8	HA
					30-60	7.5YR 7/6	7.5 5/8	HA
14	28°32'9.61" 30°16'8.60"		Slight	Moderately well	0-30	10 YR 6/6	10YR 5/8	SO
					30-50	10YR 7/6	10 YR 6/6	SHA
					50-80	7.5YR 6/8	7.5 5/8	HA
15	28°32'19.91" 30°14'6.15"		Slight	Excessive	0-40	10YR 7/4	10 YR 6/6	LO
					40-80	10YR 7/6	10 YR 6/6	SO
					80-120	7.5YR 6/8	7.5 YR 5/8	SHA
					120-150	7.5YR 6/8	7.5 YR 5/8	HA
Tableland having gently undulating topography (Pu 341)								
4	28°30'27.75" 30°18'48.55"	Gently undulating, Gently sloping, Many varysized gravel	Slight	Excessive	0-30	10YR 7/6	10YR 6/6	LO
					30-80	10YR 7/6	10YR 6/6	SHA
					80-120	7.5YR 7/4	7.5YR 5/8	HA
5	28°30'27.39" 30°21'21.52"		Slight	Excessive	0-40	10YR 7/4	10 YR 6/6	SO
					40-80	7.5YR 6/6	7.5YR 5/8	SHA
					80-120	7.5YR 6/6	7.5YR 5/8	HA
12	28°32'17.33" 30°21'38.80"		Slight	Moderately well	0-15	10YR 7/4	10 YR 6/6	SO
					15-60	7.5YR 7/6	7.5 YR 6/6	SHA
					60-85	7.5YR 8/4	7.5 YR 7/6	HA
13	28°32'8.87" 30°18'38.63"		Slight	Moderately well	0-30	10YR 7/6	10 YR 5/8	SO
					30-60	7.5YR 6/6	7.5 YR 5/6	SHA
					60-80	7.5YR 6/6	7.5 YR 5/6	HA

Table (2). Cont.

Profile No.	Lat. N Log. E	Topography, Slope, Surfac cover	Erosion	Drainage	Depth (cm)	Soil colour		Consistency*
Tableland having gently undulating topography (Pu 341)								
17	28°33'56.61" 30°10'17.07"	Gently undulating, Gently sloping, Many varysized gravel	Slight	Moderately well	0-40	10YR 7/6	10 YR 6/6	SO
					40-80	7.5YR 6/8	7.5 YR 5/8	HA
19	28°33'51.83" 30°16'22.94"		Slight	Excessive	0-20	10YR 7/4	10YR 5/8	SO
					20-60	7.5YR 6/8	7.5 YR 5/8	SHA
					60-90	7.5YR 6/8	7.5 YR 5/8	SHA
					90-120	7.5YR 6/8	7.5YR 5/8	HA
20	28°33'51.47" 30°18'51.13"		Slight	Excessive	0-30	10YR 7/6	10YR 5/8	SO
					30-50	7.5YR 6/8	7.5 YR 5/8	SHA
					50-90	7.5YR 6/8	7.5 TR 5/8	HA
					90-120	7.5YR 5/8	7.5 YR 4/6	SHA
Tableland having undulating topography (Pu 441)								
6	28°30'30.70" 30°23'50.08"	Undulating, Sloping, Many varysized gravel	Moderate	Poor	0-20	7.5YR 7/6	7.5YR 6/6	HA
					20- 35	7.5YR 7/6	7.5YR 6/6	HA
11	28°32'17.33" 30°23'43.46"		Moderate	Excessive	0-40	10YR 7/4	10YR 5/8	SO
					40-80	10 YR 6/6	10YR 5/8	SHA
					80-150	5YR 6/6	5YR 5/6	HA
18	28°33'45.95" 30°13'56.96"		Moderate	Poor	0-25	10YR 7/4	10YR 5/8	SHA
					25-45	7.5YR 7/6	7.5YR 6/6	HA
21	28°33'50.36" 30°21'39.54"		Moderate	Excessive	0-30	10YR 7/4	10YR 5/8	SHA
					30-65	7.5YR 6/8	7.5 YR 5/8	HA
					65-110	7.5YR 6/8	7.5 YR 5/8	HA
22	28°33'31.24" 30°23'37.21"		Moderate	Excessive	0-30	10YR 7/4	10 YR 5/8	SHA
					30-80	7.5YR 7/6	7.5 YR 6/6	HA
					80-120	7.5YR 7/6	7.5 YR 6/6	HA

Table (3). Physical, and chemical soil properties in the investigated area.

10.5	Depth (cm)	Gravel (%) > 2 mm	Texture class	pH	EC dSm^{-1} in soil paste extract	$CaCO_3$ %	Gypsum %	ESP %
Plateau foot slope (Pu 231)								
8	0-30	16.67	S	7.72	13.40	18.77	1.76	4.74
	30-90	6.15	S	7.6	24.20	29.30	2.28	8.33
	90-105	9.52	S	7.51	29.50	27.16	2.77	9.23
	105-120	3.81	S	7.44	50.20	29.92	4.68	9.61
9	0-30	0.00	S	7.65	9.03	10.70	2.22	8.68
	30-60	25.00	GrS	7.37	25.02	23.87	4.01	9.88
	60-90	24.32	GrS	7.5	29.50	27.98	3.94	9.60
24	0-30	16.67	S	7.72	13.40	18.77	1.76	4.74
	30-90	6.15	S	7.6	24.20	29.30	2.28	8.33
	90-105	9.52	S	7.51	29.50	27.16	2.77	9.23
	105-120	3.81	S	7.44	50.20	28.50	4.68	9.61
Tableland having almost flat topography (Pu 232)								
7	0-30	12.50	LS	7.79	22.50	65.68	3.55	16.00
10	0-35	4.55	S	7.86	3.88	18.93	1.71	8.50
	35-55	15.38	LS	7.4	8.20	32.10	2.14	9.00
	55-90	26.67	GrS	7.75	29.17	40.99	4.50	10.50
23	0-30	7.14	S	8.1	20.45	66.34	3.07	21.00

*Texture: S - Sand, LS - loamy sand, GrS - Gravelly sand, VGrS - Very gravelly sand, VGrLS - Very gravelly loamy sand

Table (3). Cont.

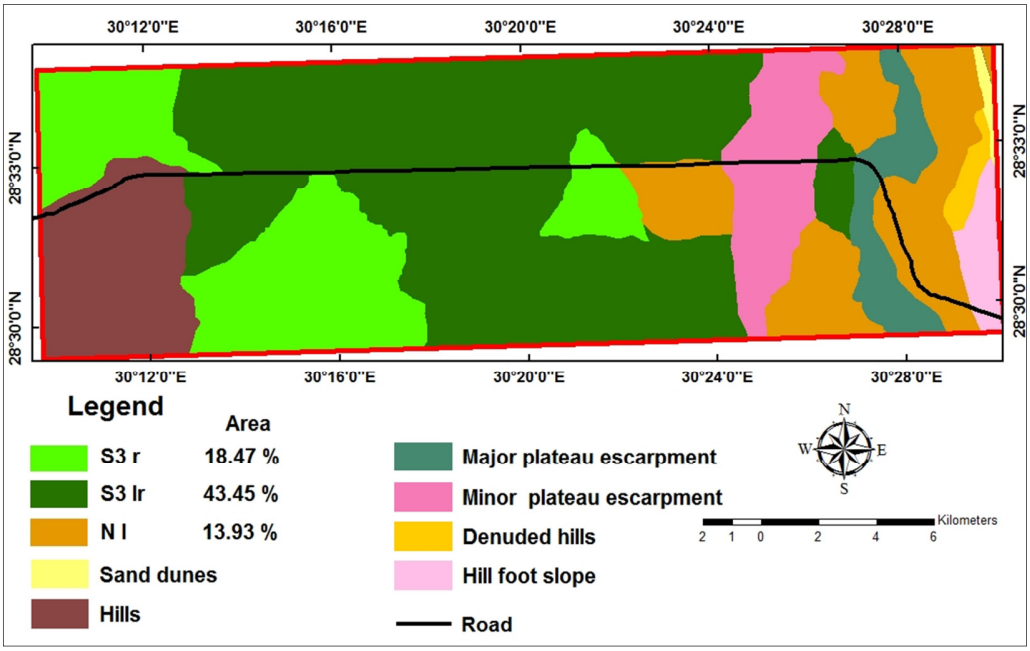
Profile No.	Depth (cm)	Gravel (%) > 2 mm	Texture class	pH	EC dSm-1 in soil paste extract	CaCO3 %	Gypsum %	ESP %
Depression (Pu 241)								
2	0-25	4.17	S	7.98	2.18	10.51	0.03	9.04
	25-65	58.75	VGrS	8.06	14.50	8.07	1.99	6.54
	65-90	63.45	VGrS	7.75	13.20	10.35	0.81	5.51
3	0-30	6.67	S	7.95	3.13	4.49	0.25	7.64
	30-60	30.00	GrLS	7.79	6.00	5.76	2.02	5.11
14	0-30	8.33	S	8.1	3.95	9.17	1.68	7.91
	30-50	6.86	LS	7.92	9.20	8.48	1.20	7.70
	50-80	10.43	LS	7.73	13.35	9.01	1.20	6.46
15	0-40	3.85	S	8.02	3.38	9.22	1.68	10.10
	40-80	26.92	GrS	7.94	6.77	6.58	0.67	13.00
	80-120	27.27	GrS	7.67	6.91	9.05	0.25	8.83
	120-150	18.06	GrS	7.6	9.50	10.04	0.30	5.96
Tableland having gently undulating topography (Pu 341)								
4	0-30	4.55	S	7.82	4.64	11.85	1.38	9.05
	30-80	66.67	VGrLS	7.91	4.60	18.11	1.98	8.38
	80-120	56.50	VGrLS	7.93	4.85	30.78	1.66	10.21
5	0-40	25.00	GrS	8.4	4.26	13.99	1.52	9.83
	40-80	50.50	GrS	7.87	10.82	13.33	2.08	14.50
	80-120	57.81	GrS	7.67	8.85	19.09	1.98	13.11
12	0-15	16.67	S	7.76	4.20	13.99	1.16	9.67
	15-60	14.00	LS	8.42	10.16	3.29	2.00	14.50
	60-85	34.00	GrLS	8.34	10.55	3.62	2.43	14.50

Table (3). Cont.

Profile No.	Depth (cm)	Gravel (%) > 2 mm	Texture class	pH	EC dSm^{-1} in soil paste extract	$CaCO_3$ %	Gypsum %	ESP %
Tableland having gently undulating topography (Pu 341)								
13	0-30	9.57	S	8.02	5.95	9.88	1.98	12.00
	30-60	13.83	S	7.74	22.50	9.38	2.59	13.00
	60-80	35.00	GrS	7.63	22.03	11.52	2.62	14.50
17	0-40	9.09	S	8.22	4.07	10.37	1.78	12.82
	40-80	9.52	LS	8.01	17.26	10.37	2.18	9.72
19	0-20	14.29	LS	7.82	4.56	11.85	1.12	12.00
	20-60	12.00	LS	7.86	6.51	22.39	1.98	13.60
	60-90	14.78	S	7.68	8.30	27.49	1.78	13.75
	90-120	3.70	S	7.8	10.46	35.56	1.98	6.50
20	0-30	11.76	LS	7.88	4.20	12.51	1.64	14.50
	30-50	4.17	LS	7.75	4.10	12.18	2.20	14.50
	50-90	4.35	S	7.46	27.25	12.51	4.16	14.50
	90-120	3.45	S	7.6	19.25	11.03	2.57	14.20
Tableland having undulating topography (Pu 441)								
6	0-20	51.85	VGrS	7.86	4.45	3.46	1.71	2.90
	20- 35	37.00	GrLS	8	13.75	7.01	2.30	2.50
11	0-40	51.28	VGrS	7.64	16.10	42.80	1.72	4.20
	40-80	79.23	VGrLS	7.54	20.60	12.35	3.37	12.50
	80-150	26.32	GrS	8.09	8.50	15.80	1.06	14.60
18	0-25	40.17	VGrS	7.93	4.16	12.35	1.55	14.90
	25-45	36.67	GrLS	8.14	14.25	7.24	2.57	2.60
21	0-30	13.89	LS	8.31	4.97	16.79	0.04	14.50
	30-65	70.32	VGrLS	7.4	16.50	29.63	1.58	16.24
	65-110	65.16	VGrLS	7.55	13.30	34.57	1.58	16.10
22	0-30	19.35	GrS	8.02	3.16	9.22	1.60	8.50
	30-80	62.67	VGrLS	8.22	12.30	13.50	2.22	13.80
	80-120	53.33	VGrS	7.92	7.86	15.64	1.98	11.20

C- Land capability of the investigated area

Results of the agricultural land capability evaluation generated by CERVATANA model constituent of MicroLEIS DSS are presented in Table (4) and Map (5). They include land capability classes and associated limitations of the studied soils representing different landforms. Two land capability classes were recognized, "Moderate Capability, S3" and "Non-Productive, N". Lands of moderate capability have two subclasses abbreviated as "S3 r" referring to soils with slight constraint severity, and "S3 lr" including soils affected by severe soil constraints and erosion risk. S3 r subclass includes soils of most of the depression unit and partially the tableland having gently undulating topography, which has slight limitation regarding erosion factor. Meanwhile, S3 lr subclass has considerable limitations linked to topographic (slope), edaphic (shallow profile, poor drainage, and/or high gravel content), or climatic factors. It includes partially soils of the table-land having almost flat topography and depression units, whereas it includes most of the table-land having gently undulating or tableland having undulating topography. These substantially reduce the range of possible crops and the productive capability. Management techniques are more difficult to apply due to higher costs. Intensive practices are necessary - and sometimes special conservation practices to maintain a continued productivity. Non-productive land (N l) includes soils of plateau foot slope, most of the tableland having almost flat topography and partially of the tableland having undulating topography. They do not provide the ecological conditions necessary for agricultural crops, therefore they are recommended for pasture or forestry land utilization types. They may need very different management and conservation practices to overcome its topographic (slope), edaphic (high salinity and gravels), or climatic deficiencies.



Map (5). Land capability grades of the investigated area.

Table (4). Main land characteristics of representative soil profiles of the investigated area and its capability classes.

Profile No.	Slope*	Depth (cm)	Texture	Gravel (%) > 2 mm	Drainage	EC dS/m	Soil erosion	vegetation	Erosivity	Water dificency	Frost	Capability* class and limitation	Area (acre)
Plateau foot slope (Pu 231)													
8	NL	120	S	10.7	Excessive	20.60	Slight	Nil	Slight	Moderate	Slight	Nl	1033
9	NL	90	S	11.5	Moderatly well	17.00	Slight	Nil	Slight	Moderate	Slight	Nl	1634
24	NL	120	S	9.4	Excessive	19.00	Slight	Nil	Slight	Moderate	Slight	Nl	2343
Tableland having almost flat topography (Pu 232)													
7	NL	30	S	12.5	Poor	22.50	Slight	Nil	Slight	Moderate	Slight	Nl	2584
10	NL	90	S	10.6	Moderatly well	9.20	Slight	Nil	Slight	Moderate	Slight	S3lr	1033
23	NL	30	S	7.14	Poor	20.45	Slight	Nil	Slight	Moderate	Slight	Nl	1688
Depression (Pu 241)													
2	VGS	90	S	33.4	Moderatly well	8.50	Slight	Nil	Slight	Moderate	Slight	S3r	2703
3	VGS	60	S	14	Moderatly well	4.00	Slight	Nil	Slight	Moderate	Slight	S3r	3890
14	VGS	80	S	7.8	Moderatly well	6.70	Slight	Nil	Slight	Moderate	Slight	S3r	1993
15	VGS	150	S	14.6	Excessive	4.70	Slight	Nil	Slight	Moderate	Slight	S3lr	2286
Tableland having gently undulating topography (Pu 341)													
4	GS	120	S	38.5	Excessive	4.60	Slight	Nil	Slight	Moderate	Slight	S3lr	3679
5	GS	120	S	37	Excessive	6.40	Slight	Nil	Slight	Moderate	Slight	S3lr	5654
12	GS	85	S	13.3	Moderatly well	7.20	Slight	Nil	Slight	Moderate	Slight	S3r	1984
13	GS	80	S	9.8	Moderatly well	10.50	Slight	Nil	Slight	Moderate	Slight	S3lr	3291

Table (4). Cont.

Profile No.	Slope*	Depth (cm)	Texture	Gravel (%) > 2 mm	Drainage	EC dS/m	Soil erosion	vegetation	Erosivity	Water dificency	Frost	Capability* class and limitation	Area (acre)
17	GS	80	S	9	Moderatly well	6.20	Slight	Nil	Slight	Moderate	Slight	S3r	4736
19	GS	120	S	12.7	Excessive	6.60	Slight	Nil	Slight	Moderate	Slight	S3lr	2265
20	GS	120	S	6.9	Excessive	11.00	Slight	Nil	Slight	Moderate	Slight	S3lr	6494
Tableland having undulating topography (Pu 441)													
6	S	35	S	46	Very poor	7.5	Moderate	Nil	Slight	Moderate	Slight	S3lr	1024
11	S	150	S	51	Excessive	19.9	Moderate	Nil	Slight	Moderate	Slight	Nl	2169
18	S	45	S	14.6	Poor	7.4	Moderate	Nil	Slight	Moderate	Slight	S3lr	5071
21	S	110	S	45.3	Excessive	10	Moderate	Nil	Slight	Moderate	Slight	S3lr	2522
22	S	120	S	42.7	Excessive	7.6	Moderate	Nil	Slight	Moderate	Slight	S3lr	2691

*Slope: NL-Nearly level, GS- Gently sloping, S- Sloping

**Capability classes: (S3r) Moderate capability soils with slight constraint severity due to erosion risk

– (S3lr) Moderate capability soils with sever soil constraints and erosion risk.

– (Nl) Non productive soils with sever topographic (slope), edaphic (high salinity and gravel)

D- Land suitability of the investigated area

The physical and chemical soil properties (soil suitability criteria) were further evaluated to define land suitability for ten land uses types which are; wheat, maize, melon, potatoes, sunflower, sugar beet, alfalfa, peach, citrus, and olive. For each land utilization type, matching soil characteristics with the crop requirements were performed to recognize the current suitability, and limiting factors. The land suitability evaluation results are shown in Tables (5 and 6) and Maps (6, 7, 8, and 9) for the selected land uses. The results showed that the soils under consideration were placed in classes S2, S3, S4, and S5 as follows;

1- Suitable soils (S2)

Limited area is evaluated as suitable for some of the tested crops, namely; peach, citrus and olive (about 2,286 acre for each). This area is generally deep, sandy with almost flat topography. They are represented by profile 15. Agriculture limitations are mostly ascribed to the presence of slight salinity, and excessive drainage. Economically, under low input level, these soils will be highly suitable for these crops.

2- Moderately suitable soils (S3)

Wide areas are evaluated as moderately suitable for the tested crops as follow; 1- Sugar beet and alfalfa (26,549 acre for each), 2- Wheat, maize, watermelon, potato and sunflower (22,225 acre for each), 3- Olive (19,192 acre) and 4- Peach and citrus (12,884 acre for each).

These areas are represented by profiles 3, 10, 12, 13, 14, 15, 17, 18, and 19. Agriculture limitations for the tested crops generally include coarse texture and severe salinity in addition to excessive drainage in profiles 18, and moderately effective depth for fruit trees in profile 3. From economical point of view, these soils under moderate to high input level will be better to be utilized for the tested crops.

3- Marginal suitable soils (S4)

The marginally suitable area for the tested crops ranges from 4,324 – 22,320 acre. They are represented by profiles 2, 4, 5, 7, 8, 9, 10, 12, 13 18, 20, 21, 22, 23, and 24. The main limitations of land are severe salinity, moderate to severe soil texture, poor drainage, effective depth, and gravel content.

4- Not suitable soils (S5)

Most of the soils in the studied area are considered not suitable for the tested crops. These soils have severe problems due to the high salinity and alkalinity, severe soil texture, high gravel content, shallow rooting zone, and poor drainage.

Table (5). Main landform and representative soil profiles and its suitability classes* for the selected land use types in the investigated area.

Profile No.	Land use										Area (acre)
	Wheat	Maize	Melon	Potato	Sunflower	beet	Alfalfa	Peach	Citrus	Olive	
Plateau foot slope (Pu 231)											
8	S5s**	S5s	S5s	S5s	S5s	S4s	S4s	S5s	S5s	S5s	1033
9	S5s	S5s	S5s	S5s	S5s	S4s	S4s	S5s	S5s	S5s	1634
24	S5s	S5s	S5s	S5s	S5s	S4s	S4s	S5s	S5s	S5s	2343
Tableland having almost flat topography (Pu 232)											
7	S5s	S5s	S5s	S5s	S5s	S4ps	S4ps	S5ps	S5ps	S5ps	2584
10	S4s	S4s	S4s	S4s	S4s	S3ts	S3ts	S5s	S5s	S3s	1033
23	S5s	S5sa	S5s	S5s	S5s	S4psa	S4psa	S5ps	S5ps	S5ps	1688
Depression (Pu 241)											
2	S5t	S5t	S5t	S5t	S5t	S5t	S5t	S4ts	S4ts	S4t	2703
3	S3t	S3t	S3t	S3t	S3t	S3t	S3t	S3p	S3p	S3p	3890
14	S3t	S3t	S3ts	S3t	S3t	S3t	S3t	S3s	S3s	S3s	1993
15	S3t	S3ta	S3t	S3t	S3t	S3t	S3t	S2tds	S2tds	S2tdc	2286
Tableland having gently undulating topography (Pu 341)											
4	S5t	S5t	S5t	S5t	S5t	S5t	S5t	S4t	S4t	S4t	3679
5	S5t	S5t	S5t	S5t	S5t	S5t	S5t	S4t	S4t	S4t	5654
12	S3ts	S3tsa	S3ts	S3ts	S3ts	S3t	S3ts	S4s	S4s	S3s	1984
13	S4s	S4s	S4s	S4s	S4s	S3ts	S3ts	S5s	S5s	S3s	3291
17	S3t	S3ta	S3ts	S3t	S3t	S3t	S3t	S3s	S3s	S3s	4736
19	S3t	S3ta	S3ts	S3t	S3t	S3t	S3t	S3s	S3s	S3s	2265
20	S5s	S5s	S5s	S5s	S5s	S4s	S4s	S5s	S5s	S5s	6494

Table (5). Cont.

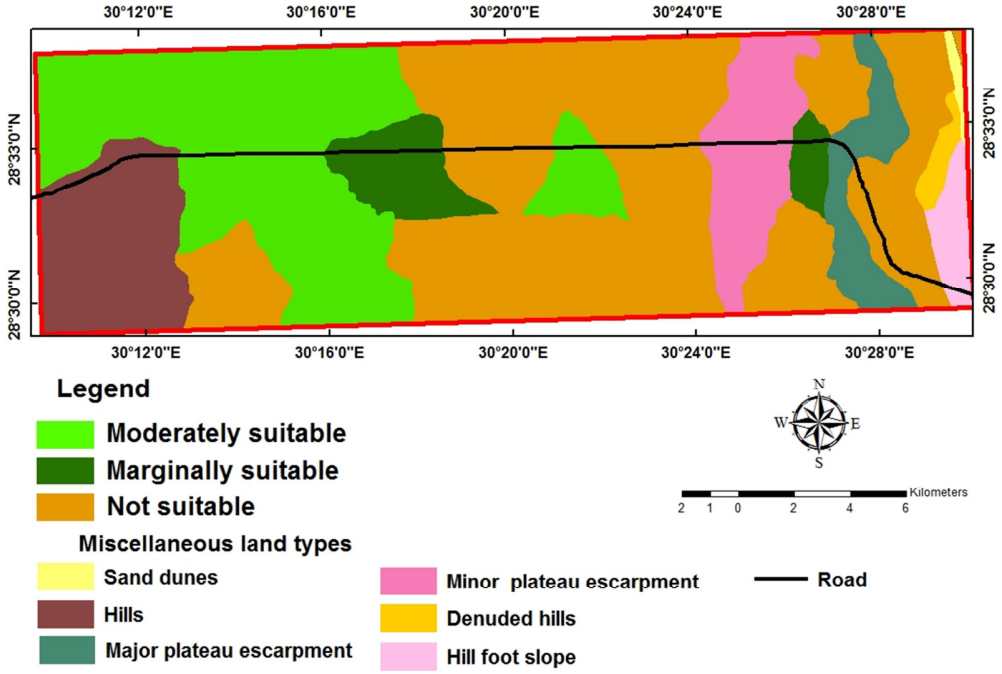
10.	Land use										Area (acre)
	Wheat	Maize	Melon	Potato	Sunflower	beet	Alfalfa	Peach	Citrus	Olive	
Tableland having undulating topography (Pu 441)											
6	S5t	S5t	S5t	S5t	S5t	S5t	S5t	S5p	S5p	S5p	1024
11	S5ts	S5ts	S5ts	S5ts	S5ts	S5t	S5t	S5s	S5s	S5s	2169
18	S3tds	S3tsa	S3pts	S3ts	S3pts	S3ptd	S3ptd	S4pds	S4pds	S4pd	5071
21	S5t	S5t	S5t	S5t	S5t	S5t	S5t	S5s	S5s	S4t	2522
22	S5t	S5t	S5t	S5t	S5t	S5t	S5t	S4ts	S4ts	S4t	2691

* Suitability classes: (S1) highly suitable soils – (S2) suitable soils – (S3) moderately suitable soils - (S4) marginally suitable soils – (S5) not suitable soils
** Soil limitations: (p) useful depth - (t) texture - (d) drainage condition - (c) carbonates content - (s) salinity - (a) sodium saturation.

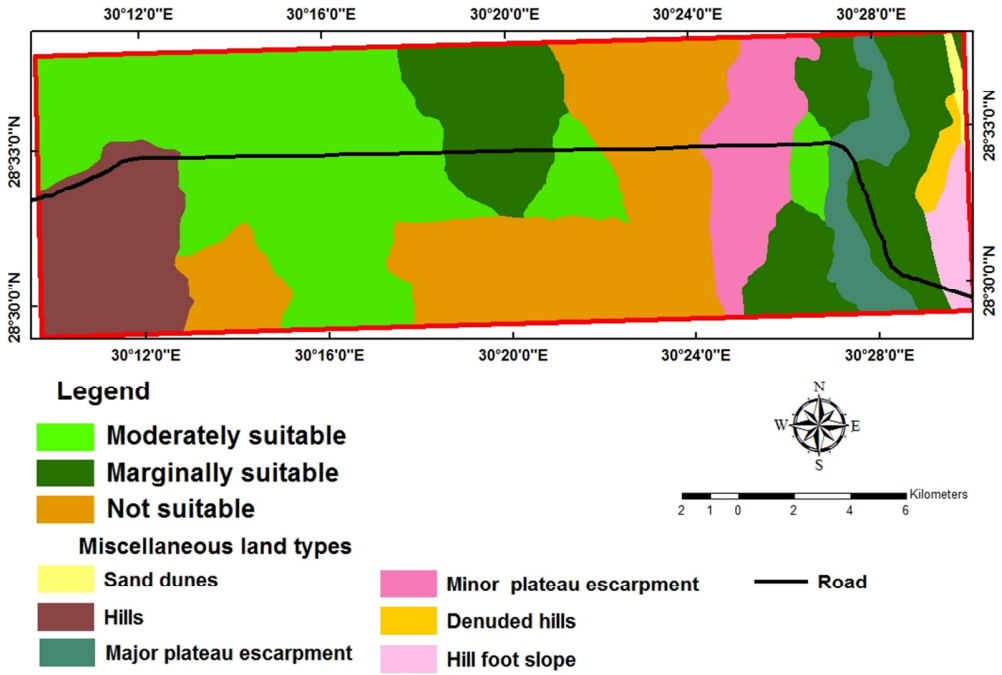
Table (6). Suitability classes for the selected land uses and their areas (acre) in the investigated area.

Suitability class*	Land use									
	Wheat	Maize	Melon	Potato	Sunflower	Sugar beet	Alfalfa	Peach	Citrus	Olive
S2								2286	2286	2286
S3	22225	22225	22225	22225	22225	26549	26549	12884	12884	19192
S4	4324	4324	4324	4324	4324	15776	15776	21782	21782	22320
S5	36314	36314	36314	36314	36314	20442	20442	28602	28602	19065

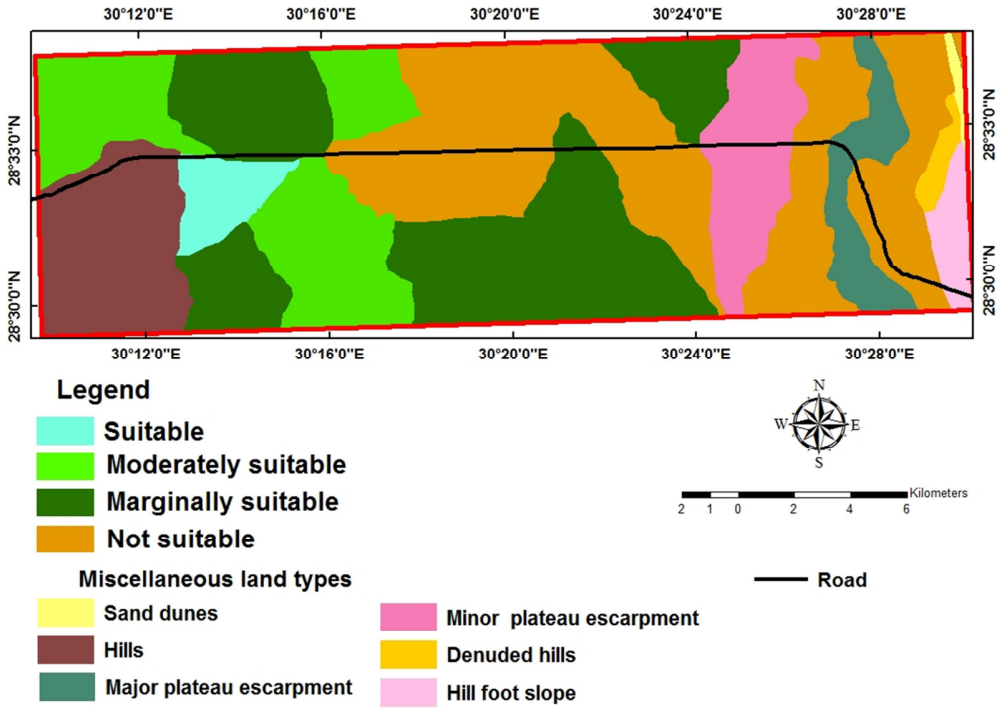
* Suitability classes: (S1) high suitable soils – (S2) suitabe soils – (S3) moderate suitable s – (S4) marginal suitable soils – (S5) not suitable soils



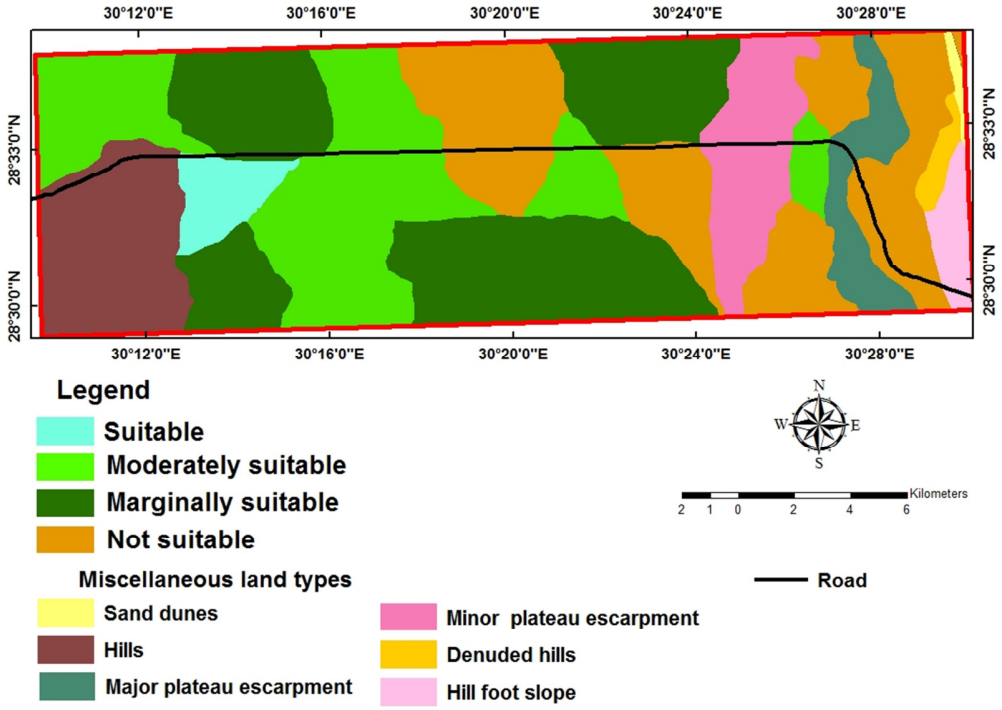
Map (6). Land suitability grades for wheat, maize, melon, potato, sunflower of the investigated area.



Map (7). Land suitability grades for sugar beet, alfalfa of the investigated area.



Map (8).Land suitability grades for peach, citrus of the investigated area.



Map (9). Land suitability grades for olive of the investigated area.

CONCLUSIONS

This study dealt mainly with the geomorphologic setting, soil condition, its classification and land evaluation of potentialities of some land resources located adjacent to Bani Mazar-El-Boiety Road, West of El-Minia, for their optimum agricultural use. It is based on remote sensing data, GIS facilities, and physical and chemical characteristics of the different soil units. The present study indicates the following:

1- The study area has different geomorphic units; i.e. plateau foot slope, depression and the tableland with varying topography i.e, undulating, gently undulating, and almost flat topography, showed detectable amount of secondary formations of carbonates and gypsum throughout some layers without any characteristics of diagnostic horizons. So, they are classified as *Typic Torripsamments*, *Typic Torriorthents* and *Lithic Torriorthents.* It is concluded that there is no relationship between the geomorphic units and the existed soil taxa.

2- With regard to the evaluation of soil resources potentialities; the most severe limitations are; salinity, texture and graveled subsurface stoniness followed by the useful depth and internal drainage. Whereas the carbonate and sodium saturation are the least influential ones but not generally associated with specific geomorphic units except the plateau foot-slope unit that is characterized by high salinity level that hinders agricultural use for the time being..

3- In general, the soils within the study area can be classified into four (4) suitability classes, i.e. suitable (S2) with 2,286 acres (2.75% of the total area), moderately suitable (S3) 12,884 acres (for some orchards) to 26,549 acres (for alfalfa and sugerbeet) amounting to about 25.23 % of the total area, marginally suitable (S4) which ranged from 4,324 to 22,320 acres, representing roughly (14.36 %) of the total area for the crops under study and not suitable (S5) that reached around 33.36 % of the total area.

4- In conclusion, one third of the study area is not suitable for growing any crop under study.

5- It is recommended that a good land management program be designed to overcome some of the temporarily limiting factors that impede the optimum agricultural use.

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الملخص العربى

إمكانات الموارد الأرضية لبعض المناطق المتاخمة لطريق بنى مزار– البويطى، غرب المنيا ، مصر

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تعتبر الأراضى الواقعة فى غرب محافظة المنيا أحد المناطق الواعدة فى الصحراء الغربية المصرية للتوسع الزراعى ضمن المشروع القومى لاستصلاح مليون ونصف مليون فدان لامتلاكها موارد تنموية تجعلها منطقة ذات انتاجية زراعية عالية اذا ما أحسن استغلالها. لذلك تهدف هذه الدراسة الحالية الى تقييم إمكانات الموارد الأرضية لبعض المناطق المتاخمة لطريق بنى مزار – البويطى بالظهير الصحراوى الغربى لمحـــــافظة المنيا، حيث أختيرت منطقة الدراسة بين خطى طول ٠٠" ٠٩ ٣٠° و ٠٠" ٣٠ ٣٠° شرقا ودائرتى عرض ٠٠" ٣٠ ٢٨° و ٠٠" ٣٥ ٢٨° شمالا، لتغطى مساحة 82,883 ايكر. وبناءا على الدراسة الحقلية والتحليلات المعملية والتحليل الطيفى للمرئية الفضائية Landsat 8 OLI مع التحليل الطبوغرافى للنموذج الرقمى للإرتفاعات بإستخدام GIS، أمكن تمييز عدد (١١) وحدة أشكال أرضية بالخريطة الجيومورفولوجية للمنطقة منها ٣ أشكال لسطح الهضبة مختلفة فى التنوع الطبوغرافي (الشبه مستوى – خفيف التموج – المتموج) ومنطقة منخفضة فى سطح الهضبة وأقدام منحدرات الهضبة والمنحدرات الشديدة والمتوسطة الانحدار والتلال المتقطعة ومنحدراتها الموجودة اسفل الهضبة والتلال الصخرية الموجودة على سطح الهضبة بالاضافة الى الكثبان الرملية. تم حصر أراضى المنطقة بإستخدام ٢٢ قطاع أرضى ممثل للاختلافات الطيفية لسطح التربة للأشكال الأرضية السائدة بها ووصفت مورفوبيدولوجيا، وتم تجميع عينات التربة منها لإجراء التحليلات المعملية اللازمة لتقدير صفات وخصائص التربة الطبيعية والكميائية، كما أمكن تقسيم تربة هذه الأشكال الأرضية السائدة لعدد (٣) تحت مجموعة عظمى طبقا للتصنيف الأمريكى الحديث هى

Lithic Torriorthents – Typic Torripsamments – Typic Torriorthents

كذلك تم تقييم القدرة الإنتاجية للأراضى بإستخدام نموذج CERVATANA لبرنامج MicroLEIS حيث وجد أن الاراضى التى تم دراستها تتبع قسمين من أقسام القدرة الإنتاجية وهما "متوسطة S3 و "وغير منتجة N على إمتداد ٦١.٩ ، ١٣.٩٣ % من إجمالى المساحة على الترتيب وان ٢٤ % المتبقية من اجمالى المساحة تشكل وحدات شكل الارض من الكثبان الرملية والمنحدرات والتلال الصخرية. كما أمكن تحديد تحت أقسام القدرة الانتاجية لثلاث وحدات

هى S3 r ، S3 lr ، N l، تبعا لنوع وشدة المحدات الأرضية السائدة. وحددت الدراسة أنواع ومواقع المحدات الأرضية ببعض المساحات بالمنطقة والتى تركزت فى وعورة السطح وشدة الميول – ضحالة قطاع التربة – سوء الصرف – إرتفاع الملوحة – إرتفاع نسبة الحصى – زيادة مخاطر التعرية . كما تم تقييم صلاحية الأراضى لزراعة بعض المحاصيل بأستخدام نموذج ALMAGARA لبرنامج MicroLEIS الذى أوضح أن الأراضى التى تم دراستها يمكن زراعتها بالمحاصيل وفقا لذلك الترتيب وهو الزيتون، بنجر السكر، البرسيم، الخوخ، الموالح، القمح، الذرة، البطيخ، البطاطس، عباد الشمس. كما اتضح من الدراسة ان ٢.٧٥ % من أجمالى المساحة صالحة بدرجة عالية لزراعة كلا من الخوخ والموالح الزيتون فى حين ان مساحة ٢٥.٢٣ % صالحة بدرجة متوسطة وأن ١٤.٣٦ % من منطقة الدراسة صالحة بدرجة هامشية وأن ٣٣.٣٦ % غير صالحة لزراعة المحاصيل تحت الدراسة. كما تم استخدم برنامج Arc–GIS 9.3 لانتاج الخرائط المعلوماتية المختلفة لوحدات الاشكال الارضية وانواع التربة ووحدات القدرة الانتاجية والصلاحية لزراعة المحاصيل تحت الدراسة لأيضاح توزيعها المكانى. وفى العموم قدمت الدراسة دلائل كمية قد تكون من الأهمية بمكان لمتخذ القرار الزراعى فى إدارة الموارد الطبيعية بإقليم الظهير الصحراوى لمحافظة المنيا كنموذج لمناطق استصلاح واستزراع المليون ونصف فدان.

Effect of Spraying "Anna" Apple Trees with Moringa and Seaweed Extracts to Alleviation of Heat Stress and Improving of Its Yield.

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ABSTRACT: This study was conducted to evaluate the efficacy foliar application of moringa leaf extract (MLE) and seaweed extract (SWE) as a natural crop growth enhancer to alleviation of heat stress and improving growth and yield of "Anna" apple trees (Malus domestica L.), under normal and heat stress conditions during 2015 and 2016 seasons successively. The study included 3 levels of heat [low (T1), medium (T2) and high (T3)] and in each temperature level 7 treatments were done as follows: control treatment moringa extract at dilution (10,20 and 30 time) and Seaweed extract at (1, 2 and 3ml/ L.).Results revealed that there was significant effect on all studied traits form the two factors except in shoot thickness where the interaction was not significant and in leaf area where the heat and interaction were not significant too. Results indicated positive effects on vegetative growth and yield. In general the best results for all applied treatments were in (T2). MLE10 treatment caused the best results of vegetative growth parameters (except in shoot thickness where SWE3 gave the highest value), fruit drop% and the yield. MLE20 treatment gave the highest values of initial fruit set%, final fruit set%. The study recommended that foliar application of MLE 20 at full bloom and MLE10 at month after full bloom and at two month after full bloom to get the best results.
Keywords: Apple, Anna, moringa, seaweed, vegetative growth, yield, heat stress.

INTRODUCTION

Apple (*Malus domestica* L.) is a fruit of temperate climate and native in many parts of world and the first five countries in the apple production are China, United States, India, Turkey and Poland, respectively while, Egypt is ranked 22 globally (FAOSTAT, 2013). Apples are wonderful fruits because their components are essential for optimal growth, development and overall wellness. Apple production is not only important for the fresh fruit market, but it also develops favorable conditions for fruit processing industry.

Temperature stress can reduce the yield of major crops (Sabir *et al.,* 2014) because it effect on flowering, blooming time, color, size and shapes of apple (Slingo, 2009). Since sexual reproduction is substantially more sensitive to heat stress than vegetative processes (Zinn *et al.,* 2010). Crop production is affected in addition to the threats to food security as an impact of climate change (Miraglia *et al.,* 2009). Thus, there is need to improve crop productivity under changed climate and abiotic stresses in addition to meet the needs of increasing world populations.

Improve abiotic stress tolerance in plants through conventional breeding, (Athar and Ashraf, 2009) but to develop crop plants for these traits are laborious and time consuming (Javid *et al.,* 2011). The alternative approaches are management practices including exogenous application of various antioxidants, mineral elements and plant growth regulators (PGRs). Among different natural

sources used to extract PGRs and antioxidants moringa (*Moringa oleifera*) and seaweed (Ascophyllum nodosum) are gaining a lot of attention these days (Foidle *et al.,* 2001). Moringa leaf extract (MLE), being rich in amino acids, K, Ca, Fe, ascorbate, and growth regulating hormones like zeatin, is an ideal plant growth enhancer (Basra *et al.,* 2009 a, b). Moreover, MLE has the potential to promote plant growth; hence, it is used as a natural plant growth enhancer. As noted tests on several crops under stress conditions In addition, to the improving of leaf mineral content, yield, physical and chemical characteristics of "Le-Conte" pear plants (Abd El–Hamied and El-Amary, 2015). On the other hand, studies suggest that seaweed products elicit abiotic stress tolerance in plants and that the bioactive substances derived from seaweeds impart stress tolerance and enhance plant performance. As well seaweeds contain various trace elements, vitamins, amino acids and plant growth hormones (IAA, IBA and Cytokinins) which cause many beneficial effects on plant growth and development (Abdel-Mawgoud *et al.,* 2010). In addition, stress improved crop yield of some fruit crops such apple (Spinelli *et al.,* 2009). Therefore, this product would be recommended to use for alleviating the adverse effects of such abiotic stress condition for sustainable grape production (Sabir *et al.,* 2014).

Therefore, in the present study, moringa and seaweed extracts as a natural crop growth enhancer was exogenously applied to assess up to what extent it can improve temperature stress tolerance especially at the reproductive stage and improve growth and yield of "Anna" apple tree.

MATERIALS AND METHODS

The present study was carried out during two successive seasons 2015 and 2016 in a private orchared located at Rosetta area, Beheira, Governorate, Egypt. On 105 " Anna " apple trees (*Malus domestica* L.), ten years old, similar to a large extent, budded on Balady rootstock, with planting space 4×3.5 m apart and grown on sandy soil under surface irrigation system. The experimental was conducted under normal and heat stress conditions in control chambers and field conditions.

Preparation of moringa and seaweed extract:

For preparation MLE, young shoots (leaves and tender branches) of moringa were brought from farm (clay soil) in Rosetta area and grinding with a pinch of water (1 L / 10 kg fresh material) in a locally fabricated extraction machine. After sieving through cheese cloth the extract was centrifuged for 15 min. Various dilutions MLE10, MLE20 and MLE30 (diluted to 10, 20 and 30 times with water respectively) of the extract were prepared with distilled water then used in experiments for as foliar spray.

For preparation SWE, composite trading (Algae foll) contains the type *Ascophyllum nodosum* used in the preparation of three solutions of a concentration at 1ml/ liter (SWE1), 2ml/ liter (SWE2) and 3ml/ liter (SWE3) then used in experiments for as foliar spray.

The layout of experimental treatments:

The experiment was established at split plot design with two factors, the main factor is the temperature in three levels (Low (T1), Medium (T2) and High (T3)) and sub main factor is moringa (*moringa olefira*) and seaweed (*Ascophyllum nodosum*)extracts spraying (seven treatments) as follows: tr1(control), tr2(MLE10), tr3(MLE20), tr4(MLE30), tr5(SWE3), tr6(SWE2), tr7(SWE1).

The evaluations were carried out both in the field, outside and inside a polyethylene cage, as controlled temperature chambers. Such a system has been shown to be a valuable method to increase temperature in the field without negatively affecting other parameters (Hedhly *et al*., 2003). Temperature inside and outside the plastic cages was monitored throughout the periods of experiment (Tables 1 and 2) as maximum/minimum, where the maximum occurring 6 h into the main photosynthetic light period and the minimum, 6 h into the dark period according to (Warrington *et al*., 1999).

Table (1). Average temperature [℃] data throughout flowering and fruit set period inside and outside the plastic cage during 2015 season.

Period	HC Air temperature [℃] 2015					
	Low level (T1)		Medium level (T2)		High level (T3)	
	Min	max	min	max	min	max
0 DAFB	6.10	13.10	9.50	18.00	11.00	32.00
1-10 DAFB	6.41	15.91	11.00	24.00	14.00	35.00
11-40 DAFB	8.28	20.30	13.50	27.00	15.00	38.00
41-80 DAFB	11.18	23.55	14.00	29.00	17.50	40.00
81- Harvest(128)	15.59	27.74	15.59	27.74	15.59	27.74

Table (2). Average temperature [℃] data throughout flowering and fruit set period inside and outside the plastic cage during 2016 season.

Period	HC Air temperature [℃] 2016					
	Low level (T1)		Medium level (T2)		High level (T3)	
	Min	max	min	Max	min	max
0 DAFB	8.40	18.00	10.00	20.00	11.50	33.00
1-10 DAFB	7.88	21.05	11.50	24.00	14.50	36.00
11-40 DAFB	9.52	22.50	13.50	27.00	15.50	38.50
41-80 DAFB	12.30	24.90	14.00	29.00	18.00	41.00
81- Harvest(122)	17.06	28.98	17.06	28.98	17.06	28.98

The trees were divided to three sections, each section contains 35 trees in the form of blocks (5 blocks) each block component of **7** trees (as replicates). Two of the sections chosen as warm treatment and the third one (normal climatic) were

left as a cool treatment. When flowers were at balloon stage, four branches from every tree were chosen and marked. At full bloom, one of the warm sections (high level) covered with 0.180-mm-thick polyethylene film as a green house with number of windows of every side. The other warm section (medium level) covered by polyethylene sheets from the up to half every side only, This day date was recorded as zero day after full bloom (0 DAFB) and all applications were applied three times separated by a month the first one at full bloom (80% flowering+) randomly on the replicate of each block. The covers were removed at 80 DAFB. The effect of the previous treatments was studied by evaluating their influence on the following parameters:

Vegetative growth:

Shoot length (cm):

In the spring of each season, 20 non –fruiting shoots of spring cycle were tagged at constant height and at all direction of each tree. In May, the average length of tagged shoots was measured.

Shoot thickness (cm):

At late May in both seasons, shoot thickness for twenty shoots was measured by hand caliber.

Leaf area (cm^2):

Leaf area was examined during the second half of May on fully developed mature leaves by portable area meter LI-COR model LI-3000A No.PAM 1671 (Bioletti, 1938).

Total chlorophyll (reading):

It was determined by chlorophyll meter apparatus in ten leaves from each plot at 60 and 75 DAS, according to the method that described by (Moran, 1982).

Fruit set and drop (%):

In the spring, four branches were chosen from each tree and marked. The number of flowers, number of fruits on these branches and the remained fruits on these branches were counted then the initial and final fruit set and fruit drop percentages were calculated according to the proper equation.

Initial fruit set (%):

On each replicate tree five shoots distributed on different sides were chosen randomly and tagged at the beginning of the growing season. All inflorescences on each shoot were counted and recorded. Three weeks after flowering initial fruit set percentage on replicate trees of the studied treatments was calculated from the following formula:

Initial fruit set (%) = FR * 100/AVF * NF

FR= Number of fruits/ shoot

AVF= Average number of flowers/ inflorescence

NF= Number of inflorescences/ shoot

Final fruit set (%):

Sixty days after flowering, final fruit set percentage was calculated in the same sequence mentioned above for the initial fruit set percentage according to this formula (Westwood, 1978):

$$\text{Final fruit set (\%)} = \frac{No\ of\ \ fruit\ lets}{No\ of\ \ opened\ \ flowers} \text{X}\ 100$$

Fruit drop (%):

Fruit drop %: was calculated by counting the number of dropping fruits from the middle of June till the commercial harvesting time under experimental conditions (Middle of July), then expressed as a percentage from the whole number of fruits remained on the tree at the middle of June according to this formula:

$$\text{Fruit drop (\%)} = \frac{No\ of\ \ dropped\ \ fruits}{No\ of\ \ set\ \ fruit\ lets} \text{X}\ 100$$

Yield: The produced yield (Ton/feddan) was expressed by multiply the weight of fruits/ tree (kg) which was attained at harvest stage X number of trees/feddan.

Statistical analysis:

Results of the measured parameters were subjected to computerized statistical analysis using COSTAT package for analysis of variance (ANOVA) and means of treatments were compared using LSD at 0.05 level of possibility using Split plot design according to Snedecor and Cochran (1990).

RESULTS AND DISCUSSION

The results obtained from the present investigation of two successive seasons of 2015 and 2016 to study the effect of foliar application of different concentrations of moringa and seaweed extracts at three times with month interval starting at full bloom in different temperature level on some vegetative growth parameters, setting and drop of fruits and yield Tables (3 and 4).

1. Effect of spraying different MLE and SWE concentrations on the vegetative growth:

Results of the effects of foliar application of different MLE and SWE concentrations in different temperature level on some vegetative growth parameters on "Anna" apple trees during 2015 and 2016 seasons are presented in Table(3).The data revealed that MLE10 treatment had the significantly highest shoot length value as compared with the rest treatments. As temperature effect, T2 level in both seasons gave significantly higher than T3 and T1 levels, respectively. Regarding the interaction between treatments and heat data showed that apple treated with MLE10 under T2 level recorded the significantly greatest value in both seasons. However, control at T1 level gave considerable lowest in both seasons. These results are in agreement with Zavala *et al*. (2004) as for effect of temperature on shoot growth. On the other hand with regard to effect of extracts

spraying, the result above came on line with Al-Rawi *et al*. (2016) they showed that the sprayed seaweed extract at levels 4ml.L-1 on Peento peach trees gave highest average of branches length in both seasons.

Data analysis showed a significant effect of temperature level and spraying different rates of MLE and SWE on shoot thickness but the interaction was not significant. Data cleared that, (T2) gave the highest values of shoot thickness (cm) followed by (T1) then (T3) in both seasons. Also, the data clearly indicated that foliar application of SWE 3ml/L recorded highest value of the shoot thickness and MLE10 recorded the second value. Generally, control treatment gave the lowest values of shoot thickness compared with all treatment in both seasons. The same result showed by Fuglie (2000), who found that all the growth parameters were positively influenced by the spray with moringa leaf extract, and Foidle *et al*. (2001) come on same line. Also Al-Rawi (2016) found that; spray Peento peach trees with seaweed increase stem diameter in both seasons.

On the other hand, data illustrated show effects of different rates of MLE and SWE concentrations in different temperature level on leaf area. Data analysis showed that the effects of spray extracts were significant unlike the effect of temperature level was not significant and interaction between them was not significant too in both seasons. All applied treatments significantly increased leaf area comparing with control treatment, especially MLE10 treatment that gave the highest leaf area comparing with all remainder treatments under each temperature level in both seasons. This results supported by the result from Sabir *et al.* (2014) they showed that seaweed had non-significant effect in leaf area on grapevines. Also Abd El–Hamied and El-Amary (2015) showed that MLE treatments were significantly effective on “Le-Conte" pear leaf area.

The effects of applying different rates of MLE and SWE in different temperature level on total chlorophyll (reading), data showed significant effect of temperature level, foliar application of different rates of MLE and SWE and interaction between them on total chlorophyll (reading)in both seasons. From data, (T2) gave the highest values of total chlorophyll (reading) followed by (T1) then (T3) in both. For the application with different rates of extracts data indicated that, increasing concentration led to increase total chlorophyll as compared with control in both experimental seasons in each temperature level. Generally, control treatment gave the lowest values of Total chlorophyll, while spraying MLE10 gave the highest values of Total chlorophyll. These results in line with what has been recorded by Abd El–Hamied and El-Amary (2015) on "Le-Conte" pear and Al-Rawi (2016) on Peento peach trees.

Table (3). Effect of foliar application with different moringa leaf and seaweed extracts on vegetative growth characters in different temperature level of "Anna" apple trees during 2015 and 2016 seasons.

Character	Factor	Spray treatments								L.S.D 0.05
	Heat	tr1	tr2	tr3	tr4	tr5	tr6	tr7	Average	
Shoot length (cm): 2015	T1	28.17	35.47	37.40	38.60	37.73	37.43	36.07	35.83	Heat =0.139
	T2	29.07	36.80	38.07	40.07	39.77	39.23	37.40	37.20	Treatment =0.233
	T3	28.93	36.07	37.87	39.21	38.80	38.70	37.00	36.65	Averages = 0.349
	Average	28.72	36.11	37.78	39.29	38.77	38.46	36.82		
Shoot length (cm): 2016	T1	28.27	35.53	37.20	38.53	37.80	37.47	36.27	35.87	Heat=0.0989
	T2	29.07	36.80	38.20	40.13	39.93	39.47	37.33	37.26	Treatment =0.171
	T3	28.80	35.93	37.93	39.13	38.87	38.67	37.17	36.64	Averages = 0.344
	Average	28.71	36.09	37.78	39.27	38.87	38.53	36.92		
Shoot thickness (cm): 2015	T1	0.73	0.77	0.79	0.83	0.85	0.79	0.75	0.79	Heat =0.008
	T2	0.73	0.78	0.81	0.83	0.87	0.80	0.77	0.80	Treatment =0.012
	T3	0.71	0.75	0.77	0.79	0.83	0.75	0.74	0.76	Averages =0.0198
	Average	0.72	0.77	0.79	0.82	0.85	0.78	0.75		
Shoot thickness (cm): 2016	T1	0.72	0.77	0.79	0.82	0.85	0.78	0.75	0.78	Heat=0.007
	T2	0.73	0.78	0.82	0.83	0.86	0.80	0.76	0.80	Treatment = 0.01
	T3	0.71	0.75	0.77	0.79	0.83	0.74	0.73	0.76	Averages =0.0160
	Average	0.72	0.76	0.79	0.81	0.85	0.77	0.75		
Leaf area (cm2) 2015	T1	27.67	35.27	36.73	37.33	36.87	35.87	33.93	34.81	Heat=0.507
	T2	27.87	35.60	36.80	37.67	37.07	35.87	35.60	35.21	Treatment= 0.587
	T3	28.07	35.73	36.93	37.80	37.13	36.03	34.07	35.11	Averages = 1.08
	Average	27.87	35.53	36.82	37.6	37.02	35.92	34.53		
Leaf area (cm2) 2016	T1	27.83	35.53	36.53	37.37	36.80	35.97	34.30	34.9	Heat =0.42
	T2	27.93	35.63	36.87	37.73	37.13	35.90	35.63	35.26	Treatment =0.24
	T3	28.13	35.80	37.00	37.87	37.13	36.07	34.13	35.16	Averages = 0.873
	Average	27.97	35.66	36.80	37.66	37.02	35.97	34.68		
Total chlorophyll (reading) 2015	T1	48.33	48.93	52.93	55.93	55.47	53.80	53.23	52.66	Heat=0.267
	T2	49.07	51.80	54.53	58.20	57.13	54.53	54.33	53.56	Treatment =0.257
	T3	47.33	48.13	52.07	54.13	54.07	51.93	48.33	50.86	Averages = 0.456
	Average	48.24	49.62	53.18	56.09	55.56	53.42	51.97		
Total chlorophyll (reading) 2016	T1	46.53	48.63	52.13	54.87	54.60	53.13	52.60	51.79	Heat=0.252
	T2	48.63	51.20	54.07	56.60	56.17	54.20	54.07	53.56	Treatment =0.282
	T3	47.07	48.07	51.80	54.07	54.00	51.63	48.00	50.66	Averages = 0.418
	Average	47.41	49.30	52.67	55.18	54.92	52.99	51.56		

T1: Low level of heat, T2: Medium level of heat, T3: High level of heat
tr1 (Control), tr2 (MLE 30), tr3 (MLE 20), tr4 (MLE 10), tr5 (SWE3), tr6 (SWE2), tr7 (SWE1)

2. Effect of spraying different rates of MLE and SWE concentrations on fruit set and drop percentages:

Results of the effects of different rates of MLE and SWE on fruit set% and drop% in different temperature level of "Anna" apple trees during 2015 and 2016 seasons are presented in Table (4).

Regarding the effects of spraying different rates of (MLE) and (SWE) in different temperature level on initial fruit set%, data revealed that there was a significant effect of temperatures level and spraying extracts on initial fruit set % in both season. Besides having a significant effect for spraying extracts on the impact of temperatures on initial fruit set % in both season too. As the temperature level

data showed that, (T2) gave the highest values of initial fruit set % in both season. Furthermore, the data revealed that foliar application with MLE20 gave the highest values of initial fruit set % and control treatment in both growing seasons gave the lowest values of initial fruit set % compared with other treatment in every temperature level.

The data concerning the effect of application different rates of (MLE) and (SWE) concentrations in different temperature level on final fruit set % showed that, the effects of temperature level, spray extracts and interaction were Significant. For temperature data revealed that the best results were in (T2), (T1) and (T3) respectively in both season. Furthermore, data clarified that spraying the trees with MLE20 treatments increased final fruit set % significantly as compared with control treatment and other foliar application treatments in both growing seasons in each temperature level. Generally, control treatment gave the lowest values of final fruit set %, while foliar of MLE20 gave the highest values of final fruit set % compared with all treatment in different temperature level in both season.

The results of fruit set (initial and final) are agreed with Featonby-Smith and Van Staden (1987). Same results are reported by Arthur et al. (2003) they reported that application of seaweed extract-based preparations triggers earlier flowering, better fruit set and development of fruits of numerous crop plants. In same line this result came with that reported by Nasir et al. (2016). The data concerning the effect of different rates of (MLE) and (SWE) in different temperature level on fruit drop % of "Anna" apple trees during 2015 and 2016 seasons revealed that, high Significant effect of temperature level and foliar application of different MLE and SWE extracts concentrations on fruit drop %. Data showed that (T3) cause highest value of fruit drop % for every foliar extract treatment but the lowest values were in (T2) in both season. Also data cleared positive effect for application of different MLE and SWE on decrease fruit drop % in every temperature level in both season. Generally, the MLE10 gave less values of fruit drop % while control treatments gave a higher value of fruit drop in each temperature level in both seasons in partnership with SWE1ml /L in low level in first season only. The same results were reported by Nasir et al. (2016).

3. Effect of spraying different concentrations of moringa leaf extract (MLE) and seaweed extract (SWE) on yield:

Concerning the effects of different concentrations of spraying the rates of (MLE) and (SWE) on yield of "Anna" apple trees during 2015 and 2016 seasons the data is shown in Table (4). 3.1Yield weight/feddan (Ton): The data in Table (4) represented the effect of spraying of different concentrations of Moringa leaf extract and Seaweed extract in different level of temperature on yield weight/feddan (ton) of “Anna” apple trees during the both seasons. The data indicated that all concentrations increased significantly yield weight/feddan (ton) as compared with control in both season in each temperature level. The best results that achieved of yield as a result of spraying various treatments was found in (T2) and lowest values was in (T3) in both season in general. Furthermore, data

revealed that the Yield of each spraying extract treatments in (T1) was higher than it in (T3) for the same treatment. In general, data cleared that the control treatment gave the lowest value of yield weight/feddan (ton) while MLE10 gave the highest value of yield weight/feddan (ton) in each temperature level in both seasons.

These results are supported by Iqbal (2014) who reported that moringa leaf extract is rich with numerous growth hormones, particularly zeatin that has been reported to increase the crops yield in the range of 10-45 % and it also contains micronutrients in sufficient quantities and suitable proportions that increase the yield and yield components. Also same results found on “Le-Conte" pear by Abd El-Hamied and El-Amary (2015).

Table (4). Effect of foliar application with different moringa leaf and seaweed extracts on initial fruit set %, final fruit set %, fruit drop %in different temperature level of "Anna" apple trees during 2015 and 2016 seasons.

	Factor	Spray treatments								L.S.D 0.05
	Heat	tr1	tr2	tr3	tr4	tr5	tr6	tr7	Average	
Initial fruit set % 2015	T1	45.95	51.68	52.45	52.07	51.13	50.87	49.15	50.47	Heat =0.347
	T2	52.58	53.50	54.60	53.76	53.86	52.87	52.83	53.43	Treatment=0.792
	T3	48.24	50.96	52.01	51.09	50.98	50.56	49.15	50.43	Averages =1.192
	Average	48.92	52.05	53.02	52.31	51.99	51.42	50.39		
Initial fruit set % 2016	T1	48.26	51.66	52.79	52.22	51.76	51.27	49.78	51.11	Heat =0.535
	T2	50.03	53.07	56.40	54.71	53.25	51.76	51.56	52.97	Treatment = 0.92
	T3	45.62	49.57	52.39	50.91	49.76	48.60	47.80	49.24	Averages =0.892
	Average	47.97	51.44	53.86	52.61	51.59	50.54	49.71		
Final fruit set% 2015	T1	12.41	15.69	18.73	17.80	16.62	16.16	14.44	15.98	Heat= 0.135
	T2	14.11	17.62	19.69	18.56	18.50	18.11	17.48	17.72	Treatment=0.176
	T3	12.72	14.64	16.02	14.59	14.75	13.16	13.81	14.24	Averages =0.391
	Average	13.08	15.98	18.15	16.98	16.62	15.81	15.24		
Final fruit set% 2016	T1	14.68	17.54	19.22	18.37	18.54	18.28	17.33	17.71	Heat =0.161
	T2	16.67	21.56	22.23	21.03	18.17	17.98	16.19	19.12	Treatment=0.173
	T3	12.78	14.21	15.63	14.33	14.19	13.31	12.76	13.89	Averages =0.364
	Average	14.71	17.77	19.03	17.91	16.97	16.52	15.43		
Fruit drop% 2015	T1	69.43	64.35	63.82	61.50	65.26	68.38	69.15	65.98	Heat = 0.545
	T2	67.07	62.53	63.64	58.66	64.15	64.23	66.51	63.83	Treatment=1.298
	T3	82.98	80.67	79.64	76.70	78.83	80.71	81.47	80.14	Averages =2.405
	Average	73.161	67.895	69.03	66.902	69.41	71.106	72.378		
Fruit drop% 2016	T1	81.30	78.98	73.65	73.18	73.33	74.76	76.43	75.95	Heat = 0.748
	T2	77.21	75.76	75.20	75.01	75.64	77.97	79.05	76.55	Treatment=0.681
	T3	83.89	82.33	82.25	81.40	81.91	82.06	82.73	82.37	Averages =1.375
	Average	80.80	79.02	77.03	76.53	76.96	78.26	79.41		
Yield weight (Ton/fed) 2015	T1	7.70	9.91	10.91	10.93	10.85	9.95	9.7	9.99	Heat = 0.255
	T2	7.96	10.68	12.24	12.41	11.71	10.92	10.24	10.88	Treatment=0.156
	T3	5.57	5.78	6.86	7.25	7.04	6.09	5.79	6.34	Averages =0.218
	Average	7.08	8.79	10.00	10.19	9.87	8.99	8.58		
Yield weight (Ton/fed) 2016	T1	7.26	9.64	10.34	10.77	10.53	9.62	9.56	9.67	Heat = 0.132
	T2	7.43	10.38	11.48	11.53	11.35	10.72	10.04	10.42	Treatment=0.192
	T3	5.83	6.19	7.26	7.28	7.20	6.58	6.17	6.64	Averages =0.281
	Average	6.84	8.74	9.69	9.86	9.69	8.97	8.59		

T1: Low level of heat, T2: Medium level of heat, T3: High level of heat
tr1 (Control), tr2 (MLE 30), tr3 (MLE 20), tr4 (MLE 10), tr5 (SWE3), tr6 (SWE 2), tr7 (SWE1)

CONCLUSIONS

Results of this study revealed that all studied traits were significantly affected by temperature level except in leaf area. Also all applied treatments led to significant effect too. The interaction between temperature and foliar treatments was significant except in shoot thickness and leaf area. Generally, the level (T2) had best results for all applied treatments. MLE10 treatment caused the best results of vegetative growth parameters (except in shoot thickness where SWE3 gave the highest value), fruit drop% and the yield. MLE20 treatment gave the highest values of initial fruit set%, final fruit set %. Based on these results the study recommends the application of MLE 20 at full bloom and MLE10 at month after full bloom and at two month after full bloom.

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الملخص العربى

تأثير الرش بمستخلصات المورينجا وأعشاب البحر لتقليل الاجهاد الحراري وتحسين المحصول في اشجار التفاح الانا

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أجريت هذه الدراسة لتقييم فعالية رش مستخلصات اوراق المورينجا واعشاب البحر كمحسن نمو طبيعي على التخفيف من اثار الإجهاد الحراري وتحسين النمو و محصول أشجار التفاح صنف "آنا" فى الظروف العادية و تحت ظروف الإجهاد الحرارى خلال موسمى الدراسة (٢٠١٥ و ٢٠١٦) على التوالي. وشملت الدراسة ثلاثة مستويات من عامل الحرارة هى منخفض(طبيعي) ومتوسط ومرتفع وتحت كل مستوى لدرجات الحرارة طبقت سبع معاملات هى على النحو التالي: معاملة الكنترول ، ومستخلص المورنجا في تخفيف (١٠ ، ٢٠ ، ٣٠ مرة) ومستخلص الأعشاب البحرية بتركيز (١ و ٢ و ٣ مللى/ لتر). تم تطبيق كافة المعاملات ثلاث مرات يفصل بينهما شهر ابتداء من الإزهار الكامل (٨٠٪ من الإزهار).

اظهرت النتائج أن جميع المعاملات المطبقة أدت إلى تأثير كبير على جميع الصفات المدروسة ونفس الشيء بالنسبة لمستوى درجة الحرارة والتفاعل بين العاملين إلا في حالة سمك الافرخ حيث كان التفاعل غير معنوى، وكذا في حالة مساحة الورقة حيث كان تاثير الحرارة وتفاعلها مع المعاملات غير معنوى ايضا. وأشارت النتائج الى وجود تاثير ايجابى على النمو الخضري والمحصول. عموما، كانت أفضل النتائج لجميع المعاملات المطبقة فى مستوى درجات الحرارة المتوسط (T2) . تسببت معاملة MLE10 على أفضل النتائج لصفات النمو الخضري (باستثناء سمك الافرخ حيث أعطت معاملة SWE3 أعلى قيمة)، ونسبة تساقط الفاكهة والمحصول. أعطت معاملة MLE20 أعلى قيمة لنسبة العقد الابتدائى و نسبة العقد النهائى. وبناء على هذه النتائج اوصت الدراسة بالرش الورقى ب MLE 20 في الإزهار الكامل و ب MLE10 بعد شهر من الإزهار الكامل و شهرين بعد الإزهار الكامل للحصول على أفضل النتائج.

Effect of Potassium Fertilizer and Biofertilizers Inoculation on Vegetative Growth and Volatile Oil Content of Rosemary

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ABSTRACT: The field experiments was carried out at the Horticulture Researches Sabhia Station , Horticulture Research Institute, Agriculture Research Center, Alexandria, Egypt during 2014 to 2016 in order to study the effect of potassium and biofertilization on growth, chemical composition of essential oil and major compounds of rosemary (*Rosmarinus officinalis* L.). The experimental design was randomize complete block design with three replicates. The main results could be summarized as follows: (1) the K+ fertilization treatments, differently, affected the mean values of all studied characters, whereas the application treatment of (150 kg K2SO4/fed + NP mineral significantly, increased plant fresh and dry weights (g/plant), (2) the application of 300 kg K2SO4/fed + phosphorein + Ceraline treatment; gave the highest chemical composition (P and K%) and carbohydrate (%) during both seasons, whereas, the highest mean value of N% was recorded by 450 kg K2SO4/fed + Cerealin + phosphorein, and (3) the application of 20 L/fed Potassmage + phosphorein + Ceraline; gave rise to the highest essential oil (%). Also, the various fertilizers; brought about the highest major's compounds (α-Pinene, β- Pinene, Cineol, Camphor, Borneol, Borneol acetate and Eugenol) percentages during 2015 season.
Key words: Mineral potassium, Biofertilization,Rosemary, Major active compounds.

INTRODUCTION

Medicinal plants occupy a prominent position, because of the increasing demands of both the local industry and exportation. In order to cover such increase, an increasing interest in the cultivation of medicinal and aromatic plants has been settled in Egypt. Recently, a considerable attention has been directed in the newly reclaimed lands and to improve the growth and the yield of various aromatic and medicinal plants (Hassan *et al*., 2006).

Rosemary (*Rosmarinus officinalis* L.*)* Fam. Lamiaceae (Labiatae) is a shrubby evergreen bush (grows in the Mediterranean countries) up to 2 meters high with silver green needless, shaped leaves and pote blue flowers. The whole plant is strongly aromatic and is one of the important medicinal aromatic and spices plants. It is analgesic, antioxidant, antiseptic carminative, fungicidal, nerving stomachic and toxic. It is, extensively, used in soap manufacture, perfumes, especially meat products, as well as serves as a source of material antioxidants (Lawiess, 1992).

Potassium is an essential macro-element for plant growth and it is important in agriculture practices. It plays an important role in several physiological processes in plant such as energy transfer, formation of sugars, starch, and protein in plant (Kassem, 1997). Furthermore, biofertilization is an important factor being used to produce without some mineral fertilizers that cause environmental pollution problems and high rates of it; leads to decrease the potential activity of microflora and the mobility of organic matters. Hence, the attention has been focused on the researches of biofertilizers to provide as

alternative to specific chemical fertilizer. In this context biofertilizers play vital role for increasing the number of microorganisms and accelerate certain microbial process in the rhizosphere of inoculated soil of plants which change unavailable forms to the available forms of some nutrients to the plants (Kandeel *et al*., 2001; Mohamed and Abdu, 2004; Hassan *et al*.,2006).

This research, hence, is an attempt to find out the best fertilizer combination of chemical fertilizer and biofertilizer that enhance the vegetative growth and chemical composition of rosemary (*Rosmarinus officinalis* L.).

MATERIALS AND METHODS

Two field experiments were carried out at the Horticulture Researches Sabhia Station , Horticulture Research Institute, Agriculture Research Center, Alexandria, Egypt, during two growing seasons of 2014 - 2016, in order to study the effect of potassium and biofertilization on growth and chemical composition of rosemary (*Rosmarinus officinalis* L.).The experimental design of the present study was a randomized complete block design with three replicates. Experimental unit for all treatments contains 9 plants.

The experimental soil analyses during growing season of the present study were determined according to Page *et al*. (1982)as presented in Table (1).

Table (1).The physical and chemical properties of the experimental soil in 2015.

Soil properties	2015
A- Particle size distribution (%)	
Sand%	30.50
Silt%	33.50
Clay%	36.00
Soil texture	Clayey loam soil
B- Chemical analysis	
pH (1:1)	7.40
EC (1:1) dS/m	2.30
1- Soluble cations (1:2) (cmol/kg soil)	
K^+	1.12
Ca^{++}	4.20
Mg^{++}	3.20
Na^+	8.10
2- Soluble anions (1:2) (cmol/kg soil)	
$CO^{=}_3$+ HCO^{-}_3	2.90
Cl^-	12.10
$SO^{=}_4$	0.55
Calcium carbonate (%)	7.80
Total nitrogen (%)	1.20
Available Phosphorus (mg/kg)	3.90
Available K (mg/kg)	170.90

Plant material:

The rooted cuttings were obtained from MAPRD farm in AL- Quanater Alkheria and planted in the field on February 8th 2014 in pots 50 cm diameter , and the treatments were conducted as follows:

1- 10 L Potassmage/fed + biofertilizer (Cerealine + Phosphorein).
2- 15 L Potassmage/fed + biofertilizer (Cerealine + Phosphorein).
3- 20 L Potassmage/fed + biofertilizer (Cerealine + Phosphorein).
4- 10 L Potassmage/fed + NP mineral fertilization.
5- 15 L Potassmage/fed + NP mineral fertilization.
6- 20 L Potassmage/fed + NP mineral fertilization.
7- 150 kg/fed K_2SO_4 + biofertilizer (Cerealine + Phosphorein).
8- 300 kg/fed K_2SO_4 + biofertilizer (Cerealine + Phosphorein).
9- 450 kg/fed K_2SO_4 + biofertilizer (Cerealine + Phosphorein).
10- 150 kg/fed K_2SO_4 + NP mineral fertilization.
11- 300 kg/fed K_2SO_4 + NP mineral fertilization.
12- 450 kg/fed K_2SO_4 + NP mineral fertilization.
13- Control (Recommended dose of NPK)

The plants were taking cut on November 15th 2014 and June 11th 2015 for both growing seasons 2015 and 2016. The plants were left in the field to the second season 2016 and the treatments were reported on them during the second season. The main average of two cut were calculate for all determine characters of two seasons.

Applied mineral fertilizers:

Potassium sulphate (K_2SO_4) (48% K_2O) treatments were used at rates of 150,300 and 450 kg/fedan. The used chemical fertilizers were mixed (NP) as recommended dose as 300 kg ammonium sulfate (20.5% N) per feddan and phosphorus at the rate of 300 kg calcium super phosphate (15.5% P_2O_5) per feddan.NP mineral fertilizers added as constant level for different levels of k_2so_4 and Potassmage (Treatments No.4,5,6,10,11 and 12).The recommended dose of NPK (2:1:1) as control treatment was applied as ammonium sulphate (20.5%N), calcium superphosphate (15.5% P_2O_5) and potassium sulphate (48% K_2O) at (150 kg/fed, respectively) which are the recommended dose.

All mineral fertilizers treatments were divided into three equal parts, the first one was applied one month after sowing time, the second one was applied after the first cut and the third one was applied after the second cut.

Applied bio- fertilizers:

The used bio- fertilizers of bacteria *Bacillus megatherum* and phosphorus dissolving bacteria (P.D.B). Bacillus circulanis (silicate potassium dissolving Bacterea) [K. D. B]. Potassmage contained *Azospirillum Lipoferum* and *Azotobacterea Chroococcum* , and Cerealine provided from National Research Center. Inoculations with biofertilzers were done with irrigation water on May 21 each growing season.

At harvest dates in the two growing seasons, guarded plants were randomly taken from each plot and the following characteristics were recorded:

Vegetative characteristics:

The following data were recorded at harvesting time of each cut season:

1. Plant height (cm).
2. Number of branches per plant.
3. Leaf area index (LAI).
4. Plant fresh weight (g).
5. Plant dry weight (g).

NPK and total carbohydrate % analyses:

Element percentage and total carbohydrate (%) was conducted in dry herb at 70ºC for 72 hours, at constant weight then ground to a fine powder for the determination of both nutrient elements and carbohydrates (Herbert and Philips 1971).

Plant digestion was made on eight of the dried samples (0.2 g) by using a mixture of hydrogen peroxide and sulfuric acid at a ratio (4:10).

1- Nitrogen % was determined using the micro Kieldahl method according to Black (1983)
2- Phosphorus% was determined colorimetrically according to Jackson (1967).
3- Potassium % was estimated using flame photometer method according to Richards (1954).
4- Total carbohydrates percentages in the herb were determined according to Herbert *et al*. (1971).

Rosemary essential oil percentage:

The essential oil percentage was determined in the air dried herb according to British Plarmacopoeia (1963) by solvent method in order to extract the essential oil.

Essential oil analysis and its major's component:

The essential oils (for second growing season) were diluted in diethyl ether (20 ml in 1 ml) and analyzed with GC (HP 8644) with flame ionization detector (FID) on a fused silica 132 capillary column DB-5, 25 m in length, 0.32 mm i.d., and 0.5 mm film thickness.133 Helium was used as the carrier gas with a flow rate of 1.6 ml/min; the detector 134 temperature was 260 °C, the oven temperature was programmed to increase from 130 to 260 ℃ at a rate of 4 ℃/min. The split injector was heated at 250 ℃, the split 136 ratio was 15:1. Data were processed on a DP 800 integrator. The percentage of majors constituents (α- Pinene, β- Pinene, Cineol, Camphor, Borneol, acetate and Eugenol) were estimated by measuring the peak area of the different compounds of the chromatogram according to Heftman (1967) and Gunther and Joseph (1978). Sources of the principal components of rosemary which used as reference for determined essential oil of Rosemary by GC were Ciba Gigi, NY, USA. For α- Pinene, β- Pinene, Cineol, Camphor, Borneol, acetate and Eugenol.

Statistical Analysis:

The obtained data were, statistically, analyzed according to Gomez and Gomez (1984). The L.S.D. at 5% level of probability was used to declare the significant for differences among means.

RESULTS AND DISCUSSION

A- Growth parameters:

The obtained results, given in Table (2) cleared that fertilizer's treatments exhibited a significant effect on all estimated traits during both seasons. Application the treatment 150 kg/fed K_2SO_4 + NP mineral, significantly, increased plant height, fresh and dry weights (g/plant), except number of branches/plant which was increased with application of 150 kg/fed K_2SO_4 + biofertilizer NP (Cerealine + Phosphorein)during both seasons. Its could be concluded that the positive effect on growth characters in response to K_2SO_4 fertilizer levels may be attributed to increasing maentration in plant tissues. The previous results agree, more or less, with the finding of Rashed (2002) on parsley, Abdel- Wahab (2000) on rosemary; Kandeel *et al*. (2001) and Mohamed and Abdu (2004) on *Foeniculum vulgare*.

B- Chemical composition and carbohydrate (%):

The data in Table (3) showed that all treatment of fertilization affected, significantly, chemical composition (N, P and K %) and carbohydrate (%) during both seasons. It is clear from data that the highest mean values of chemical composition (P and K%) and carbohydrate (%) resulted from the treatments of 300 kg/fed K_2SO_4 + biofertilizer NP (Cerealine + Phosphorein) in both seasons, and the highest mean value of N% recorded by 450 kg K_2SO_4 + biofertilizer NP (Cerealine + Phosphorein) in both seasons.

The increment of chemical composition (N, P and K%) and carbohydrate content of plant leaves using the treatments of potassium sulfate and (NP) biofertilization may be attributed to increase in the occupancy root zone of plant as a results of adding fertilization treatments which reflected on nutrients uptake by plants and confirm the enhancement of vegetative growth. Similar results, more or less, were obtained by Kassam (1997) on rosemary, Kandeel *et al*. (2001) and Abou- El- Maged *et al.* (2008) on fennel; Rashed (2002) on *Petrselinium sativum*. Likwise, the results showed significant differences for potassium sulfate + NP biofertilization in both seasons , which gave the greatest values for all chemical composition.

Table (2). Growth characters of rosemary plants as affected by potassium and bio- fertilizer during 2015 and 2016 seasons.

Treatments	Plant height (cm)		No. of branches/plant		Fresh weight/plant (g)		Dry weight/plant (g)	
	2015	2016	2015	2016	2015	2016	2015	2016
10 L/fed Potassmage+(Cerealine + Phosphorein)	39.80	45.00	26.07	29.30	200.3	191.4	90.8	91.60
15 L/fed Potassmage + (Cerealine + Phosphorein)	35.50	45.40	24.70	27.30	154.2	154.8	82.70	75.40
20 L/fed Potassmage + (Cerealine + Phosphorein)	36.30	45.40	20.80	25.30	115.4	148.3	60.20	75.8
10 L/fed Potassmage + NP mineral fertilization	40.00	49.60	33.20	31.50	112.2	127.2	58.7	64.7
15 L/fed Potassmage + NP mineral fertilization	42.60	44.97	22.70	33.30	93.5	93.87	46.5	50.90
20 L/fed Potassmage + NP mineral fertilization	35.80	47.60	27.80	33.10	211.3	223.00	97.7	122.30
150 kg K_2SO_4/fed + Cerealine + Phosphorein	33.39	46.00	38.07	33.10	225.4	243.30	98.9	123.6
300 kg K_2SO_4/fed + Cerealine + Phosphorein	31.16	31.87	39.70	43.90	309.5a	310.60c	100.3	172.3
450 kg K_2SO_4/fed + Cerealine + Phosphorein	30.90	43.20	26.00	24.60	171.5	153.10	97.5	80.00
150 kg K_2SO_4/fed + NP mineral fertilization	31.10	46.80	22.80	22.47	178.4	199.80	88.6	142.8
300 kg K_2SO_4/fed + NP mineral fertilization	44.26a	58.90a	31.70	43.70	28.40a	439.40a	201.6a	223.00a
450 kg K_2SO_4/fed + NP mineral fertilization	35.03	52.97	36.50	39.60	207.50	228.60	157.0	185.5
Control	40.07	54.70	35.70	39.20	292.10	267.50	150.4	190.6
L.S. D. $_{0.05}$	**0.90**	**0.95**	**0.30**	**0.50**	**4.7**	**5.60**	**3.7**	**4.50**

Table (3). Chemical composition of rosemary as affected by potassium and biofertilizer during 2015 and 2016 seasons.

Treatments	Nitrogen (%)		Phosphorus (%)		Potassium (%)		Carbohydrate (%)	
	2015	2016	2015	2016	2015	2016	2015	2016
10 L/fed Potassmage + (Cerealine + Phosphorein)	3.10	3.30	0.43	0.52	1.62	1.65	43.60	44.20
15 L/fed Potassmage + (Cerealine + Phosphorein)	1.72	1.63	0.51	0.55	1.45	1.47	43.10	41.00
20 L/fed Potassmage + (Cerealine + Phosphorein)	2.30	2.41	0.59	0.63	1.48	1.52	44.50	38.00
10 L/fed Potassmage + NP mineral fertilization	2.61	2.70	0.60	0.67	1.50	1.53	41.60	40.70
15 L/fed Potassmage + NP mineral fertilization	1.90	1.98	0.46	0.52	1.56	1.60	45.70	41.30
20 L/fed Potassmage + NP mineral fertilization	1.75	1.88	0.45	0.68	1.59	1.64	50.70a	51.50a
150 kg K_2SO_4/fed + Cerealine + Phosphorein	2.44	2.66	0.71	0.79	1.63	1.67	46.40	47.30
300 kg K_2SO_4/fed + Cerealine + Phosphorein	2.85	2.72	0.65	0.73	1.69	1.71	45.30	46.20
450 kg K_2SO_4/fed + Cerealine + Phosphorein	3.98	3.50	0.54	0.63	1.65	1.70	44.70	48.60
150 kg K_2SO_4/fed + NP mineral fertilization	2.70	2.60	0.52	0.55	1.73	1.84	49.60	49.80
300 kg K_2SO_4/fed + NP mineral fertilization	2.65	2.75	0.50	0.58	1.57	1.66	40.80	42.70
450 kg K_2SO_4/fed + NP mineral fertilization	3.04	3.20	0.46	0.53	1.67	1.70	42.90	43.10
Control	1.90	1.88	0.43	0.47	1.20	1.38	40.50	33.00
L.S. D. $_{0.05}$	**0.40**	**0.30**	**0.04**	**0.06**	**0.05**	**0.16**	**0.51**	**0.48**

C- Essential oil (%):

The essential oil percentage was affected by using potassium fertilization during both seasons; whereas, the highest essential oil % was found to be recordes due to the application of 10 L Potassmage/fed + (NP mineral fertilization) during both seasons as shown in Table (4). This may finding be taken place due to the synergiatic effect of biofertilizers (Potassmage + Phosphorein + Cerealine) to increase the availability of NPK to be uptake by plants at a considerable rate to build up more metabolites necessary for including the volatile oil synthesis. These results were in agreement with those of Abdel Wahab (2000) on rosemary who used 100% NPK + organic manure, which gave the highest values of volatile oil percentage in both seasons.

Table (4). Volatile oil (%) as affected by potassium and biofertilizer during 2015 and 2016 seasons.

Treatments	2015	2016
10 L/fed Potassmage + (Cerealine + Phosphorein)	0.42	0.50
15 L/fed Potassmage + (Cerealine + Phosphorein)	0.44	0.70
20 L/fed Potassmage + (Cerealine + Phosphorein)	0.51	0.75
10 L/fed Potassmage + NP mineral fertilization	0.57a	0.80a
15 L/fed Potassmage + NP mineral fertilization	0.38	0.45
20 L/fed Potassmage + NP mineral fertilization	0.54	0.76
150 kg K_2SO_4/fed + Cerealine + Phosphorein	0.53	0.74
300 kg K_2SO_4/fed + Cerealine + Phosphorein	0.51	0.73
450 kg K_2SO_4/fed + Cerealine + Phosphorein	0.48	0.55
150 kg K_2SO_4/fed + NP mineral fertilization	0.45	0.54
300 kg K_2SO_4/fed + NP mineral fertilization	0.48	0.57
450 kg K_2SO_4/fed + NP mineral fertilization	0.55	0.77
Control	0.53	0.66
L.S. D. $_{0.05}$	**0.03**	**0.04**

D- Major components percentage of essential oil:

The effect of fertilization treatments on essential oil's major compound (α-Pinene, β- Pinene, Cineol, Camphor, Borneol, acetate and Eugenol) percentages are shown in Table (5). The results indicated that using potassium's fertilization which had significant effect on the studied major compound percentages of rosemary oil contents. The application of different fertilization; gave rise to the highest percentages of major compounds in 2014/2015 season. Similar results were reported by Darzi *et al*. (2006) on fennel, and Ismal *et al.* (2009) on Majoram plant.

Table (5). Chemical composition of rosemary oils major components (%) during 2016 season.

T/comp.	α- Pinene	β- Pinene	Cineol	Camphor	Borneol	Borneol acetate	Eugenol
1	12.07	3.01	13.92	17.52	11.49	6.03	2.44
2	14.60	3.75	18.97	22.63	12.84	6.89	2.67
3	15.20	5.13	19.13	21.72	9.14	7.27	1.24
4	16.82	4.91	19.44	23.51	10.06	7.09	1.84
5	12.22	3.46	17.63	21.11	15.80	9.00	1.32
6	10.90	3.12	20.52	27.52	11.88	9.98	2.28
7	14.87	3.34	21.76	27.01	11.01	9.83	2.01
8	13.99	3.37	21.88	27.25	10.26	9.31	2.00
9	14.1	4.02	21.91	27.58	10.06	9.02	1.91
10	13.71	4.39	21.12	28.53	9.26	8.10	1.32
11	16.89	4.32	21.53	23.45	7.76	8.43	1.28
12	15.71	3.33	19.72	23.72	7.48	7.76	1.29
13	11.99	3.50	19.25	24.66	13.75	10.76	1.31
$L.S.D._{0.05}$	**0.05**	**0.03**	**0.50**	**0.40**	**0.30**	**0.45**	**0.12**

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الملخص العربي

تأثير التسميد البوتاسي والتلقيح الحيوي على النمو الخضري ومكونات الزيت العطري لنباتات حصالبان

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فرع النباتات الطبية والعطرية

أقيمت التجربة الحقلية بمحطة بحوث البساتين بالصبحية ،معهد بحوث البساتين، مركز البحوث الزراعية ، إسكندرية، مصر، أثناء موسمي نمو ممتد من ٢٠١٥ الى ٢٠١٦ لدراسة تأثير التسميد المعدني والحيوي البوتاسي على النمو والمحتوى الكيماوي والنسبة المئوية للزيت لنباتات الحصالبان– صممت التجربة بتصميم القطاعات العشوائية الكاملة مع ثلاث مكررات ويمكن تلخيص أهم النتائج فيما يلي:

معاملات التسميد أثرت بقيم مختلفة على كل الصفات عند إضافة المعاملة ١٥٠كجم كبريتات البوتاسيوم/فدان + التسميد المعدني للنتروجين والفوسفور زادت معنوية طول النبات، الوزن الطازج والجفاف (جم/نبات). مع إضافة المعاملة ٣٠٠ كجم كبريتات بوتاسيوم/فدان + الفوسفورين + السيريالين أعطت أعلى محتوى كيماوي (النسبة المئوية الفوسفور والبوتاسيوم) والنسبة المئوية للكربوهيدرات في كلا الموسمين.أيضاً إضافة ٤٥٠ كجم كبريتات بوتاسيوم/فدان + سيريالين + فوسفورين أدت إلى زيادة النسبة المئوية للنتروجين في كلا الموسمين. أدى إضافة ٢٠ لتر بوتاسيوماج /فدان + الفوسفورين + السيريالين أعلى نسبة مئوية للزيت. أيضاً اختلافات التسميد أدى إلى ارتفاع المكونات الفعالة للزيت (α– Pinene, β–Pinene, Cineol, Camphor, Borneol, acetate and Eugenol) كنسبة مئوية في الموسم ٢٠١٥.

Effect of Girdling and Sitofex (CPPU) on Vegetative Growth, Fruit Set, Yield and Fruit Quality of Le-Conte Pear Trees

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ABSTRACT: This study was carried out during two successive seasons 2015 and 2016 on 20 years old "Le-Conte" pear trees budded on Pyrus communis rootstock and grown on sandy loam soil in a private orchard located at Burg El-Arab, Alexandria Governorate. The experiment involved the following treatments: 1) Untreated trees (control); 2) Girdling in mid-February (branch 2 year); 3) Girdling in mid- February (branch 3 year); 4) Girdling in mid- March (branch 2 year); 5) Girdling in mid- March (branch 3 year); 6) Sitofex 10 mg/L; 7) Sitofex 15 mg/L and 8) Sitofex 20 mg/L. All applications of Sitofex were applied twice, at full bloom (80-100% flowering) and after one month from setting. Results revealed that Sitofex (CPPU) at 10 to 20 mg/L increased the fruit set, yield characters (fruit weight, yield per tree and total yield), physical characters (fruit length, fruit diameter, L/D ratio, fruit size and fruit firmness), chemical characters (TSS, acidity, TSS/Acid ratio, vitamin C and starch content) and nutrient contents (nitrogen, phosphorus, potassium, calcium and magnesium as percentage) while the same treatments decreased fruit drop and total sugar percentage. On the other hand, treatments of girdling increased fruit set, yield characters, physical characters and chemical characters, while the same treatments decreased vegetative growth characters, fruit drop and leaf nutrient contents compared with untreated check trees with significant differences.

Key words: girdling, Sitofex (CPPU), "Le-Conte" pear, vegetative growth, fruit set, yield and fruit quality.

INTRODUCTION

"Le-Conte" pear (Pyrus communis L.) is one of the most important deciduous fruit crops grown in Egypt. "Le-Conte" pear tree is a hybrid between (Pyrus communis x Pyrus pyrifolia) and it is the main pear cultivar grown in Egypt.The tree needs essential elements, growth regulator and water in order to complete its life cycle with high production of good quality.

Pear trees grown in Egypt suffer from low fruit set and high fruit drop. Increasing fruit set and reducing fruit drop can be achieved by using suitable agriculture treatments, mainly fertilization. In Egypt although there are many cultivars and recorded selections, the fruit is smaller than that cultivated out abroad.

In the last 20 years, the pear cultivated area in Egypt decreased from 14923 feddans in 1995 to 10616 feddans in 2012 (Ministry of Agric., 2012). "Le-Conte" pear is considered a popular fruit in the temperate regions and in addition, it represents an important share of the cultivars grown in Egypt.

Aly et al. (2012a) reported that girdling of shoot three years old on "Le-Conte" pear trees budded on (Pyrus betulaefolia) rootstock, gave the highest increase of spurs number, number of fruits per tree, fruit weight, fruit size, fruit firmness, total soluble solids (TSS %) and the reducing sugars, while, it gave significant decrease in fruit acidity (%) in both seasons of study. Mohamed (2012) reported that shoot girdling on three years old (5mm in width) at mid-

April or shoot bending of two and three years old shoot at mid-November increased number of spurs, fruit set percent, total number of fruits per tree, total yield (ton / feddan) and improved fruit quality of 5 years old "Le-Conte" pear trees.

"Le-Conte" pear trees grow successfully under Egypt conditions and are still in need for further studies to improve the fruit set and fruit quality. To improve fruit size and to increase the yield, new growth regulator namely Sitofex (CPPU) is one of plant growth regulators (N-(2-chloro-4-pyridinyl)-N'-phenylurea); common name forchlorfenuron) which plays a role in cell division and cell wall elongation (Nickell, 1985). The synthetic cytokinin derived from phenylurea (CPPU) and spraying with some nutrients was proposed (Taher and Hassan, 2005; Aly et al., 2012b; Azatoni, 2016).

Sitofex (CPPU) increased fruit weight and dimensions, yield and delayed fruit maturity in stone, pome and other related fruit crops (Abou Grah et al., 2009; Aly et al., 2012b; Banyal et al., 2013). The role of Sitofex (CPPU, cytokinin-like effect) is a synthetic plant growth regulator, it acts on early cell division or it acts throught changing natural hormone activity, thus the fruit gets bigger size because it has enough cells, the building blocks of fruit mass and also the cells have been able to attract so much water, minerals and carbohydrates that enable the fruit to expand to a large size (Lowes and Woolley, 1992).The present investigation aimed to study the effect of girdling and Sitofex (CPPU) application treatments on vegetative growth, fruit set, yield and fruit quality of "Le-Conte" pear trees.

MATERIALS AND METHODS

This study was carried out during two successive seasons 2015 and 2016 on 20 years old "Le-Conte" pear trees (*Pyrus communis* x *Pyrus pyrifolia*) budded on *Pyrus communis* rootstock and grown on sandy loam soil in a private orchard located at Burg El-Arab, Alexandria Governorate.

Forty trees as uniform as possible were selected for achieving this study. The trees were planted at 5 x 5 m aparts.Trees were of normal growth, uniform in vigor and received normal fertilization and cultural practices as scheduled in the farm.This experiment was arranged in a randomized complete block design on 40 trees as 8 treatments and each treatment comprised of five trees arranged randomly in five blocks.

The trees were sprayed with the specified solutions till run off on trees at full bloom stage at which 80% of flower buds reached the stage of full open and one month after fruit setting. A fine mist ensured complete coverage of fruits before runoff.

The experiment involved the following treatments: 1- Untreated trees (control); 2- Girdling in mid-February (branch 2 year); 3- Girdling in mid- February (branch 3 year); 4- Girdling in mid- March (branch 2 year); 5- Girdling in mid-March (branch 3 year); 6- Sitofex 10 mg/L (at full bloom and after one month from fruit setting); 7- Sitofex 15 mg/L (at full bloom and after one month from fruit

setting) and 8- Sitofex 20 mg/L (at full bloom and after one month from fruit setting). The effects of the previous treatments were studied by evaluating their influence on the following parameters: shoot length (cm), shoot thickness (cm) and leaf area (cm^2) measured by portable area meter LI .COR model LI-3000 A. No. PAM 1671 (Bioletti, 1938).

Initial fruit set (%) calculated by five shoots from each replicate distributed on different sides were chosen randomly and tagged at the beginning of the growing season. All inflorescences on each shoot were counted and recorded.

Three weeks after flowering, initial fruit set percentage on replicate trees of the studied treatments was calculated from the following formula:

$$\text{Initial fruit set (\%)} = \frac{\text{FR X 100}}{\text{AVF X NF}}$$

FR= Number of fruits/ shoot.
AVF= Average number of flowers/ inflorescence.
NF= Number of inflorescences/ shoot.

Final fruit set (%) was calculated sixty days after flowering according to this formula (Westwood, 1978):

$$\text{Final fruit set (\%)} = \frac{\text{No. of fruit lets}}{\text{No. of opened flowers}} \quad \text{X 100}$$

Fruit drop (%) was calculated by counting the number of dropping fruits from the middle of June till the commercial harvesting time under experimental conditions (Mid of July), then expressed as a percentage from the whole number of fruits remained on the tree at the middle of June according to this formula:

$$\text{Fruit drop (\%)} = \frac{\text{No. of dropped fruits}}{\text{No. of set fruit lets}} \quad \text{X 100}$$

The produced fruit yield on each replicate tree resulting from the applied treatments was expressed as number of fruits/tree and weight of fruits in kg/ tree which was attained at harvest stage. This was determined 90 days after flowering in both seasons of the study.

Sample of 10 fruits per tree from each replicate was collected randomly, when the fruits were yellow colored (15 August) in both seasons, then transported quickly to the laboratory to determine physical and chemical fruit characteristics. Regarding the physical fruit characteristics, samples of 10 fruits from each replicate tree i.e. 50 fruits for each of the applied treatment were picked randomly at harvest to determine: average fruit weight (g), yield produced as Ton/feddan was expressed by multiplying the weight of fruits/tree x number of trees/feddan. Average fruit length (L) and diameter (D), in cm were measured by using hand caliper and then fruit shape index (L/D ratio) was calculated. Fruit firmness, was expressed as (pound / $Inch^2$) according to (Magness and Taylor, 1982). Flesh firmness was measured in two opposite sides of the fruit using Magness Taylor

pressure tester (Magness and Taylor, 1982).

Regarding to the chemical fruit characteristics, at harvest time the following parameters were determined: total soluble solids of fruit juice (TSS %) by hand refractometer; the percentage of total acidity (Chen and Mellenthin, 1981). The titratable acidity was expressed as grams of malic acid / 100 milliliters fruit juice and then TSS/ acid ratio were calculated for each replicate of the applied treatments. The ascorbic acid content (Vitamin C) of the juice was determined by titration with 2, 6 dichloro phenol-indo-phenol (A.O.A.C., 1985) and calculated as milli-grams per 100 ml of juice. Also, total sugars were determined in fresh fruit samples according to Malik and Singh (1980). Sugars were extracted from 5 gram fresh weight and determined by phenol sulfuric and Nelson arsenate-molybadate colorimetric method Malik and Singh (1980).

Starch contents were determined in 0.1 g of the residue by hydrolysis with concentrated HCl for 3 h under reflux condenser (A. O. A. C., 1985). The total nutrient reducing power was determined according to the method of (Malik and Singh, 1980) and the factor 0.9 was used to calculate the starch (Woodman, 1941).

Leaf and fruit chemical analysis:

At the end of June of both seasons, samples of 20 leaves /tree were taken at random from the previously tagged shoots, the leaf samples were washed with tap water and distilled water, and then oven dried at 70°C to constant weight and then ground. To determine the leaf nutrient contents, ground material of each sample was digested with H_2SO_4 and H_2O_2 according to (Wolf, 1982).

In the digested material, total nitrogen and phosphorus were determined colorimetrically according to (Evenhuis and De waard, 1976) and (Murphy and Riley, 1962), respectively and potassium was determined by flame photometer as described by (Cheng and Bray, 1951). Calcium and magnesium leaf contents were determined by Perkin Elmer atomic absorption Spectrophotometer according to (Carter, 1993).

Statistical analysis:

Results of the measured parameters were subjected to computerized statistical analysis using COSTAT package for analysis of variance (ANOVA) and means of treatments were compared using LSD at 0.05 level of possibility according to Snedecor and Cochran (1990).

MATERIALS AND METHODS

Data concerning the effect of girdling and Sitofex (CPPU) foliar application on vegetative growth, fruit set, fruit drop, yield, fruit quality and macronutrient contents of "Le-Conte" pear trees were presented in Tables (1 to 5).

Vegetative growth characters

The data for both experimental seasons of 2015 and 2016, regarding the effect of girdling and Sitofex (CPPU) application treatments on the shoot length on "Le-Conte" pear trees are shown in Table (1). The data indicated that all

application treatments of girdling reduced shoot length shoot thickness and leaf area as compared with control. Moreover, Sitofex (CPPU) from 10 to 20 mg/L increased shoot length, shoot thickness and leaf area on "Le-Conte" pear trees in both seasons. Furthermore, results showed that Sitofex (CPPU) with concentrations of 20 mg/L gave the best results in both seasons as compared with untreated treatment with significant differences.

The same data showed that treatment of girdling in mid-March on branch two years old gave the lowest value, in both seasons with significant differences among treatments as compared with untreated trees.

These data are supported with those obtained by Eliwa (2003) who found that girdling of branches on peach trees decreased leaf area with 42.21 cm^2 and 41.0 cm^2 compared with the control in both seasons, respectively. Mansour *et al*. (2008) found that 20 mg/L Sitofex (CPPU) treatment on "Le-Conte" pear trees gave the highest values of leaf area and shoot thickness as compared with all treatments during both experimental seasons; furthermore, the control treatment gave the lowest values during the two seasons.

Aly *et al.* (2012b) reported that Sitofex (CPPU) treatment with concentration of 20 mg/L on "Le-Conte" pear trees increased shoot thickness in both successive seasons of 2010 and 2011.

Mohamed (2012) stated that all shoot girdling treatments on "Le-Conte" pear trees decreased shoot length and leaf area as compared with the control in both successive seasons of 2009 and 2010. Azatoni (2016) showed that Sitofex (CPPU) with concentration 15 mg/L on "Anna" apple trees had the highest values of shoot length, shoot thickness and leaf area in both successive seasons of 2015 and 2016.

Table (1). Effect of girdling and Sitofex (CPPU) application treatments on some vegetative growth of "Le-Conte" pear trees during 2015 and 2016 seasons.

Treatments	Shoot length (cm)		Shoot thickness (cm)		Leaf area (cm^2)	
	2015	2016	2015	2016	2015	2016
Untreated trees (Control).	50.41^{d}	52.01^{d}	0.74^{d}	0.75^{d}	31.02^{d}	31.15^{d}
Girdling in mid-Feb. (branch 2 y.)	39.22^{f}	38.82^{g}	0.52^{f}	0.56^{g}	27.31^{g}	27.45^{g}
Girdling in mid- Feb. (branch 3 y.)	42.00^{e}	40.58^{e}	0.60^{e}	0.61^{f}	28.22^{e}	28.61^{e}
Girdling in mid- Mar. (branch 2 y.)	36.01^{g}	38.66^{h}	0.51^{f}	0.53^{h}	27.09^{h}	27.42^{g}
Girdling in mid- Mar. (branch 3 y.)	39.16^{f}	39.01^{f}	0.62^{e}	0.64^{e}	28.01^{f}	28.12^{f}
Sitofex (CPPU) at 10 mg/L	53.43^{c}	52.20^{c}	0.82^{c}	0.83^{c}	33.60^{c}	33.42^{c}
Sitofex (CPPU) at 15 mg/L	55.04^{b}	55.43^{b}	0.91^{b}	0.90^{b}	34.15^{b}	34.03^{b}
Sitofex (CPPU) at 20 mg/L	56.80^{a}	57.62^{a}	0.95^{a}	0.97^{a}	35.43^{a}	35.40^{a}

Means not sharing the same letter(s) with each column are significantly different at 0.05 level of probability.

Fruit set and Fruit drop (%)

The results in Table (2) showed the effect of girdling and Sitofex (CPPU) application treatments on fruit set and fruit drop percentages on "Le-Conte" pear trees in 2015 and 2016 seasons. The results indicated that all application treatments of girdling and Sitofex (CPPU) increased initial fruit set and final fruit set percentages as compared with untreated trees. In addition, the data revealed that Sitofex (CPPU) with concentration 20 mg/L recorded the best initial fruit set and final fruit set percentages with significant differences among treatments compared with control treatment. Regardless of control treatment the data showed that treatment of girdling in mid-February on branch two years old gave the lowest initial fruit set and final fruit set percentages as compared with other treatments in both seasons, with significant differences. Data also showed that all application treatments of girdling and Sitofex (CPPU) decreased fruit drop percentage as compared with untreated trees.

Data showed that Sitofex (CPPU) with concentration 20 mg/L recorded the best data compared with control treatment in both seasons with significant difference. Also, it was noticed that treatment of girdling in mid-February on branch two years old gave the highest fruit drop percentage in the first season but treatment of girdling in mid-March on branch two years old gave also the highest fruit drop percentage in the second season as compared with other treatments except control with significant differences.

Results of this study, to some extent, were in agreement with those of other researchers. For example, in Egypt, Naguib *et al.* (2010) reported that spraying Sitofex (20 mg/L) + Dormex 3% and Sitofex (15 mg/L) + Dormex 3% treatments on "Costata" persimmon trees increased final fruit set %. While, Mohamed (2012) reported that shoot girdling on three years old (5mm in width) at mid-April increased number of spurs, fruit set percent, total number of fruits per tree, total yield (ton / fed) and improved fruit quality of 5 years old "Le-Conte" pear trees. Banyal *et al.* (2013) revealed that foliar application of Sitofex (CPPU) gave the least fruit drop percentages, and maximum fruit yield of apple trees. However, Nasr *et al.* (2015) showed that girdling treatments in 1st of January increased fruit set % and fruit yield on "Le-Conte" pear trees. Azatoni (2016) showed that Sitofex (CPPU) increased fruit set percentage and decreased fruit drop percentage on "Anna" apple trees. Also,Taha and El-Ghany (2016) reported that Sitofex increased fruit set percentage and decreased fruit drop percentage during the two successive seasons of 2012 and 2013 on "Anna" apple trees.

Table (2). Effect of girdling and Sitofex (CPPU) application treatments on initial fruit set, final fruit set and fruit drop percentages of "Le-Conte" pear trees during 2015 and 2016 seasons.

Treatments	Initial fruit set (%)		Final fruit Set (%)		Fruit drop (%)	
	2015	2016	2015	2016	2015	2016
Untreated trees (Control).	58.64^{h}	59.18^{h}	8.12^{h}	9.23^{h}	86.15a	84.40a
Girdling in mid-Feb. (branch 2 y.)	62.40^{g}	61.46^{g}	15.70^{g}	16.31^{f}	74.84b	73.46c
Girdling in mid- Feb. (branch 3 y.)	65.10^{e}	63.90^{e}	17.85^{e}	17.15^{e}	72.58d	73.16d
Girdling in mid- Mar. (branch 2 y.)	63.53^{f}	62.75^{f}	16.32^{f}	15.46^{g}	74.31c	75.42b
Girdling in mid- Mar. (branch 3 y.)	66.42^{d}	65.33^{d}	18.26^{d}	18.87^{d}	72.50e	71.11e
Sitofex (CPPU) at 10 mg/L	75.78^{c}	75.56^{c}	21.90^{c}	21.54^{c}	71.10f	71.04f
Sitofex (CPPU) at 15 mg/L	78.33^{b}	77.61^{b}	23.10^{b}	22.86^{b}	70.50g	70.54g
Sitofex (CPPU) at 20 mg/L	79.15^{a}	79.24^{a}	24.62^{a}	24.11^{a}	68.93h	63.87h

Means not sharing the same letter(s) with each column are significantly different at 0.05 level of probability.

Yield characters

The results in Table (3) showed the effect of girdling and Sitofex (CPPU) application treatments on fruit weight, yield per tree and yield per feddan on "Le-Conte" pear trees in 2015 and 2016 seasons. Results referred that all application treatments of girdling and Sitofex (CPPU) increased fruit weight, yield per tree and total yield as compared with untreated trees. Treatment of Sitofex (CPPU) with concentration 20 mg/L gave the best result in fruit weight, yield per tree and total yield in both seasons as compared with untreated trees.

Regardless of control treatment the data showed that treatment of girdling in mid-February on branch two years old gave the lowest results in fruit weight, yield per tree and total yield as compared with other treatments in both seasons, with significant differences.

Results of this study are agreement with those of Aly *et al*. (2012a) who reported that girdling of shoot three years old on "Le-Conte" pear trees gave the highest increase of number of fruits per tree, fruit weight and yield in both successive seasons of 2010 and 2011, while Nasr *et al.* (2015) showed that girdling treatments in 1st of January increased fruit set % and fruit yield on "Le-Conte" pear trees. Azatoni (2016) showed that Sitofex (CPPU) with concentration 15 mg/L on "Anna" apple trees increased fruit weight, total yield in both successive seasons of 2015 and 2016. Taha and El-Ghany (2016) showed that Sitofex increased fruit yield and number of fruits/ branch and/ tree and decreased fruit drop percentage on "Anna" apple trees.

Table (3). Effect of girdling and Sitofex (CPPU) application treatments on Fruit weight and yield of "Le-Conte" pear trees in 2015 and 2016 seasons.

Treatments	Fruit Weight (g)		Yield (kg/tree)		Gross Yield (ton/feddan)	
	2015	2016	2015	2016	2015	2016
Untreated trees (Control).	141.22^{h}	143.10^{h}	30.22^{h}	30.76^{h}	5.07^{h}	5.16^{h}
Girdling in mid-Feb. (branch 2 y.)	160.82^{g}	164.21^{g}	35.86^{g}	36.78^{g}	6.02^{g}	6.17^{g}
Girdling in mid- Feb. (branch 3 y.)	181.98^{e}	183.33^{e}	43.67^{e}	44.54^{e}	7.33^{e}	7.48^{e}
Girdling in mid- Mar. (branch 2 y.)	166.57^{f}	169.12^{f}	39.14^{f}	39.91^{f}	6.57^{f}	6.70^{f}
Girdling in mid- Mar. (branch 3 y.)	184.15^{d}	186.83^{d}	44.93^{d}	45.77^{d}	7.54^{d}	7.68^{d}
Sitofex (CPPU) at 10 mg/L	190.71^{c}	192.52^{c}	47.86^{c}	48.51^{c}	8.04^{c}	8.14^{c}
Sitofex (CPPU) at 15 mg/L	196.14^{b}	195.01^{b}	51.58^{b}	51.48^{b}	8.65^{b}	8.64^{b}
Sitofex (CPPU) at 20 mg/L	198.00^{a}	199.23^{a}	53.85^{a}	54.38^{a}	9.04^{a}	9.13^{a}

Means not sharing the same letter (s) with each column are significantly different at 0.05 level of probability.

Fruit physical characteristics

The listed results in Table (4) showed the effect of girdling and Sitofex (CPPU) application treatments on fruit length, fruit diameter, L/D ratio, fruit size and fruit firmness on "Le-Conte" pear trees in 2015 and 2016 seasons.

Results showed that all application treatments of girdling and Sitofex (CPPU) increased fruit length, fruit diameter, L/D ratio, fruit size and fruit firmness as compared with untreated trees. In the same time Sitofex (CPPU) with concentration 20 mg/L gave the best results in fruit length, fruit diameter, fruit size and fruit firmness as compared with untreated trees in both seasons, with significant differences.

Results showed that girdling in mid-February on branch two years old gave the lowest results in fruit length, fruit diameter, fruit size and fruit firmness as compared with untreated trees in both seasons with significant differences. Also, girdling in mid-March on branch two years gave the highest L/D ratio in both seasons while treatment of Sitofex (CPPU) with concentration 10 mg/L gave the lowest L/D ratio as compared with control treatment, in both seasons, with significant differences.

Results of the present study agree to a great extent with those obtained by Aly *et al.* (2012a) who reported that girdling of shoot three years old on "Le-Conte" pear trees gave the highest fruit firmness increase in both successive seasons of 2010 and 2011. In addition to, Aly *et al.* (2012b) reported that Sitofex (CPPU) with concentration 15 and 20 mg/L on "Le-Conte" pear trees increased fruit size in both successive seasons of 2010 and 2011. Nasr *et al.* (2015) showed that girdling treatments in 1st of January increased fruit diameter on "Le-Conte" pear trees. Taha and El-Ghany (2016) showed that Sitofex increased fruit quality (fruit weight, size and diameter) during the two successive seasons of 2012 and 2013 on "Anna" apple trees.

Table (4). Effect of girdling and Sitofex (CPPU) application treatments on some physical fruit parameters of "Le-Conte" pear trees during 2015 and 2016 seasons.

Treatments	Fruit length(cm)		Fruit diameter(cm)		L/D (Ratio)		Fruit size(cm^3)		Fruit firmness (pound/inch2)	
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
Untreated trees (Control).	7.25^{h}	7.20^{h}	5.65^{h}	5.60^{h}	1.28^{b}	1.28^{c}	115.83^{h}	120.45^{h}	16.63^{h}	16.80^{h}
Girdling in mid-Feb. (branch2 y.)	8.10^{g}	8.15^{g}	6.13^{g}	6.15^{g}	1.31^{ab}	1.32^{ab}	135.71^{g}	138.55^{g}	17.75^{g}	17.76^{g}
Girdling in mid-Feb. (branch3 y.)	8.63^{e}	8.65^{e}	6.50^{e}	6.53^{e}	1.32^{ab}	1.32^{ab}	150.62^{e}	152.41^{e}	18.30^{e}	18.25^{e}
Girdling in mid-Mar. (branch2 y.)	8.40^{f}	8.42^{f}	6.20^{f}	6.27^{f}	1.35^{a}	1.34^{a}	140.13^{f}	144.23^{f}	17.85^{f}	17.90^{f}
Girdling in mid-Mar. (branch3 y.)	8.85^{d}	8.90^{d}	6.70^{d}	6.78^{d}	1.32^{ab}	1.31^{b}	155.87^{d}	153.01^{d}	18.60^{d}	18.64^{d}
Sitofex (CPPU) at 10 mg/L	9.30^{c}	9.35^{c}	7.15^{c}	7.18^{c}	1.30^{ab}	1.30^{bc}	169.80^{c}	170.31^{c}	19.10^{c}	19.14^{c}
Sitofex (CPPU) at 15 mg/L	9.70^{b}	9.75^{b}	7.40^{b}	7.42^{b}	1.31^{ab}	1.31^{b}	178.75^{b}	180.12^{b}	19.50^{b}	19.53^{b}
Sitofex (CPPU) at 20 mg/L	9.80^{a}	9.89^{a}	7.50^{a}	7.51^{a}	1.30^{ab}	1.31^{b}	186.11^{a}	189.59^{a}	19.68^{a}	19.70^{a}

Means not sharing the same letter(s) with each column are significantly different at 0.05 level of probability.

Fruit chemical characters

The results in Table (5) showed the effect of girdling and Sitofex (CPPU) application treatments on chemical fruit characteristics of "Le-Conte" pear trees in 2015 and 2016 seasons.

Results showed that all application treatments of girdling and Sitofex (CPPU) increased TSS percentage as compared with untreated trees. Generally, girdling in mid-March on branch three years old gave the highest result, in both seasons. On the other hand, treatment of Sitofex (CPPU) with concentration 10 mg/L recorded the lowest TSS percentage in both seasons as compared with other treatments except control treatment with significant differences. In the same time, all application treatments of girdling decreased acidity percentage while treatments of Sitofex (CPPU) increased acidity percentage as compared with untreated trees. Generally, Sitofex (CPPU) with concentration 20 mg/L gave the best result in both seasons. The data also showed that

treatment of girdling in mid-March on branch three years old gave the lowest TSS percentage in both seasons, with significant differences.

Furthermore, data showed that all application treatments of girdling and Sitofex (CPPU) increased vitamin C content as compared with untreated trees except treatments of girdling in mid-February on branch two years old which decreased vitamin C content in the first season only and girdling in mid-March on branch two years old which decreased vitamin C content in second season. Results showed that Sitofex (CPPU) with concentration 20 mg/L recorded the highest vitamin C content in both seasons. The results also showed that treatment of girdling in mid-March on branch two years old gave the least treatment in vitamin C content in both seasons, with significant differences. Also, all application treatments of girdling increased total sugars percentage while all treatments of Sitofex (CPPU) decreased total sugars percentage as compared with untreated trees. Generally, girdling in mid-March on branch three years old gave the highest value in both seasons. The data also showed that treatment of Sitofex (CPPU) with concentration 20 mg/L gave the lowest total sugars percentage in both seasons, with significant differences.

Results referred that all application treatments of girdling decreased starch percentage while all treatments of Sitofex (CPPU) increased starch percentage as compared with untreated trees. Generally, Sitofex (CPPU) with concentration 20 mg/L gave the highest value in both seasons. The data also showed that treatment of girdling in mid-Feb. and mid-March on branch three years old gave the lowest starch percentage as compared with control treatment in both seasons, with significant differences.

The abovementioned results agree to a great extent with those obtained by Eliwa (2003) who found that girdling near the base of branches and hand fruit thinning on chemical composition of peach trees increased total soluble solids content (11.95 and 11.50%) and total carbohydrate (21.80 and 21.07%). Also, all treatments significantly reduced fruit acidity compared with the control. Chanana and Beri (2004) found that girdling plus thinning, girdling alone done at full bloom and 28 days thereafter, and thinning at 2 weeks after full bloom matured 12, 6 and 5 days earlier than control fruits, respectively and gave the beast treatment in sugar content and total soluble solids content. In the same time, Kitren and Chuck (2006) found that Sitofex (CPPU) improved the conversion of starch and sugars content. Aly *et al.* (2012a) reported that girdling of shoot three years old on "Le Conte" pear trees gave the highest increase of total soluble solids (TSS%) and decreased fruit acidity percentage in both successive seasons of 2010 and 2011. Mohamed (2012) stated that all shoot girdling treatments on "Le-Conte" pear trees increased total sugars content as compared with the control in both successive seasons of 2009 and 2010. Azatoni (2016) showed that Sitofex (CPPU) with concentration 15 mg/L on "Anna" apple trees increased TSS (%), total acidity (%), vitamin C and starch (%) in both successive seasons of 2015 and 2016.

Table (5). Effect of girdling and Sitofex (CPPU) application treatments on some chemical characteristics of "Le-Conte" pear trees during 2015 and 2016 seasons.

Treatments	TSS(%)		Acidity (%)		Vitamin C (mg/100 ml juice)		Total sugars (%)		Starch (%)	
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
Untreated trees (Control).	11.52^{f}	11.56^{h}	0.47^{c}	0.49^{c}	20.80^{e}	20.50^{f}	7.54^{e}	7.5^{e}	2.73^{cd}	2.76^{c}
Girdling in mid-Feb. (branch 2 y.)	12.67^{de}	12.70^{e}	0.34^{d}	0.35^{d}	20.60^{f}	20.62^{e}	8.21^{d}	8.23^{d}	2.70^{de}	2.71^{d}
Girdling in mid- Feb. (branch 3 y.)	14.80^{b}	14.83^{b}	0.27^{e}	0.28^{e}	21.50^{b}	21.52^{b}	8.39^{b}	8.42^{b}	2.66^{fg}	2.64^{e}
Girdling in mid- Mar. (branch 2 y.)	13.27^{c}	13.38^{c}	0.29^{e}	0.28^{e}	20.46^{g}	20.43^{f}	8.30^{c}	8.31^{c}	2.68^{ef}	2.69^{d}
Girdling in mid- Mar. (branch 3 y.)	15.40^{a}	15.40^{a}	0.24^{f}	0.24^{f}	21.52^{b}	21.46^{b}	8.53^{a}	8.55^{a}	2.63^{g}	2.65^{e}
Sitofex (CPPU) at 10 mg/L	12.16^{e}	12.14^{g}	0.50^{b}	0.51^{b}	21.18^{d}	21.15^{d}	7.33^{f}	7.32^{f}	2.77^{bc}	2.79^{b}
Sitofex (CPPU) at 15 mg/L	12.43^{de}	12.45^{f}	0.52^{ab}	0.52^{b}	21.30^{c}	21.36^{c}	7.29^{g}	7.31^{f}	2.81^{ab}	2.80^{b}
Sitofex (CPPU) at 20 mg/L	13.00c^{d}	12.98^{d}	0.53^{a}	0.54^{a}	23.45^{a}	23.40^{a}	7.24^{h}	7.25^{g}	2.83^{a}	2.85^{a}

Means not sharing the same letter(s) with each column are significantly different at 0.05 level of probability.

Nutrient contents:

The listed results in Table (6) showed the effect of girdling and Sitofex (CPPU) application treatments on N, P, K, Ca and Mg in leaves of "Le-Conte" pear trees in 2015 and 2016 seasons. Results showed that Sitofex (CPPU) with concentration 20 mg/L recorded the highest nitrogen, phosphorus and magnesium percentage, while treatment of girdling in mid-March on branch three years old gave the lowest values compared with control treatment in both seasons, with significant differences.

Results showed that all application treatments of Sitofex (CPPU) increased potassium and calcium percentages but all treatments of girdling decreased potassium and calcium percentage except treatment of girdling in mid-March on branch two years old that increased calcium percentage in the second season as compared with untreated trees with significant differences.Moreover, Sitofex (CPPU) with concentration 20 mg/L gave the best results in increasing of potassium percentage in both seasons and calcium percentage in the first season only but treatment of girdling in mid-March on branch two years old recorded the best result of calcium percentage, in the second season.

The data also showed that treatment of girdling in mid-February on branch two years old gave the lowest potassium percentage, while treatment of girdling in mid-March on branch three years old gave the least calcium percentage as compared with control treatment in both seasons, with significant differences.The above demonstrated results were in agreement with those mentioned by Hossain *et al.* (2004) who found that girdling plants decreased potassium (K), calcium and magnesium content in the leaves of peach trees compared with the control. Mohamed (2012) stated that all shoot girdling treatments on "Le-Conte" pear trees decreased leaf nitrogen, phosphorus, potassium and magnesium content as compared with the control in both successive seasons of 2009 and 2010. On the other hand, Naseb (2012) reported that Sitofex (CPPU) with concentration 20 mg/L on "Le-Conte" pear trees increased nitrogen, potassium calcium and magnesium in both successive seasons of 2010 and 2011.

Table (6). Effect of girdling and Sitofex (CPPU) application treatments on leaf macronutrient contents of "Le-Conte" pear trees during 2015 and 2016 seasons.

Treatments	N %		P%		K%		Ca%		Mg%	
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
Untreated trees (Control).	1.92^{d}	1.93^{d}	0.30^{d}	0.31^{d}	1.41^{d}	1.43^{d}	1.45^{c}	1.47^{e}	0.46^{c}	0.47^{c}
Girdling in mid-Feb. (branch 2 y.)	1.84^{e}	1.85^{e}	0.27^{e}	0.29^{e}	1.28^{h}	1.29^{h}	1.29^{d}	1.30^{f}	0.41^{d}	0.42^{d}
Girdling in mid-Feb. (branch 3 y.)	1.78^{fg}	1.79^{fg}	0.26^{ef}	0.26^{f}	1.32^{f}	1.34^{g}	1.20^{f}	1.22^{g}	0.39^{de}	0.38^{e}
Girdling in mid-Mar. (branch 2 y.)	1.81^{ef}	1.80^{f}	0.27^{e}	0.28^{ef}	1.30^{g}	1.31^{f}	1.24^{e}	1.91^{a}	0.40^{d}	0.41^{d}
Girdling in mid-Mar. (branch 3 y.)	1.75^{g}	1.76^{g}	0.25^{f}	0.26^{f}	1.35^{e}	1.39^{e}	1.19^{f}	1.18^{h}	0.37^{e}	0.38^{e}
Sitofex (CPPU) at 10 mg/L	1.98^{c}	1.99^{c}	0.33^{c}	0.34^{c}	1.54^{c}	1.55^{c}	1.51^{b}	1.50^{d}	0.50^{b}	0.50^{b}
Sitofex (CPPU) at 15 mg/L	2.07^{b}	2.08^{b}	0.35^{b}	0.36^{b}	1.58^{b}	1.59^{b}	1.52^{b}	1.53^{c}	0.51^{ab}	0.52^{a}
Sitofex (CPPU) at 20 mg/L	2.44^{a}	2.49^{a}	0.38^{a}	0.39^{a}	1.60^{a}	1.62^{a}	1.66^{a}	1.68^{b}	0.53^{a}	0.52^{a}

Means not sharing the same letter(s) with each column are significantly different at 0.05 level of probability.

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الملخص العربي

تأثير التحليق والسيتوفكس على النمو الخضري، عقد الثمار، المحصول وجودة ثمار أشجار الكمثرى "ليكونت"

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كلية الزراعة سابا باشا قسم الإنتاج النباتي[١]، معهد بحوث البساتين– مركز البحوث الزراعية – مصر– الجيزة[٢] ، خبير قضائى تخصص زراعى – وزارة العدل – مصر[٣]

أجريت هذه الدراسة خلال موسمىّ ٢٠١٥، ٢٠١٦ على أشجار الكمثرى عمرها ٢٠ عام صنف ليكونت مطعومة على أصل كمثرى كميونس ومنزرعة في أرض رملية لومية في أحد المزارع الخاصة في منطقة برج العرب محافظة الأسكندرية. ولقد تكونت التجربة من المعاملات التالية : ١) الأشجار الغير معاملة (الكنترول)، ٢) التحليق فى منتصف فبراير (فرع عمر سنتين)، ٣) التحليق فى منتصف فبراير (فرع عمر ثلاث سنوات)، ٤) التحليق فى منتصف مارس (فرع عمر سنتين)، ٥) التحليق فى منتصف مارس (فرع عمر ثلاث سنوات)، ٦) السيتوفكس بتركيز ١٠ مجم/لتر، ٧) السيتوفكس بتركيز ١٥ مجم/لتر و ٨) السيتوفكس بتركيز ٢٠ مجم/لتر. وقد تم رش جميع معاملات السيتوفكس مرتين فى تمام التزهير وبعد تمام التزهير بشهر. وقد أوضحت النتائج أن السيتوفكس من ١٠ إلى ٢٠ مجم/لتر أدى إلى زيادة نسبة العقد والمحصول (وزن الثمار، محصول الثمار لكل شجرة والمحصول الكلى)، الصفات الفيزيائية (طول الثمرة، وقطر الثمرة، ومعامل شكل الثمرة، حجم الثمرة وشكل الثمرة)، الصفات الكيمائية (المواد الصلبة الذائبة الكلية، الحموضة، المواد الصلبة الذائبة الكلية إلى نسبة الحموضة، فيتامين ج ومحتوى النشا)، والعناصر المعدنية الكبرى (النتروجين، الفوسفور، البوتاسيوم، الكالسيوم و الماغنسيوم) بينما أدت نفس هذه المعاملات إلى نقص نسبة التساقط و السكريات الكلية. ومن ناحيةٍ أخرى أدت مُعاملات التحليق إلى زيادة نسبة العقد، الصفات المحصولية، الصفات الفيزيائية والكيميائية بينما أدت إلى نقص الصفات الخضرية، نسبة التساقط و محتوى العناصر المعدنية الكبرى مقارنة بالأشجار الغير معاملة مع وجود إختلافات معنوية.

Longevity of Cut Carnation (Dianthus Caryophyllus L.) Flowers Using some Postharvest Treatments

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ABSTRACT: Keeping quality and length of vase life are important factors for evaluation of cut flowers quality, for both domestic and export markets. These investigations proposed to determine the effectiveness of some postharvest solutions as silver thiosulphate (0.5, 1.0 and 2.0 mM), copper sulphate (100,200 and 300 mg/l), citric acid (100, 200 and 300 mg/l) and ascorbic acid (150, 300 and 450 mg/l) on quality parameters of (Dianthus caryophyllus L. cv. Pink Dover') flowers. Results showed that all treatments significantly increased the vase life (Day), fresh weight (g), flower diameter (cm), total chlorophyll (SPAD) and percentage of protein in leaves compared to control. The highest increase in vase life, flower diameter was obtained by silver thiosulphate (2.0 mM). On other hand, ascorbic acid (450 mg/l) was more effective on increasing fresh weight. Whilst, citric acid (300 mg/l) resulted in the maximum chlorophyll content in both experiments. Moreover, copper sulphate (300 mg/l) recorded the most increase in the percentage of protein in leaves in both experiments, furthermore ascorbic acid (150 mg/l), silver thiosulphate (1.0 mM) and copper sulphate (200 mg/l) in second experiment compared to control.
Key words: Carnation, vase life, postharvest treatments, cut flowers

INTRODUCTION

Carnation (*Dianthus caryophllus* L.) belongs to family Caryophyllaceae, is native to the Mediterranean region and Central Asia , is among the three top cut flowers around the world (Hashemabadi *et al*., 2015).Carnation has more than 300 species (Ramtin *et al*., 2016) and well known throughout the world for its beauty, diversity colors, excellent keeping quality and wide flower range. Vase life of cut flowers is mainly affected by two main factors; ethylene which accelerates the senescence of many flowers and microorganisms which cause vascular blockage and thus reduces the vase life of cut flowers (Sardoei *et al*., 2013). Silver thiosulphate (STS) competes with ethylene for the same site of action and therefore, reduces the negative effect of ethylene. Copper ions have been used in flower vase solutions as a biocide and a wound reaction enzyme (Edrisi *et al*., 2012). Citric acid reduces the risk of vascular blockage in cut flowers through its anti-embolism habit (Sheikh *et al*., 2014). Ascorbic acid plays an important role in the electron transport system (Sheikh *et al*., 2014). The aims of this study were to determine the effectiveness of silver thiosulphate, copper sulphate, citric acid and ascorbic acid with different concentrations as preservation treatments on Carnation cut flowers senescence and vase life quality and longevity.

MATERIALS AND METHODS

Two separated experiments were conducted in the Plant Production Department, Faculty of Agriculture, Saba Basha, Alexandria University in (January and February, 2016) on Carnation cut flowers, to study the effect of silver thiosulphate, copper sulphate, citric acid and ascorbic acid treatments

with different concentrations on vase life of Carnation cut flowers (Pink Dover variety). Cut flowers were cut in early morning, wrapped using polyethylene then quickly transported to the laboratory. The stems of cut flowers were shorted before pulsing treatments to 50cm. The lower leaves were removed to avoid contamination in the vase solution then placed in plastic containers which contained the pulsed solution in tap water, of an average temperature of (18° C ±1) and (50- 60 %) relative humidity and light from a white fluorescent lamp. After that, flower stems were pulsed in freshly solutions which prepared at the start of experiments from concentrations of (silver thiosulphate, copper sulphate, citric acid and ascorbic acid) in plastic container for 24 hours. Then the flowers were moved to glass containers (vases) which contained 300 ml of tap water to calculate the vase life and the tested parameters.

Treatments and design

The treatments were arranged in a factorial experiment with Randomized Complete Block Design (RCBD) in two factors (treatments and Dates) with 3 replications. All data were statistically analyzed by the analysis of variance as described by Steel and Torrie (1980), and done by average of SAS (2002) statistical software. Cut flowers were pulsed in concentrations of silver thiosulphate (0.50, 1.00 and 2.00 mM) copper sulphate (100, 200 and 300 mg/l), citric acid (100, 200 and 300 mg/l) and ascorbic acid (150, 300 and 450 mg/l) with 2 liter tap water and 1% sucrose in the same time, control cut flowers pulsed in 2 liters tap water and 1% sucrose for 24 hours.

Vase Life (days):

Was determined by observing senescence symptoms, i.e., in-rolling of petals or wilting of one third of petals in each flower (Edrisi *et al.*, 2012).

Total Fresh Weight (g):

The average fresh weight of fresh stems carrying leaves and the flowers were calculated at the full opening stage (Barakat, 2013).

Flower Diameter (cm):

Increase diameter of flower was a suitable measurement to indicate efflorescence of flower Zadeh and Mirzakhani (2012).

Chlorophyll Index (SPAD):

Chlorophyll index was measured by chlorophyll meter (SPAD- 502, Minolta Co. Japan). Average of 3 measurements from different spots of a single leaves was considered (Yadava, 1986).

Determination of protein content in leaves (%):

determined on the basis of total nitrogen content according to A.O.A.C. (2000). The average nitrogen (N) content of protein was found to be about 16 %, which use the calculation N x 6.25 (1/0.16 = 6.25) to convert nitrogen content to protein Agriculture and consumer protection (2003).

RESULTS AND DISCUSSION

Vase Life (Days)

As shown from data in Table (1), the three silver thiosulphate postharvest treatments (0.50, 1.00 and 2.00 mM) significantly increased the vase life in days of Carnation cut flowers compared to control, in both experiments (January and February, 2016). The beneficial effect of silver thiosulphate might be due to the production of Ag^+ in the vase water, which might inhibit the rise of ethylene precursor, thereby enhancing the longevity of cut flowers as proved by Khan *et al*. (2015).The results are in harmony with Musembi *et al*. (2015) on Eustoma flowers, Asghari (2015) on Lilium and Rose, they showed that silver thiosulphate (STS) prolonged the vase life.

With respect to copper sulphate, results in Table (1) confirmed that the three concentrations of copper sulphate (100, 200 and 300 mg/l) significantly increased the vase life compared to control, except to (100 mg/l) treatment in the second experiment. These results are in accordance with Farokhzad *et al.* (2008) on Eustoma cut flowers, who confirmed that copper sulfate treatments was the most effective in extending the vase life. The effect of copper sulphate on improving vase life might be attributed to the use of copper ions have been used in flower vase solutions as a biocide and a wound reaction enzyme Edrisi *et al*. (2012).

However, citric acid at (100, 200 and 300 mg/l) increased vase life of Carnation cut flowers, in Table (1), compared to control in the two experiments. The improving effect might be due to the possibility of citric acid to inhibit microorganisms' growth through the reduction of pH in preservative solutions as proved by Sheikh *et al.* (2014). Results are in conformity with those of Gupta *et al*. (2006) on Chrysanthemum and Kumar *et al.* (2010) on Tuberose.

Data in Table (1) indicated that all concentrations of ascorbic acid (150, 300, 450 mg/l) increased vase life of Carnation cut flowers compared to control in the two experiments, except for ascorbic acid treatment at (150 mg/l) in the second experiment only.

Significant differences were also found between (450 mg/l) compared to (300 mg/l) concentrations in the first experiment only. This positive effect might be attributed to the acidifying as well as inhibiting effects of ascorbic acid on many bacteria & fungi as reported by Satoh *et al.* (2005). These results found to be in agreement with those of Abdulrahman *et al*. (2012) on Snapdragon cut flowers.

Table (1). Effect of some postharvest solutions on vase life (days) of cut Carnation (*Dianthus caryophyllus,* L.) cv. "Pink dover" flowers in two experiments (January and February, 2016).

Treatments	First experiment (January, 2016)	Second experiment (February, 2016)
	Vase life (Days)	Vase life (Days)
Control	9.22 ^{f}	10.56 ^{d}
Silver thiosulphate (0.5 mM)	12.23 ^{bcd}	12.22 ^{bc}
Silver thiosulphate (1.0 mM)	12.26 ^{bcd}	12.33 ^{bc}
Silver thiosulphate (2.0 mM)	14.26 ^{a}	14.33 ^{a}
Copper sulphate (100 mg/l)	11.30 ^{de}	11.56 ^{cd}
Copper sulphate (200 mg/l)	11.82 ^{cde}	11.89 ^{c}
Copper sulphate (300 mg/l)	13.15 ^{b}	13.22 ^{b}
Citric acid (100 mg/l)	12.10 ^{cde}	12.17 ^{c}
Citric acid (200 mg/l)	12.38 ^{bc}	12.45 ^{bc}
Citric acid (300 mg/l)	12.15 ^{cd}	12.22 ^{bc}
Ascorbic acid (150 mg/l)	11.48 ^{cde}	11.55 ^{cd}
Ascorbic acid (300 mg/l)	11.16 ^{e}	12 ^{c}
Ascorbic acid (450 mg/l)	12.26 ^{bcd}	12.33 ^{bc}
L.S.D at 0.05	**0.98**	**1.04**

Total Fresh Weight (g):

As for silver thiosulfate, it has been found that all concentrations (0.5, 1.0 and 2 mM) treatments significantly increased the fresh weight of cut Carnation compared to control in Table (2), also between (2.0 mM) compared to (0.5 mM). These results proved to be in agreement with Hayat *et al*. (2012) on Roses, they showed that the maximum flower fresh weight was recorded by silver thiosulfate treatment. Chamani *et al.* (2013) showed that the positive effect of silver thiosulfate may be due to its competes with ethylene for the same site of action and therefore reduces the negative effect of ethylene.

Data in Table (2), revealed that generally the three copper sulphate treatments significantly increased fresh weight of Carnation cut flowers compared to control. Significant differences were also found among the three treatments, except between the two higher concentrations (200 and 300 mg/l) in the second experiment. This effect of copper sulphate is because copper ions have been used in flower vase solutions as a biocide and a wound reaction enzyme Edrisi *et al.* (2012).Similar results are found by Hojjati *et al.* (2007) on Eustoma cut flowers.

With Regard to citric acid, data in Table (2), cleared that all citric acid concentrations caused significant increase in fresh weight compared to control in two experiments. Also found between citric acid at (300 and 100 mg/l) treatments compared to citric acid at (200 mg/l) in both experiments. These results found to be in agreement with Pal and Sirohi (2007) on Gladiolus. Effectiveness of citric acid might be related to the effect citric acid on reducing the pH of water and, consequently, the proliferation of bacteria, which block the

xylem vessels in the cut region and interfere with the normal flux of water through the stem indicated by Zamani *et al.* (2011).

In relation to ascorbic acid treatments Table (2), showed that the three ascorbic acid treatments (150, 300 and 450 mg/l) lead to significant increase in fresh weight compared with control in the two experiments on Carnation cut flowers. It was also found between (450 mg/l) compared to (150 and 300 mg/l). This result is in agreement with the result obtained by Mohamed (2015) on Rose cut flowers, Their significant effect might be attributed to the effect of ascorbic acid (AsA) on inhibiting bacteria growth, which has been extensively evaluated for protecting cut flowers from physical plugging as recorded by Abdul Jaleel (2009)

Regarding the effect of vase life periods on the change of fresh weight on Carnation cut flowers it was increased by increasing vase life periods until sample date 5, and then decreased by increasing dates periods in both experiments. The differences among all tested vase life periods were statistically significant. The increment in relative fresh weight at initial vase life days could be due to the higher solution uptake during the early storage time as supported by Seyf *et al.* (2012). Furthermore, Alaey *et al.* (2011) reported that the highest relative fresh weight of cut rose flowers was observed in vase solutions which showed the greatest water uptake. The decrease in relative fresh weight of cut flowers during the days of after harvest could be due to the decrease in water uptake Soleimany-Fard *et al.* (2013).

Table (2). Effect of some postharvest solutions on fresh weight (g) of cut Carnation (*Dianthus caryophyllus*, L.) cv. "Pink dover" flowers in two experiments (January and February, 2016).

Vase life (days)	Control	Silver thiosulphate (mM)			Copper sulphate (mg/l)			Citric acid (mg/l)			Ascorbic acid (mg/l)			Dates Average
		0.5	1.0	2.0	100	200	300	100	200	300	150	300	450	
First experiment (January 2016)														
0	20.01	22.68	23.07	22.84	23.97	22.07	21.72	22.32	21.86	23.61	23.45	21.31	25.78	22.90^{b}
5	23.99	25.06	26.23	24.93	25.99	27.54	24.73	25.96	25.62	26.54	25.78	27.96	28.75	26.08^{a}
10	18.11	21.98	21.24	20.38	20.79	19.64	18.94	18.97	18.81	19.29	21.16	20.96	22.98	20.25^{c}
15	13.52	17.97	15.98	16.81	16.41	15.39	15.73	16.24	14.59	15.12	15.77	14.56	19.24	15.95^{d}
Treatments Average	18.91^{h}	21.92^{b}	21.63^{bcd}	21.24^{cde}	21.79^{bc}	21.16^{de}	20.28^{fg}	20.87^{ef}	20.22^{g}	21.14^{de}	21.54^{bcd}	21.95^{b}	24.18^{a}	
L.S.D at$_{0.05}$		**Treatments: 0.61**				**Dates: 0.34**					**Treatments x Dates: 1.23**			
Second experiment (February 2016)														
0	20.04	22.74	23.14	22.90	24.03	23.14	21.77	22.40	21.92	23.66	23.50	24.37	25.83	22.96^{b}
5	24.46	25.13	26.30	24.99	26.66	26.10	24.80	26.32	25.68	26.61	25.84	27.01	28.81	26.05^{a}
10	18.06	22.06	21.31	20.46	20.85	19.71	19.61	21.93	18.88	21.34	22.23	21.73	23.81	21.31^{c}
15	13.63	18.07	16.07	16.89	16.48	15.48	15.81	16.33	14.68	15.20	15.84	14.64	19.23	16.03^{d}
Treatments Average	19.05^{e}	22^{b}	21.71^{b}	21.31^{bc}	22.01^{b}	20.86^{cd}	20.50^{d}	12.74^{b}	20.29^{d}	21.70^{b}	21.85^{b}	21.94^{b}	25.69^{a}	
L.S.D at$_{0.05}$		**Treatments: 0.73**				**Dates: 0.41**					**Treatments x dates: 1.49**			

Flower Diameter (cm):

Data in Table (3), cleared that all silver thiosulphate concentrations (0.5, 1.0 and 2 mM) significantly increased flower diameter of cut Carnation compared to control in the two experiments. Significant differences were also found among the three treatments, except between the two lower concentrations (0.5 and 1.0 mM) in the first experiment. This positive effect may be attributed to the role of silver thiosulphate in enhancing flower diameter through effective solution uptake. STS also inhibits the microbial population, which causes the vascular occlusion of stems as confirmed by Dung *et al.* (2016). Similar results were obtained by El-Sayed (2011) on Carnation.

Regarding copper sulphate effect, data in Table (3) cleared that, all copper sulphate (100, 200 and 300 mg/l) treatments increased flower diameter significantly compared with control in both experiments. Significant differences were found among the three treatments, except between the two higher concentrations (200 and 300 mg/l) in the second experiment. Our results are in harmony with findings of Edrisi *et al*. (2012) on Eustoma cut flowers. These results may be taken place because the use of calcium, aluminum, boron, copper, nickel and zinc salts extends the vase life of cut flowers as confirmed by Mohammadi *et al.* (2012).

Table(3), recorded that flower diameter increased significantly with increasing citric acid concentrations compared to control in both experiments of Carnation cut flowers, except citric acid at (200 mg/l) in the second experiment. Significant differences were also found among all treatments, except between citric acid at (100 and 300 mg/l) in the first experiment. These results are similar with Nandre *et al*. (2009) on Rose. Thus it seemed to be referred to the regular effect of citric acid which acts as a pH regulator on reduces bacterial proliferation and enhances the water conductance in xylem of cut flowers showed by Van Doorn (2010).

Regarding ascorbic acid application (150, 300 and 450 mg/l), our results in Table (3) revealed that all ascorbic acid concentrations had significant effect on increasing flower diameter (cm) compared to control in both experiments, also between (150 and 300 mg/l) compared to (450 mg/l) in both experiments. These results consistent with Mohamed (2015). These significant effects might be attributed to the acidifying and inhibiting effects of ascorbic acid on many fungi and bacteria as reported by Satoh *et al*. (2005).

At vase life in Table (3), results indicated that flower diameter of Carnation cut flowers was increased by increasing vase life periods in the two separated experiments. The differences among all tested vase life periods were statistically significant. The increase in cut flower diameter during vase period was probably because petals of flowers growth is associated with flower bud opening which results from cell expansion that requires the influx of water and osmolytes such as glucose into petal cells as confirmed by Tsegaw *et al.* (2011). The decrease in flower diameter is often due to the increase of bacterial accumulation at the end of stem, which leads to vessels plugging and ethylene synthesis that links to water conductivity disorder, wilting and decreasing capitulum diameter as recorded by Jafarpour *et al.* (2015).

Table (3). Effect of some postharvest solutions on flower diameter (cm) of cut Carnation (*Dianthus caryophyllus*, L.) cv. "Pink dover" flowers in two experiments (January and February, 2016).

Vase life (days)	Control	Silver thiosulphate (mM)			Copper sulphate (mg/l)			Citric acid (mg/l)			Ascorbic acid (mg/l)			Dates Average
		0.5	1.0	2.0	100	200	300	100	200	300	150	300	450	
	First experiment (January 2016)													
0	2.17	2.50	2.67	3.07	2.37	2.27	2.37	2.23	2.37	2.37	2.27	2.47	2.27	2.41^{d}
5	3.27	4.17	4.03	4.90	3.17	4.57	4.20	4.57	3.67	4.03	3.73	4.03	3.77	4.01^{c}
10	5.63	6.47	7.03	7.47	6.17	7.13	6.37	6.17	5.57	6.77	6.23	6.27	6.03	6.41^{a}
15	4.27	5.17	5.27	5.87	4.57	5.10	5.17	5.03	4.50	5.10	5.00	4.87	4.77	4.97^{b}
Treatments Average	3.83^{i}	4.57^{cd}	4.75^{bc}	5.33^{a}	4.07^{gh}	4.77^{b}	4.53^{d}	4.50^{d}	4.03^{h}	4.57^{d}	4.31^{ef}	4.41^{de}	4.21^{fg}	
L.S.D at$_{0.05}$	**Treatments: 0.18**					**Dates: 0.10**				**Treatments x Dates: 0.37**				
	Second experiment (February 2016)													
0	2.33	2.37	2.63	2.97	2.53	2.43	2.27	2.47	2.47	2.53	2.37	2.57	2.37	2.48^{d}
5	3.13	3.97	3.77	4.67	3.17	4.27	4.13	3.77	3.47	3.83	3.67	3.77	3.57	3.78^{c}
10	5.17	6.07	6.57	7.07	5.77	6.67	6.03	5.67	5.20	6.47	5.77	5.87	5.57	5.99^{a}
15	4.13	4.87	5.03	5.57	4.37	4.77	4.87	4.67	4.27	4.77	4.73	4.63	4.47	4.70^{b}
Treatments Average	3.69^{i}	4.32^{cd}	4.50^{b}	5.07^{a}	3.96^{gh}	4.53^{b}	4.38^{bcd}	4.09^{efg}	3.85^{hi}	4.38^{bcd}	4.13^{ef}	4.21^{de}	3.99^{fgh}	
L.S.D at$_{0.05}$	**Treatments: 0.17**					**Dates: 0.09**				**Treatments x dates: 0.33**				

Total Chlorophyll (SPAD):

Data in Table (4), revealed that all applications of silver thiosulphate significantly increase total chlorophyll compared to control in the two experiments. Significant differences were also found among the three treatments, except between (0.5 and 2.0 mM) in the second experiment. Our results are similar to those of Hassan and Ali (2014) on cut Rose. These results seemed to be due to the ability of silver thiosulphate STS in inhibiting the ethylene action and prolong the vase life of cut carnations and other floricultural products as confirmed by Zadeh and Mirzakhani (2012).

As for copper sulphate, data in Table (4) showed that copper sulphate treatments lead to significantly increase total chlorophyll compared to control, except for concentration (100 mg/l) in two experiments. Significant differences were also found among the three treatments, except between (100 and 200 mg/l) in the second experiment. This positive effect may be related to the use of calcium, aluminum, boron, copper, nickel and zinc salts which extends the vase life of cut flowers as confirmed by Mohammadi *et al.* (2012). Similar results were obtained by Farokhzad *et al.* (2008) on Eustoma cut flowers.

In relation to citric acid, results in Table (4), confirmed that all concentrations of citric acid with (100, 200 and 300 mg/l) significantly increased total chlorophyll compared to control in both experiments. Significant differences were also found among the three treatments in two experiments. This positive effect of citric acid could be attributed to its important role in reducing the proliferation of bacteria, which block the xylem vessels in the cut region and interfere with the normal flux of water through the stem as proved by Zamani *et al.* (2011). These results were found to agree with El-Quesni *et al.* (2012) on *Schefflera Arboricola* cut foliage.

Table (4) showed that all treatments of ascorbic acid (150, 300 and 450 mg/l) increased significantly total chlorophyll contents compared to control in both experiments. Significant differences were also found among the three treatments in two experiments, except between the two higher concentrations (300 and 450 mg/l) in the first experiment. These results are proved to be in accordance with Abdel Aziz *et al*. (2009) on Gladiolus cut flowers. We could return this positive effect to that a high level of endogenous ascorbate which is effectively essential to maintain the antioxidant system that protects plants from oxidative damage as proved by Abdul Jaleel (2009). Likewise, our results in Table (4) confirmed the effect of vase life periods on the change in total chlorophyll content of Carnation cut flowers which was increased by increasing vase life periods until sample date 10 in first experiment and sample date 5 in the second experiment then decreased by increasing dates periods in both experiments. The differences among all tested vase life periods were statistically significant in both experiments. The maintenance of green color in the leaves is an important quality properties in these economically significant ornamental plants. It had proved that the leaf yellowing of cut flowers is associated with chlorophyll breakdown and loss, thereby decreasing significant vase life (Alimoradi, 2013). We could return this loss of chlorophyll to the high rate of respiration and the action of ethylene which usually causes yellowing leaves as recorded by Marandi *et al.* (2011).

Table (4). Effect of some postharvest solutions on chlorophyll index of cut Carnation (*Dianthus caryophyllus*, L.) cv. "Pink dover" flowers in two experiments (January and February, 2016).

Vase life (days)	Control	Silver thiosulphate (mM)			Copper sulphate (mg/l)			Citric acid (mg/l)			Ascorbic acid (mg/l)			Dates Average
		0.5	1.0	2.0	100	200	300	100	200	300	150	300	450	
	First experiment (January 2016)													
0	79.47	82.67	80.57	82.27	79.87	80.20	86.87	83.87	79.67	86.87	82.00	84.33	84.57	82.20^{c}
5	82.00	86.13	84.47	84.87	82.53	83.43	84.47	86.77	82.43	89.63	85.37	86.77	88.13	85.15^{a}
10	79.87	83.13	81.00	82.67	80.13	80.63	82.63	84.27	80.13	87.27	82.37	84.67	85.00	82.60^{b}
15	74.23	77.73	76.13	77.87	74.17	74.37	75.87	77.23	76.13	82.23	77.37	78.47	77.83	76.89^{d}
Treatments Average	78.89^{i}	82.42^{d}	80.54^{g}	81.92^{e}	79.18^{i}	79.66^{h}	81.30^{f}	83.03^{c}	79.59^{h}	86.50^{a}	81.78^{e}	83.56^{b}	83.88^{b}	
L.S.D at$_{0.05}$	**Treatments: 0.39**				**Dates: 0.21**						**Treatments x Dates: 0.78**			
	Second experiment (February 2016)													
0	80.13	83.27	81.17	82.83	80.27	80.77	82.77	84.53	80.37	87.47	82.53	84.83	86.13	82.85^{b}
5	82.20	86.43	84.77	85.23	82.77	83.70	84.83	87.07	82.73	89.87	85.63	87.17	87.40	85.37^{a}
10	77.33	81.67	79.73	80.87	77.87	78.17	80.77	81.83	78.77	85.23	80.37	82.53	83.27	80.65^{c}
15	74.63	78.13	76.57	78.13	74.57	74.87	76.37	77.63	76.57	82.63	77.87	75.50	78.17	77.05^{d}
Treatments Average	78.58^{i}	82.38^{cde}	80.56^{g}	81.77^{def}	78.87^{hi}	79.38^{h}	81.18^{fg}	82.77^{c}	79.61^{h}	86.30^{a}	81.60^{ef}	82.51^{cd}	83.74^{b}	
L.S.D at$_{0.05}$	**Treatments: 0.56**				**Dates: 0.31**						**Treatments x dates: 1.30**			

Protein (%):

The three concentrations of silver thiosulphate significantly increased protein (%) in leaves compared to control in Table (5), Significant differences were also between (1.0 and 2.0 mM) compared to (0.5 mM) in two experiments. This improvement effect of silver thiosulphate may be due to the inhibiting and antimicrobial effect on ethylene production and antimicrobial in the vase solution as recorded by Ansari and Zangeneh (2008) and Subhashini *et al.* (2011). Results found to be in harmony with those of Gul and Tahir (2013) on Daffodil cut flowers who revealed that silver thiosulphate treatments increased proteins content significantly.

Table (5), cleared that the two higher concentrations of copper sulphate (200 and 300 mg/l) treatments significantly increased protein (%) in leaves compared to (100 mg/l) and control in the two experiments. Using (300 mg/l) concentration significantly increased protein (%) compared to (200 mg/l) in the first experiment only. Could attributed this results to copper ions which have been used in flower vase solutions as a biocide and a wound reaction enzyme Edrisi *et al*. (2012). Farokhzad *et al.* (2008) recorded that copper sulfate concentrations were the most effectiveness in enhancing vase life and keeping quality of Eustoma cut flowers.

Table (5) demonstrated significant increased of protein (%) in leaves between (100 mg/l) treatment of citric acid compared to (200 mg/l) treatment and control in both experiments. The enhancing effect of citric acid may be related to its role in reducing bacterial proliferation and enhancing the water conductance in xylem of cut flowers Van Doorn (2010). Similar results were obtained by Nandre *et al.* (2009) on Rose and Kumar *et al.* (2010) on Tuberose cut flowers.

Table (5), revealed that all concentrations of ascorbic acid increased protein (%) in leaves in comparison with control, except for (300 mg/l) treatment in the two experiments. Our results consistent with those obtained by Abri *et al*. (2013) on Rose cut flowers. They observed that ascorbic acid significantly reduced the protein degradation in Rose cut flowers compared to control treatments. This significant effect might be attributed to antioxidant capacity improvement and reduction of ROS (Reactive Oxygen Species) levels as well as oxidative damage in petals as indicated by Zhang (2008).

Regarding the effect of vase life periods on the change in protein (%) in leaves of Carnation cut flowers it increased by increasing vase life periods till date 5, then decreased by increasing dates periods in both experiments. The differences among all tested vase life periods were statistically significant. Prior to visible senescence symptoms, protein levels in petals decrease, sometimes drastically as Van Doorn and Woltering (2008) decleared in Ipomoea and Petunia. They declare that the decrease in overall protein levels can be due to a decrease in synthesis as well as an increase in degradation

Table (5). Effect of some postharvest solutions on protein (%) of cut Carnation (*Dianthus caryophyllus*, L.) cv. "Pink dover" flowers in two experiments (January and February, 2016).

Vase life (days)	Control	Silver thiosulphate (mM)			Copper sulphate (mg/l)			Citric acid (mg/l)			Ascorbic acid (mg/l)			Dates Average
		0.5	1.0	2.0	100	200	300	100	200	300	150	300	450	
	First experiment (January 2016)													
0	12.11	8.98	13.29	12.42	12.15	12.98	13.98	12.54	11.61	11.92	12.61	11.40	11.75	12.13^{b}
5	12.61	12.98	13.17	13.23	13.04	13.83	14.50	13.52	13.67	13.94	13.31	13.79	13.54	13.47^{a}
10	9.13	7.19	11.61	10.36	9.08	11.00	12.61	9.73	8.29	9.21	11.94	8.77	10.00	9.92^{c}
15	6.44	5.86	8.29	8.36	7.13	7.61	9.21	7.38	6.29	6.86	6.83	5.63	7.79	7.20^{d}
Treatments Average	10.07^{ef}	8.75^{g}	11.59^{b}	11.09^{bc}	10.35^{def}	11.36^{b}	12.57^{a}	10.79^{cd}	9.96^{ef}	10.48^{de}	11.17^{bc}	9.90^{f}	10.77^{cd}	
L.S.D at$_{0.05}$	**Treatments: 0.52**				**Dates: 0.29**			**Treatments x Dates: 1.05**						
	Second experiment (February 2016)													
0	12.29	9.17	13.48	12.61	12.33	13.17	14.17	12.73	11.79	12.11	12.79	11.58	11.94	12.32^{b}
5	13.23	13.44	13.79	14.08	13.19	14.17	14.75	14.46	14.11	13.96	13.94	14.42	14.79	13.98^{a}
10	8.88	6.94	11.36	10.11	8.83	10.75	12.36	9.48	8.04	8.96	11.69	8.52	9.75	9.67^{c}
15	5.69	5.11	7.54	7.61	6.38	8.04	6.08	6.63	5.54	6.11	8.25	4.88	7.04	6.53^{d}
Treatments Average	10.02^{f}	8.66^{g}	11.54^{ab}	11.10^{bc}	10.18^{ef}	11.53^{ab}	11.84^{a}	10.82^{cd}	9.87^{f}	10.28^{def}	11.67^{a}	9.85^{f}	10.73^{cde}	
L.S.D at$_{0.05}$	**Treatments: 0.56**				**Dates: 0.31**			**Treatments x dates: 1.30**						

CONCLUSION

In conclusion, From the obtained results, it might be recommended that the two higher concentrations of silver thiosulphate (1.0 and 2.0 mM), copper sulphate (200 and 300 mg/l), citric acid (200 and 300 mg/l) and ascorbic acid (300 and 450 mg/l) gave the acceptable characteristics of flowers and this is reflected on prolonging the vase life of (*Dianthus caryophyllus*, L.) cv. "Pink dover".

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الملخص العربى

إطالة عمر أزهار القرنفل باستخدام بعض معاملات ما بعد الحصاد

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تعتبر المحافظة على جودة وعمر الأزهار من العوامل الهامة لتقييم جودة زهور القطف فى كلا من الأسواق المحلية وأسواق التصدير. تهدف هذه الدراسة إلى تحديد فاعلية بعض محاليل الحفظ مثل ثيوسلفات الفضة (٠.٥ و١.٠ و٢.٠ مللى مولار) و كبريتات النحاس (١٠٠ و٢٠٠ و٣٠٠ مجم/لتر) وحمض الستريك (١٠٠ و٢٠٠ و٣٠٠ مجم/لتر) وحمض الأسكوربيك (١٥٠ و٣٠٠ و٤٥٠ مجم/لتر) على معايير الجودة لأزهار القرنفل صنف "Pink Dover". وقد أظهرت النتائج أن كل المعاملات أدت إلى زيادة معنوية فى عمر الأزهار(يوم) والوزن الطازج (جم) و قطر الزهرة (سم) ومحتوى الكلوروفيل (SPAD) و نسبة البروتين (%) في الأوراق مقارنة بالكنترول. تم الحصول على أعلى زيادة فى عمر الأزهار وقطر الزهرة من قبل ثيوسلفات الفضة (٢.٠ مللى مولار) فى كلا التجربتين.من ناحية أخرى حمض الأسكوربيك (٤٥٠ مجم/لتر) كان الأكثر تأثير فى زيادة الوزن الطازج فى كلا التجربتين بينما نتج عن حمض الستريك (٣٠٠ مجم/لتر) أعلى زيادة فى محتوى الكلوروفيل.علاوة على ذلك، كان لكبريتات النحاس (٣٠٠ مجم/لتر) الأثر الأكبر على زيادة نسبة البروتين فى الأوراق فى كلا التجربتين، علاوة على حمض الأسكوربيك (١٥٠ مجم/لتر) وثيوسلفات الفضة (٢.٠ مللى مولار) وكبريتات النحاس (٢٠٠ مجم/لتر) فى التجربة الثانية مقارنة بالكنترول.

Effect of Nano-Amino Zinc on Cell Division and Chromosomal Aberration in Wheat

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ABSTRACT: Phytotoxicity of nano amino zinc (NPs) was tested on wheat (Triticum aestivum L.). Cytogenetical assay in root-tip cells has been used to study the effect of nano amino zinc on chromosomal aberrations and cell division. This study aimed to provide new information about genotoxicity of nano amino zinc on plant systems. The results proved that nano amino zinc could enter freely into the cells and interfere in cell's normal function. Three different expose time and three amino zinc NPs concentrations were used. Three amino zinc NPs 0.5, 1.0 and 1.5 ml (nano-amino zinc solution) were completed to total volume of 20 ml H2O and root tips were treated after 8, 16 and 24 hrs. The different concentrations of nanoparticles were added for the tested grains until the root length retched from 1.5 to 2 cm in length. Mitotic index (%) were measured from ~ 2000 cells for each amino zinc nanoparticles concentrations. The treated root-tip cells exhibited various types of chromosomal aberrations as unorientation at metaphase, breaking of chromosomes, metaphasic plate distortion, spindle dysfunctioning, stickiness, precocious movement at metaphase and bridge, fragmentation scattering, unequal separation, multiple bridge, fragmentation, scattering, laggard and elongation, gap chromosome, multi polar anaphase, erosion, distributed chromosome and lagging chromosome during the current research.
Key words: nano amino zinc, T. aestivum L., chromosomal aberrations.

INTRODUCTION

Nanotoxicology is an emerging discipline receiving increasing attraction. Nanotoxicity has been focused on many publications, for instance, alumina and zinc oxide NPs have been applied to different plant species, Lolium perenne (using ZnO nanoparticles), Zea mays (magnetic NPs), Spinacia oleracea (TiO2 NPs), and Phaseolus vulgaris (alumina NPs) and Triticum aestivum (Cu NPs), (González-Melendi et al., 2008). Concern over the potential harmful effects of such nanoparticles have stimulated the advent of nanotoxicology as a unique and significant research discipline (Ghio et al., 2009). These small size NPs can modify the physiochemical properties of the materials, which can lead to adverse biological effect on living cells (Gaidajis and Angelakoglou, 2009).

Other studies have been reported on positive and negative effects of nanoparticles on higher plants. Due to its variable shape and size, it is difficult to predict the positive or negative effect and its mode of action in the environment and within living systems (Corredor et al., 2009) Heavy metals are widely acknowledged to inhibit seed germination, growth and development of plants by disturbing their biochemical and physiological processes (Binhi, 2010). To understand the probable benefits of applying nanotechnology to agriculture, the first step should be to analyze the level of penetration and transport of

nanoparticles in plants (Oberdörster et al., 2007). Silver nanoparticles (AgNPs) are widely used in many commercial products like antimicrobial agents, textiles and detergents etc. There are growing concerns about their impact on the environment (people, animals and plants). Hence to study its impact on plants we have gone for phytotoxicity, we have selected a monocot small size plant, short generation time and ability to grow well under controlled conditions. In the present study, different concentrations of nano amino zinc (AZNPs) genotoxicity and its influence were evaluated on seed germination and root tip cells of wheat.

MATERIALS AND METHODS

Nano amino zinc

Nano amino zinc (AZNPs) were obtained from “Bio Nano Tech” for fertilization development company, Egypt (Amino acids: 10%, Vitamins: 1%, Zinc: 6%). Nano amino zinc (NPs) used in the present study were in colloidal form (25.6 –79.0 nm size).

Plant materials

The root-tip of Wheat (2n = 42) was used as the test material, “Behooth 22” [CMSS96Y03236M-050M-040M-020M-050Sy-020SY-IM-0Y] obtained from Ministry of Agriculture in Iraq, Agriculture Research Center, Department of Cereals and Legumes, to treated with the different concentrations of amino zinc nanoparticles (AZNPs).

Cytological studies:

Mitotic studies were carried out on root tips from germinated seeds. After treatments, the roots were collected as primary roots. Also, adventitious roots were collected from the older germinated seeds. The root tips were washed with distilled water and placed in 95% ethanol and glacial acetic acid (3:1) v/v for 24 hrs. at room temperature for killing and fixation. Root tips were removed from fixative solution and placed in 70% ethanol, stored in a refrigerator (4-5OC) until examined (Samad et al. 1992). Slides were examined after preparation. Karyotyping system (FUJITSU-YLCM264618-Made in Germany) was used for taking micrograph for the divided and abnormal cells using the same magnification. Different mitosis stages were observed and calculated under the different nanoparticles concentrations.

Mitotic index (%) were measured from ~ 2000 cells for each amino zinc nanoparticles concentrations as the total of divided cell, number of different mitosis stages (Prophase, Metaphase, Anaphase and Telophase). MI (%) = Number of divided cell/ number of observed cells. Also, all the chromosomal aberrations in the treated samples were recorded.

RESULTS AND DISCUSSION

A- Cell division and mitotic index:

For the control grains in all the tested materials showed high percentage of germination 100%. Mitosis division for wheat "Behoth 22" was examined using acetocarmine and all the mitosis stages were observed (Table 1). The results showed that, the total observed cells were ~1838 cells, within the observed cells, data clearly indicated that the highest divided stage was prophase by 665 cells while, Metaphase was 286 cells; Anaphase recorded 216 and Telophase 107 cells. Data showed that interphase was 564 cells and Mitotic index was 69.31%. No abnormal stages were observed. Data showed the different mitosis stages as control which includes interphase, prophase, early metaphase, polar view metaphase, anaphase, early telophase, telophase and late telophase.

Table (1). Total observed, divided cells, Mitotic index and different mitosis stages for Iraqi wheat "Behoth 22" under control conditions.

Mitosis division	Mean
No. of observed cells	1838
Interphase	564
No. of divided cells	1274
Prophase	665
Metaphase	286
Anaphase	216
Telophase	107
Mitotic Index (%)	69.31 %

B- Effect of nano amino zinc (AZNPs) on cell division and mitotic index

All the tested wheat grains showed high percentage of germination comparing with control ranged from 96.77 to 100%. The results showed the total observed cells ranged from 1650 to 2070 cells by general means as 1844.11 cells, within the observed cells data which clearly indicated that the highest divided cells were recorded to 0.5 ml / 8 hrs (nano-amino zinc solution). by 1480 cells and the lowest number were recorded to 1.5 ml /24 hrs. (nano-amino zinc solution). by 700 cells as shown in Table (2) and Figure (1).

The general mean of divided cells were 1011.88 cells by mitotic index was 53.71 %. Different mitosis stages were observed during the cell division such as prophase, metaphase, anaphase and telophase in normal way, on other hand, abnormal stages were observed as presented in Table (2). Concerning to the first mitosis stage prophase, Data in Table (2) showed that the general mean was 657.73 cells comparing with metaphase (131.78 cells), anaphase (151.78 cells) and finally telophase was (70.83 cells).

In the total divided cell, many abnormal cases were observed such as c-metaphase, fragment, bridge, uncoiling, stickiness, nucleotide deletion, distributed anaphase, Ring, multi nuclei, elongation, gap chromosome, multi polar anaphase, erosion, distributed chromosome and lagging chromosome during the current research (Table, 2 and Figures 1-2).

For instance, under 8 hrs. of treatment the abnormal cells ranged from 133 to 156 cells, while, under 16 hrs. were 128 to 144 cells and finally, under 24 hrs. were 154 to 238 cells (Table, 2). The highest abnormal cells were recorded to the high concentration of NAZ under 24 hrs. of treatment (238 cells) by 34% comparing with the divided cells (700 cells) and the lowest abnormal cells recoded to 0.5 ml/ 16 hrs. (nano-amino zinc solution) 128 cells by 13.47% in compare with the divided cells 950 cells (Table 2). The range of abnormal cells was 158 cells compare with 1011.88 in percentage was 15.61%. The average of abnormal cells such as multi nuclei and stickiness was ~ 26 forward by fragment by ~ 24 cells then 17 cells in general to uncoiling (Table 2). The data in Table (2) and Figures (1-2) clearly indicated that with increase in NAZ constrictions and time at expose, the number of abnormal cells increased and observed in different stages. The data clearly showed that high dose of NAZ and the highest time of expose caused in nucleus erosion beside the multinuclei with fragments that gave the opportunity for lysosome to digest the fragments in uncles, with the high dose of NAZ and 24 hrs. of treatment the cell wall burst and all nucleus contents go out the cell to be described as a ghost cell as shown in figure 9. From the previous data, it can be concluded that today all farmers and producers used the nano fertilizer and pesticides without any roles just they aimed to increase the yield and plant production but with the high and excessive dose of these materials caused chromosomal aberration and that mean decrease in the whole genome and may be transfer to the next generations. So, the governments and scientists should put the roles and dose of these materials to avoid the chromosol aberration.

Our results in the same line with Elena *et al*. (2013) who evaluated the amplitude of cytogenetic damage induced in *H. vulgare* L. during germination with different concentrations (10, 100, 250, 500 µM) of Zn^{+2}. The results showed that the mitostimulatory effect was present at all concentrations of both zinc compounds. Also, the rate of anaphase and telophase aberrations exceeded by two - three times comparing with the control, and the frequency of metaphase disturbances was 5.0-10.0 times higher than the control. Other studies reported that, Zn forms stable complexes with nucleic acids, it can negatively influence their stability, so producing errors in the genetic information system (Patra *et al*., 2004). The interaction between Zn and DNA is little known in the light of its involvement in carcinogenesis. Also, micronuclei were also reported at high Zn^{2+} doses in *Vicia faba* (Kumari *et al*., 2012).

The observations of genotoxicity of Zn compounds recorded on several herbaceous and woody species showed differentiated responses, depending on the concentration range, exposure duration, plant species, class of Zn

compounds, and treatment with unary or binary solutions (Ince *et al*., 1999; Marcato-Romain *et al*., 2009; Patra *et al*., 2004; Steinkellner *et al*., 1998), but also on the number of somatic and metacentric chromosomes or on the length of the diploid complement (Ma *et al*., 1995). Some reports state that high Zn concentrations are not strongly genotoxic (Codina *et al*., 2000; Gómez-Arroyo *et al*. 2001; Marcato-Romain *et al*., 2009). The aneugenic and clastogenic action of Zn was also evidenced in other species like wheat, black cumin, onion, sugarcane (El-Ghamery *et al*., 2003; Jain *et al*., 2010; Shaymurat *et al*., 2012; Somesh *et al*., 2005), but a connection between Zn concentration and aberration frequency was not always noticed. Similar studies were carried out by Bin Hussein *et al.* (2002) on the toxicology of Al_2O_3, SiO_2, ZnO, and Fe_3O_4 on *Arabidopsis thaliana*. The results showing that ZnO nanomaterials at 400mgL^{-1} capable of inhibiting germination.

Several researchers described the key role of Zn/ZnO nanomaterials for plant growths and yield (Bin Hussein *et al*. 2002). For example, higher plant mostly absorbs Zn as a divalent cation (Zn^{+2}), which acts either as a functional, structural, or as the metal component of enzymes or are gulatory cofactor of numerous enzymes.

Table (2). The effect of different nano amino zinc concentrations on mitotic index and chromosomal aberrations of Iraqi wheat "Behoth 22" under different time treatments.

Type of aberrations	Concentrations and time of treatments									General mean
	After 8 hrs.			After 16 hrs.			After 24 hrs.			
	0.5 ml (NAZ)	1.0 ml (NAZ)	1.5 ml (NAZ)	0.5 ml (NAZ)	1.0 ml (NAZ)	1.5 ml (NAZ)	0.5 ml (NAZ)	1.0 ml (NAZ)	1.5 ml (NAZ)	
NOC	2000	1800	1840	2000	1650	1730	1920	2070	1947	1844.11
NDC	1480	1301	1207	950	900	890	860	819	700	1011.88
Prophase	962.00	845.65	784.55	617.50	585.00	578.50	559.00	532.35	455.00	657.73
Metaphase	192.40	169.13	156.91	123.50	117.00	115.70	111.80	106.47	91.00	131.55
Anaphase	222.00	195.15	181.05	142.50	135.00	133.50	129.00	122.85	105.00	151.78
Telophase	103.60	91.07	84.49	66.50	63.00	62.30	60.20	57.33	49.00	70.83
MI. (%)	74.00	72.28	65.60	47.50	54.55	51.45	44.79	39.57	35.95	53.71
NAC	133	156	144	128	144	141	154	185	238	158
% aberration	9	12	12	13.5	16	15.9	18	22.6	34	15.66
C-metaphase	11	7	9	11	14	14	14	18	26	13.78
Fragments	18	19	22	22	14	25	22	30	48	24.44
Bridge	0	3	8	8	8	7	3	7	9	5.89
Uncloing	22	27	21	22	20	21	3	6	8	17.22
Stickiness	23	26	33	30	27	23	21	21	30	26.00
ND	1	2	6	0	6	8	8	9	11	5.67
DA	9	8	9	7	8	7	10	12	17	10.11
Ring	0	2	3	0	2	4	9	8	11	3.89
Multinuclei	22	29	27	18	29	23	27	27	33	26.11
Elongation	11	5	0	1	2	1	5	7	7	4.33
GC	0	3	0	1	2	0	0	2	0	0.89
MPA	4	8	4	1	0	0	4	5	5	3.44
Erosion	9	17	2	5	5	2	10	11	11	8.00
DC	1	0	0	1	3	1	9	12	12	4.33
LG	2	0	0	1	4	5	9	10	10	4.00

*0.5, 1.0 and 1.5 ml take from nano amino zinc solution

*NOC: Number of Observed Cells, NDC: Number of Divided Cells, MI: Mitotic Index, NAC: Number of Abnormal Cells, ND: Nucleotide Deletion, DA: Distributed Anaphase, GC: Gap Chromosome, MPA: Multi Polar Anaphase, DC: Distributed Chromosome, LG: Lagging Chromosome

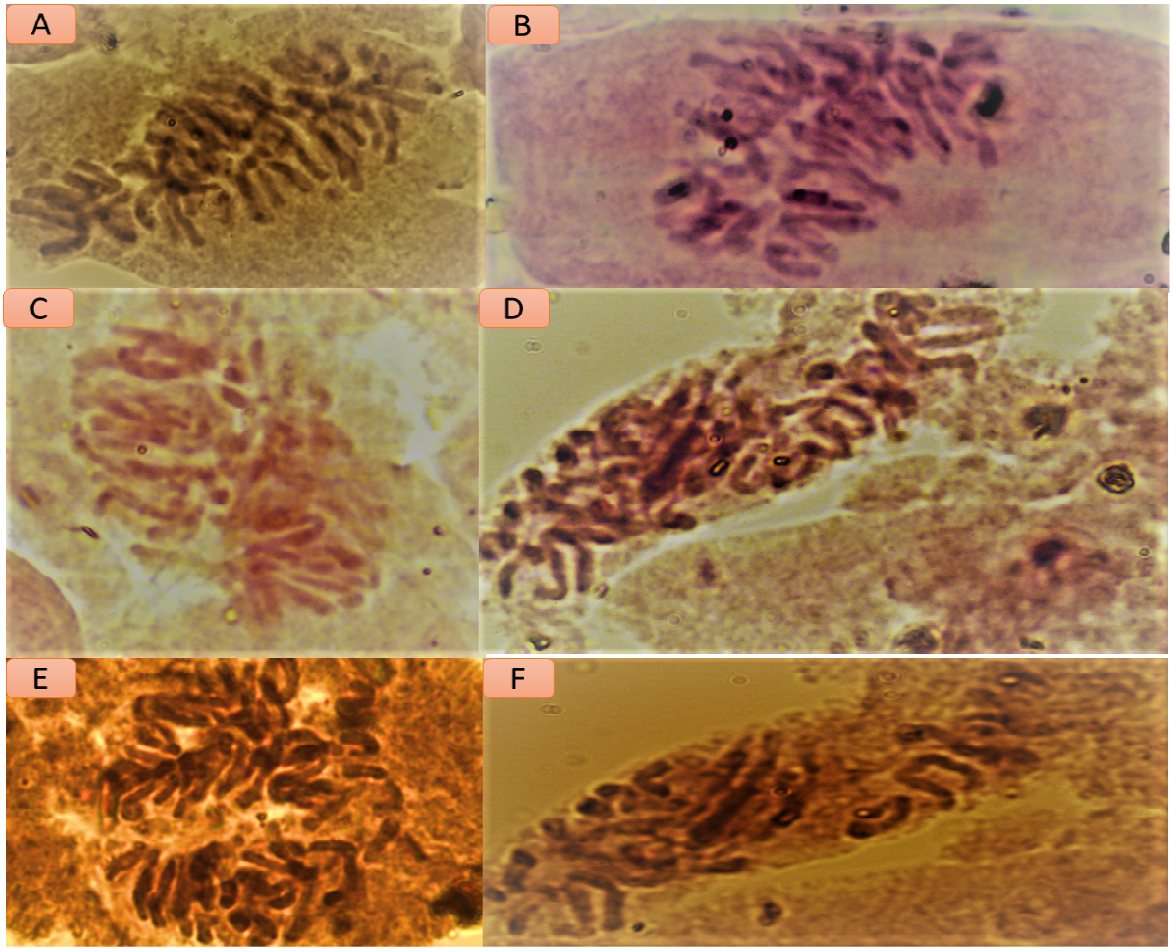

Fig.(1).The effect of different nano-amino zinc (AZNPs) concentrations on chromosomal aberrations of Iraqi wheat "Behoth 22" i.e. 1.5 ml after 8 hrs. (a & b) abnormal metaphase with c-phase, chromatids deletion and fragments; 1.5 ml after 16 hrs. (c &d) showing ring chromosome, sticky ends, fragments and lagging chromosome; 1.5 ml after 24 hrs. (e &f) showing distributed anaphase, fragments, chromatids deletion, lagging chromosome and C-phase.

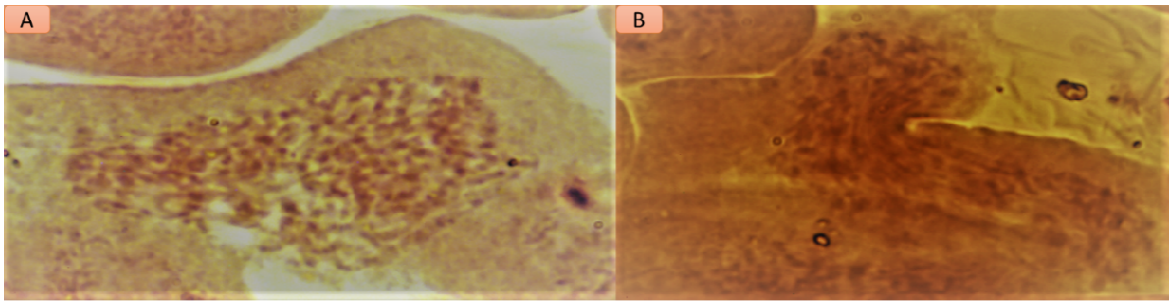

Fig.(2).Explosion in cell wall under high Nano-amino zinc (AZNPs) concentrations (1.5 ml after 24 hrs.) of Iraqi wheat.

CONCLUSION

Nano amino zinc could enter freely into the cells and interfere in cell's normal function. The treated root-tip cells exhibited various types of chromosomal aberrations as unorientation at metaphase, breaking of chromosomes, metaphasic plate distortion, spindle dysfunctioning, stickiness, bridge, fragmentation, unequal separation, fragmentation, scattering, elongation, gap chromosome, erosion, during the current research.

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الملخلص العربى

تاثير جسيمات النانو على الانقسام الخلوى والتشوهات الكروموسومية فى القمح

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أجريت هذه الدراسة بكلية الزراعة سابا باشا جامعة الاسكندرية خلال الفترة ٢٠١٥– ٢٠١٧ وتم دراسة التأثير السلبي لانواع وتراكيز وأزمنة تعرض مختلفة من جسيمات النانو على الإنقسام الخلوي والشذوذات الكروموسومية في القمح كنموذج دراسة. أوضحت النتائج ان معدل الإنبات كان يتراوح من ٩٦.٧٧ الى ١٠٠% حيث تم فحص عدد خلايا تقريبا ١٨٤٤.١١ خلية حيث كانت أعلى نسبة في الخلايا المنقسمة تقع عند تركز ٠.٥ مل / ٨ ساعات بينما كانت أقل معدل انقسام عند تركيز ١.٥ مل / ٢٤ ساعة، والمتوسط العام للخلايا المنقسمة كانت ٥٣.٧١%. أوضحت النتائج أنة تحت وقت ١٦ ساعة كانت أعداد الخلايا الشاذة تتراوح ١٢٨ الى ١٤٤ خلية شاذة منقسمة، وأخيرا عند ٢٤ ساعة كانت الخلايا الشاذة تتراوح ١٥٤ الى ٢٣٨ خلية شاذة منقسمة، فعليه نلاحظ ان اعلا عدد من الخلايا المنقسمة الشاذة والتي هية ٢٣٨ خلية تم مشاهدتها عندما كانت الخلايا تتعرض لتركيز ١.٥ مل/ ٢٤ ساعة وبنسبة ٣٤% من الخلايا المنقسمة والبالغ عددها ٧٠٠ خلية منقسمة، بينما كان اقل خلايا شاذة منقسمة سجلت تحت ٠.٥ مل / ١٦ ساعة حيث كانت ١٢٨ خلية منقسمة شاذة ونسبة مئوية ١٣.٤٧% من مجموع ٩٥٠ خلية منقسمة. ويمكن القول بكل وضوح انة بزيادة التركيز وكذلك وقت التعرض لمثل هذا النوع من جسيمات النانو سببت بزيادة حالة النحر للكروموسوم في الانوية وتعدد الانوية مع وجود القطع الكروموسومية والتي سوف تزيد من فرصة نشاط التحلل للكروموسومات في التراكيز العالية وبزيادة فترة التعرض ادت الى انفجار الخلايا وخروج محتويات الخلية الى خارج أغلفة الخلايا وأخيرا تم مشاهدت خلية شبح بدون أى محتوى.

Impact of Sulfur, Nitrogen Application Methods and Biofertilization on Productivity and Quality of Wheat Crop

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ABSTRACT: Two field experiments were conducted at the Experimental Station Farm Facility of Agriculture (Saba-Basha) AlexandriaUniversity, Egypt during 2014/2015 and 2015/2016 seasons. The objective of this study was to investigation the effect of sulfur, nitrogen application methods and biofertilization on yield, components and chemical compositions of the Gemmeiza 9 wheat cultivar to improve wheat productivity and minimizing of pollution. The results could be summarized as follows. Applying sulfur at 400 kg/fed gave higher spike length, number of spikes/m2, weight of spike g/m2 , number of spikelets/spike, 1000- grain weight, grain, straw and biological yields (ton/fed) than 200kg/fed and untreated treatment in both seasons. Also, applying 400 kg/S/fed significantly surpassed untreated treatment for crude protein percentage, N, P and K percentages in both seasons. The addition of mixture nitrogen (soil + foliar) resulted in a significant increment in yield components and chemical composition of wheat grain in both seasons. Significant variation were recorded between the tested biofertilization on yield, yield components and chemical composition of wheat grain in both seasons A- mycorrhizal significantly surpassed uninoculation (control) for yield, yield components and chemical compositions in both seasons. Thus, it is possible to obtain maximum yield, yield components and chemical compositions of grain wheat through applying 400 kg S/fed, mixture nitrogen methods (Soil + foliar) and A- mycorrhizal inoculation (biofertilizer).

Key words: Nitrogen application method, sulfur levels, biofertilizer, yield, wheat quality.

INTRODUCTION

Wheat (Triticumaestivum, L.) is one of the most important crops used in human food and animal feed in Egypt. Recently a great attention of several investigations has been directed to increase the productivity of wheat to minimize the gap between the Egyptian production and consumption by increasing the cultivated area and wheat yield per unit area. Therefore, the local production of wheat grain (about 9.4 million tons) covers only 60% of the local consumption demand which reflect the need to import about 40% of wheat grains from abroad (FAO, 2013).

The role of sulphur and the importance of sulfur fertilization in the production of the major cereal crops, wheat and corn and in the high sulphur demanding oil crops have been examining work wide. Sulfur deficiency causes decreased N utilization and yield loss and decreased the baking value of the flour of cereal crops (Mars et al., 2006).

Nitrogen is important for plant growth however, plants have limited ability to extract them from the environment and these need microbes involved in "nutrient recycling" to help a plant uptake and absorb this nutrient of optimal concentration (Zakiet al., 2012).Foliar fertilization in a widely used practice to

correct nutritional deficiencies in plant caused by improper supply of nutrient to roots (Ling and Silberbush, 2002).Increases were recorded in spike length, number of spikes/m2, number of grains/spike,1000- grain weight, grain and biological yields (ton)/fed with soil application (Gomaaet al., 2015).

Bio-fertilizers play vital role for increasing the number of microorganisms and accelerate certain microbial process in the rizosphere of inoculation soil plant which can change the available forms of nutrients into plants (Radwanet al., 2015).Arbuscularmycorrhizal (AM) fungi, forming symbiotic association with most economically important crop plant, can improve plant growth under low fertility condition and have affected a considered research to their agricultural potential use (Gomaaet al., 2011 and Radwanet al., 2014).

The aim of this investigation was designed to study the effect of sulfur, nitrogen application methods and biofertilization (A-mycorrhizal + Cerealin) on growth, productivity and quality of wheat crop.

MATERIALS AND METHODS

Two field experiments were conducted at the Experimental Farm, Faculty of Agriculture (Saba Basha), Alexandria University, Egypt, during 2014/2015 and 2015/2016 seasons. The experiments were carried out to study the combined effect of sulfur, nitrogen application methods and biofertilization (A-mycorrhizal + Cerealin) on growth, productivity and quality of Gemmeiza 9 wheat cultivar (Triticumaestivum, L.).

The experimental design was split–split plot design with three replications. Sulfur levels were allocated in the main plot methods of nitrogen fertilizer application were allocated in the sub-plots and biofertilizer treatments were allocated in the sub-sub- plots. The size of each plot was 10.5 m2 (1/400 feddan) 3.5 m long and 3.0 m wide. Each experiment included 27 treatments which were the combination among three sulfur levels, three methods of nitrogen application and three biofertilizer treatments. The experimental treatments can be described as follows:

Sulfur levels
Untreated
200 kg Sulphur /fed
400 kg Sulphur/fed

Nitrogen application methods
Soil application
Foliar spraying
Mixture (Soil + foliar)

Biofertilizers
Uninoculation
A- Mycorrhizalbiofertilizer
Cerealinebiofertilizer

Nitrogen fertilizer was added at a rate of 100 kg N/fed (the recommended dose, for soil N application half dose of N was applied at sowing time while the remaining in three split dose. In case of soil were foliar application of 100 kg N/fed at two different stage i.e. half at sowing and half at second irrigation to the soil and foliar as well as mixture (Soil + Foliar) were used. In the two experiments N fertilizer added in the form of ammonium nitrate (33.5% N) super phosphate fertilizer (15.5% P_2O_5) was applied before sowing at the rate of 150 kg/fed (the recommended dose). Potassium fertilizer was applied before sowing (during seed bed preparation at rate of 50 kg/fed in the form of potassium sulfate (48% K_2O) (The recommended dose).

The inoculation with Cerealine was performed by coating wheat grains with each product individually using a sticking substance (Arabic gum at 5%) just before planting inoculation of A- mycorrhizal fungi an inoculates for wheat grains with fungi (Glomusmacrarpium) strain from plant production Dept. (Saba Basha), Alex. Univ. at a rate of 250 ml of infected roots and was mixed with grains. The biofertilizers (Cerealine) which was produced by the General Organization for Agric. Equalization Ministry of Agriculture. Analyses of chemical and physical properties of the experimental soil (0- 30 cm) are shown in Table (1). The determination of soil physical and chemical analysis was carried out according to the methods reported by (Page et al., 1982).

Table (1).Some physical and chemical properties of the experimental soil during 2014/2015 and 2015/2016 seasons

Soil properties	2014/2015	2015/2016
A- Mechanical analysis		
Sand%	15.00	14.80
Clay%	42.00	42.20
Silt%	43.00	43.20
Soil texture	**Clay loam soil**	
B- Chemical analysis		
pH (1:1)	7.90	7.80
EC (1:1) dS/m	2.20	2.30
1- Soluble cations (1:2) (cmol/kg soil)		
K^+	0.95	0.96
Ca^{++}	4.15	4.20
Mg^{++}	3.20	3.25
Na^{++}	8.20	8.30
2- Soluble anions (1:2) (cmol/kg soil)		
CO^-_3+ HCO^-_3	2.80	2.70
CL^-	11.50	11.70
SO^-_4	0.50	0.52
Calcium carbonate (%)	7.70	7.80
Organic matter (%)	1.40	1.42
Total nitrogen (mg/kg)	1.00	0.91
Available Phosphorus (mg/kg)	3.70	3.55
Available K (mg/kg)	120.4	1240.6

At harvest one square meter was taken randomly from each sub- sub plot for the last two replication to determine yield and its components.

A- Yield and its components

Spike length (cm)
Number of spikes/m^2
Weight of spikes/m^2 (g)
Number of spikelets/spike
1000- grain weight (g)
Grain yield (ton)/ha
Straw yield (ton)/ha
Biological yield (ton)/ha

B- Grain quality

Powder of grains taken at harvest was wet- digested with H_2SO_4- H_2O_2 digest (Lowther 1980) and the following determinations were carried in the digested solution.

1-Total nitrogen content (%): the Micro- Kjeldahl method was used to determine the total nitrogen in the grain.
2-Phosphorus content percentage: Was determined by using the methods described by John (1970).
3-Potassium content percentage: Was determined photometrically by using a Flam Photometer Model corning as described by Johnson and Ulrich (1959).
4-Grain protein percentage: The total nitrogen in the grain multiplied by 5.75 to obtain percentage of crude protein according to A. O. A. C. (1980).

Data obtained were exposed to the proper method of statistical analysis of variance as described by Gomez and Gomez (1984). The treatments means were compared using the least significant differences (L.S.D.) test at 0.05% level of probability.

RESULTS AND DISCUSSION

A- Yield and its components:

Data presented in Tables (2 and 3) showed that spike length, number of spike/m^2, weight of spikes (g/m^2) number of spikelets/spike, 1000- grain weight (g), grain, straw and biological yields (ton/fed) during the two growing seasons were significantly affected by adding sulfur fertilizer levels. Application sulfur at 400 kg/fed caused a significant increase in yield and its components as compared with the other treatments. The S content in plant increases and the plant will accumulate more nutrients in reach the balance between cations and anions. Therefore, push the plant to give the best dry matter and length of roots which offer the plant to absorb more nutrients and assimilate the bio chemical processes by plant. Similar results were reported by Nassaret al. (2014), Zakaria (2004), Mars et al. (2006) and Mahmoud (2008).

Yield and yield components of wheat plant as affected by nitrogen fertilizer application methods described that nitrogen fertilizer application had significantly affected the yield and its components Tables (2 and 3). Data showed that the highest all yield and its components i.e. spike length, number of spike/m^2, weight of spikes/m^2, number of spikelets/spike, 1000- grain weight (g), grain, straw and biological yields (ton/fed), were observed in mixture nitrogen application (soil + foliar) It could be due to mixture application (soil + folair) of nitrogen at yield and its components of improving the ability of grain for best vigor, viability and among source – sink relationship to minimize application of N resulted the best grain yield of wheat (Saeedet al., 2012). Similar results, more or less were obtained by El- Shaarawy (2003), Saleh (2003), Hussein (2005), Bakhatet al (2010) and Gomaaet al (2015).

Inoculation of biofertilizers significantly increased, spike length, number of spike/m^2, weight of spikes (g/m^2), number of spikelets/spike, 1000- grain weight, grain, straw and biological yields (ton/fed) in both seasons. Hence, the highest yield and its components were recorded with inoculation A- mycorrhiazl as compared to other treatments. It could be concluded that inoculation of wheat grain with biofertilizers encourages the increase of yield and its components. This may be due to the effect of biofertilization which plays an important role in the assimilation of wheat plants that reflected on enhancing this characteristic. Also, this could be attributed to the role of plant phytohormones like IAA, GAs and CKs which promote plant growth cell division, breaking the special dominances, hence encouraging the photosynthesis and assimilates accumulation (Abdel- Allaet al., 2007). Many investigators reported the positive effect of biofertilization on these characters, Basha (2004), Ibrahim et al. (2004), El-Esh (2007), Zakiet al. (2007), Gomaaet al. (2011) and Radwanet al. (2015).

The effect of the interaction between sulfur levels and nitrogen application methods on spike length, number of spike/m^2, weight of spikes g/m^2 , number of spikelets/spike, 1000-grain weight (g) , grain, straw and biological yields (ton/fed) were significant (Tables 2 and 3) in both growing seasons. Applying sulfur at 400 kg/fed with application nitrogen mixture (soil + foliar) gave the highest values of yield and its components in the first and the second seasons.

The effect of interaction between sulfur levels and biofertilizers was significant for yield and its components Tables (2 and 3). However, the highest values of yield and its components were obtained by applying sulfur at 400 kg/fed with A- mycorrhizal inoculation in both seasons.

The effect of interaction between nitrogen application methods and biofertilizer was significant for all yield and its components in both seasons.
Second order interaction among three factors was significant for all yield and its components in the two growing seasons Tables (2 and 3). Applying sulfur at 400 kg/fed and nitrogen application mixture (soil + foliar) with A-mycorrhizal inoculation gave the highest values of yield and its components of wheat plant.

B- Grain quality

The obtained results recorded in Table (4) revealed that crude protein in grains and percentages of nitrogen, phosphorus, potassium were significantly affected by adding sulfur levels.

The highest values of crude protein and all chemical composition characters were obtained by applying sulfur at 400 kg/fed while, the lowest one were recorded by untreated treatment in both seasons. The positive impacts of sulfur levels on wheat crop production and its elemental composition are mainly due to improving the soil physical, chemical and biological properties and preparing the suitable bed of germination and development of plant growth, that effect on the resultant yield (Nassaret al., 2014). These results are in agreement with Azersohaiet al. (2000), Mahmoud (2008) and Muftah (2011).

Data showed in Table (4) revealed that crude protein percentage N, P and K content in grain were affected significantly by nitrogen application methods in both seasons. The highest mean value of crude protein percentage and all chemical composition were obtained by soil application than foliar spraying in both seasons. The present results are in line with those obtained by Hassanein (2001), Arifet al. (2006), Khan et al. (2006) and Zeidanet al. (2010).

The highest value of crude protein (%) and all chemical composition i.e. N, P and K content in grain with mixture of nitrogen application methods (soil + foliar) fertilizer, while the lowest one was recorded by foliar spraying in both seasons, Table (4). This may be attributed mainly to the vital physiological roles in plant cell which root up take of plant nutrition (Arifet al., 2006).

Table (2).Wheat yield and its components as affected by sulfur levels, nitrogen application methods and biofertilization during 2014/2015 and 2015/2016 seasons

Treatments	Spike length (cm)		Number of spikes/m^2		Weight of (g) spikes/m^2		Number of spikelets/spike	
	2014/2015	2015/2016	2014/2015	2015/2016	2014/2015	2015/2016	2014/2015	2015/2016
A) Sulfur levels								
Untreated	11.31 c	12.58c	212.74c	230.38c	304.26c	337.79c	28.27c	31.47c
200 kg/fed	12.17 b	13.50b	240.57b	٢٦٧.31b	400.57b	433.95b	31.75b	35.26b
400 kg/fed	12.97 a	14.42a	266.12a	295.83a	520.00a	578.02a	36.29a	40.33a
L.S.D. (0.05)	**0.52**	**0.55**	**10.70**	**11.50**	**9.80**	**10.5**	**2.60**	**2.40**
B) Nitrogen application methods								
Soil application	12.23 b	13.62b	237.8b	263.42b	414.23b	460.42b	31.99b	35.36b
Foliar spraying	11.37 c	12.63c	220.26c	238.70c	367.76c	397.48c	29.14c	32.37c
Soil + Foliar	12.84 a	14.24a	261.29a	291.39a	442.82a	492.04a	35.15a	39.06a
L.S.D. (0.05)	**0.53**	**0.55**	**10.60**	**11.50**	**9.90**	**10.6**	**2.60**	**2.45**
C) Biofertilization								
Uninoculation	11.34 c	12.58c	209.48c	226.73c	334.16c	371.40c	29.17c	32.43c
A-mycorrhizal	12.90 a	14.32a	269.73a	299.45c	474.00a	515.58a	35.40a	39.26a
Cerealine	12.19 b	13.59b	240.08b	265.64b	416.44b	462.94b	31.76b	35.40b
L.S.D. (0.05)	**0.50**	**0.54**	**10.2**	**11.30**	**8.40**	**9.50**	**2.05**	**2.00**
Interactions								
AxB	*	*	*	*	*	*	*	*
AxC	*	*	*	*	*	*	*	*
BxC	*	*	*	*	*	*	*	*
AxBxC	*	*	*	*	*	*	*	*

Mean followed by the same letter (s) in each column are not significantly differed at 0.05 level ofprobability

Table (3).Cont.

Treatments	1000- grain weight (g)		Grain yield (ton/fed)		Straw yield (ton/fed)		Biological yield (ton/ fed)	
	2014/2015	2015/2016	2014/2015	2015/2016	2014/2015	2015/2016	2014/2015	2015/2016
A) Sulfur levels								
Untreated	40.92c	45.83c	4.24b	4.69b	6.47c	7.18c	10.68c	11.87c
200 kg/fed	46.10b	51.22b	4.33b	4.88b	7.42b	8.21b	11.88b	13.06b
400 kg/fed	49.18a	54.48a	5.35a	5.92a	7.67a	8.45a	12.93a	14.37a
L.S.D. (0.05)	**2.80**	**3.10**	**0.40**	**0.30**	**0.22**	**0.20**	**0.45**	**0.50**
B) Nitrogen application methods								
Soil application	45.19b	50.27b	4.69b	5.28b	7.39b	8.22b	12.19b	13.42b
Foliar spraying	40.37c	45.19c	4.19c	4.62c	6.53c	7.21c	10.65c	11.83c
Soil + Foliar	50.60a	56.06a	5.10a	5.67a	7.64a	8.41a	12.65a	14.06a
L.S.D. (0.05)	**2.70**	**3.10**	**0.41**	**0.30**	**0.22**	**0.21**	**0.45**	**0.50**
C) Biofertilization								
Uninoculation	40.49c	44.98c	3.67c	4.07c	6.82b	7.66b	10.53c	11.71c
A-mycorrhizal	50.16a	56.08a	5.51a	6.13a	7.92a	8.79a	13.43a	14.91a
Cerealine	45.54b	50.45b	4.77b	5.29b	6.70b	7.42a	11.53b	12.68b
L.S.D. (0.05)	**2.20**	**2.60**	**0.35**	**0.28**	**0.18**	**0.20**	**0.40**	**0.43**
Interactions								
AxB	*	*	*	*	*	*	*	*
AxC	*	*	*	*	*	*	*	*
BxC	*	*	*	*	*	*	*	*
AxBxC	*	*	*	*	*	*	*	*

Mean followed by the same letter (s) in each column are not significantly differed at 0.05 levels of probaility

Data in Table (4) indicated that crude protein and percentages of nitrogen, phosphours potassium increased significantly by inoculation of wheat grain with biofertilizer during the two seasons. The maximum increment was obtained by A-Mycorrhizal followed by cerealine. The increment percentages attained were 12.64- 15.56% and 11.24- 12.50 for crude protein, 2.00- 2.19 and 1.81- 2.00 for N%, 0.614- 0.683 and 0.553- 0.619 for P% and 2.20 – 2.40 and 2.00- 2.23 for K in the two seasons for treatment A-mycorrhizal and cerealine compared with Uninoculation (control) treatment. This may be due to the role of dissolving phosphate and nitrogen fixation bacteria on increasing the endogenous phytohormons (IAA, GAs and CKs) which play an important role in formation a big active root system, increasing the nutrients uptake and photosynthesis rate and translocation as well as accumulation within different plarts(El- Khawas, 1990).This results are in agreement with those obtained by Hussein and Radwan (2002) Shomanet al (2006) Zakiet al. (2007), Abo-Marzoka (2009) Gomaaet al. (2011) and Radwanet al. (2015).

Data in Table (4) clear that the applying sulfur at 400 kg/fed with application of mixture nitrogen (soil + foliar) gave the highest values of crude protein and all chemical composition as illustrated in Table (4). That the effective treatment of crude protein and all chemical composition in two seasons were obtained from applying sulfur at 400 kg/fed with A- mycorrhizal inoculation in both seasons.

Data in Table (4) showed that the effect of interaction between nitrogen application methods with biofertilization on crude protein and all chemical compositions in both seasons. It is clear from data in Table (4) that there is a high significant increase for all treatments compared with the non- inoculation with foliar spraying in the interaction effect on all studied chemical composition. The highest values of crude protein and all chemical compositions were recorded by using the sulfur application at 400 kg/fed and mixture nitrogen (soil + foliar) with A- mycorrhizal inoculation in both seasons.

Table (4).Protein percentage and chemical composition (N, P and K %) as affected by sulfur levels, methods of nitrogen application and biofertilization during 2014/2015 and 2015/2016 seasons0.

Treatments	Protein content (%)		Nitrogen (%)		Phosphorus (%)		Potassium (%)	
	2014/2015	2015/2016	2014/2015	2015/2016	2014/2015	2015/2016	2014/2015	2015/2016
A) Sulfur levels								
Untreated	10.22c	11.32c	1.63c	1.82b	0.482c	0.537c	1.61b	1.75b
200 kg/fed	10.89b	12.13b	1.76b	1.91b	0.541b	0.605b	1.78b	1.97b
400 kg/fed	13.10a	14.34a	2.09a	2.32a	0.623a	0.692a	2.60a	2.83a
L.S.D. (0.05)	**0.60**	**0.75**	**0.12**	**0.13**	**0.042**	**0.060**	**0.25**	**0.23**
B) Nitrogen application methods								
Soil application	11.37b	12.63b	1.82b	2.00b	0.546b	0.608b	1.97b	2.19b
Foliar spraying	10.39c	11.48c	1.67c	1.85c	0.499c	0.558c	1.81b	2.01b
Soil + Foliar	12.53a	13.67c	1.97a	2.19a	0.601a	0.668a	2.17a	2.36a
L.S.D. (0.05)	**0.60**	**0.70**	**0.11**	**0.13**	**0.042**	**0.060**	**0.24**	**0.23**
C) Biofertilization								
Uninoculation	10.33c	11.40c	1.65c	1.84c	0.479c	0.533c	1.74c	1.93c
A-mycorrhizal	12.64a	15.56a	2.00a	2.19a	0.614a	0.683a	2.20a	2.40a
Cerealine	11.24b	12.50b	1.81b	2.00b	0.553b	0.619b	2.00b	2.23b
L.S.D. (0.05)	**0.50**	**0.65**	**0.10**	**0.11**	**0.040**	0.55	**0.19**	**0.15**
Interactions								
AxB	*	*	*	*	*	*	*	*
AxC	*	*	*	*	*	*	*	*
BxC	*	*	*	*	*	*	*	*
AxBxC	*	*	*	*	*	*	*	*

Mean followed by the same letter (s) in each column are not significantly differed at 0.05 levels of probaility

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الملخص العربي

تأثير الكبريت وطرق إضافة النتروجين والتسميد الحيوي على الإنتاجية والجودة لمحصول القمح

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** قسمالأراضي و الكيمياء الزراعية– كلية الزراعة سابا باشا . جامعة الإسكندرية . مصر

أجريت تجربتان حقليتان بمزرعة كلية الزراعة (سابا باشا)– الإسكندرية – مصر أثناء موسمي النمو ٢٠١٤/٢٠١٥، ٢٠١٥/٢٠١٦ وكان الهدف من الدراسة تأثير الكبريت وطرق إضافة النتروجين والتسميد الحيوي على المحصول ومكوناته والمكونات الكيميائية في صنف قمح جميزة ٩ لتحسين إنتاجية القمح وتقليل التلوث.

ويمكن تلخيص أهم النتائج فيما يلي:

أدى إضافة الكبريت عند ٤٠٠ كجم/فدان الى زيادة معنوية في طول السنبلة، عدد السنابل/م٢ ووزن السنابل (جم/م^{٢}) ، عدد السنبيلات/سنبلة، وزن ألف حبة، محصول الحبوب، والقش والمحصول البيولوجي (طن/فدان) مقارنة بالمعاملة بمعدل ٢٠٠ كجم/ فدان والمعاملة الغير مسمدة بالكبريت في كلا الموسمين. إضافة ٤٠٠ كجم كبريت/فدان تفوق معنوياً على المعاملة بدون إضافة في محتوى البروتين كنسبة مئوية، والنسبة المئوية للنتروجين والفوسفور والبوتاسيوم في كلا الموسمين. ادى طرق إضافة خليط من النتروجين (أرضي + رشاً) زيادة معنوية في المحصول ومكوناته والمحتوى الكيماوي لحبوب القمح في كلا الموسمين. تفوق التلقيح بالميكلوريزا معنوياً مقارنة بالمعاملة الغير ملقحة (كنترول) او المعاملة بالسريالين في المحصول ومكوناته والمكونات الكيميائية في كلا الموسمين. إضافة ٤٠٠ كجم كبريت/فدان مع خليط من طرق إضافة النتروجين (أرضي + رشاً) مع التلقيح بالميكوريزا كتسميد حيوي ادى الى زيادة معنوية في المحصول ومكوناته للقمح صنف جميزة ٩.

Influence of Different Drying Methods and Pretreatments on The Bioactive Compounds of Some Egyptian Tomatoes

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ABSTRACT: Tomatoes have been described as a functional food because of their particular composition of different bioactive compounds. Tomatoes have limited shelf life at ambient conditions and are highly perishable. It has become necessary to optimize drying conditions in order to achieve certain characteristics related to bioactive compounds and sensory evaluation of tomatoes. Thus, the objective of this study was to evaluate the effect of drying methods (sun drying and oven drying at 50 and 70 ℃) and pretreatments (5% sodium chloride or/and 1% sodium metabisulphite) on the quality and bioactive compounds of the dried tomatoes. Three different tomatoes varieties (Maleka, Elbasha1077 and 186) were selected. The tomatoes were sliced into 10 mm prior pretreatment, and then dehydration was carried out.
Lycopene content in fresh Egyptian tomatoes showed highest content in the most red 186 tomato variety and the lowest content in orange red of El-Basha 1077 variety. The results were adverse for β-carotene. The highest levels of lycopene and carotene were found in sun dried tomatoes pretreated with 1% Na2S2O5 and combination of 1% Na2S2O5 + 5% NaCl. After three month of storage of dried tomatoes at room temperature, lycopene, β-carotene and ascorbic acid contents decreased to about 15% to 50% for all samples depending on drying methods and pretreatments.
Highest content of ascorbic acid was recorded in El-Basha 1077 tomato variety. During sun-drying and oven drying at 70 ℃, all tomatoes lost ascorbic acid more that oven drying at 50 ℃.
The phenolic content values found in this study were in highest levels in tomato variety 186 (264 mg GAE/100 g DW). The drying temperature at 70 ℃ showed highest total phenolic contents followed by drying at 50 ℃ and sun drying methods. After three months storage at room temperature there were little differences in total phenolic contents in stored dried tomato samples.Sensory evaluation (overall acceptability of colour and falvour) showed that tomato variety 186 had the highest score. The scores of overall acceptability decreased from 30 to about 50% after 3 month of storage in all tomatoes varieties.
Key words: tomatoes; drying methods; pretreatments; bioactive compounds.

INTRODUCTION

Tomato (Solanum lycopersium) is one of the vegetable crops most widely produced in the world (Oplanić et al., 2009 and Rossini et al., 2013), both for direct consumption (fresh tomato) and for production of tomato products (processing tomato). The tomato is also the most common vegetable in the Mediterranean diet, a diet known to be beneficial for health, especially with regard to the development of chronic degenerative diseases (Kacjan-Maršić et al., 2011). Tomatoes are important not only for their commercial value, but also because they are part of the diet of many cultures (Žnidarčič et al., 2010).

Worldwide production of fresh and processing tomato combined has been steadily increasing, with total annual production growing from 120 million tonnes in 2005 to 163 million tonnes in 2015 (FAO, 2016).

Tomatoes are consumed fresh or as processed products such as canned tomato, sauce, juice ketchup, stews and soup (Lenucci et al., 2006 and Hernández Suárez et al., 2013). In fact, epidemiological studies have shown

that consumption of raw tomato and its tomato based products is associated with a reduced risk of cancer and cardiovascular diseases (Clinton, 1998 and Giovannucci, 2002). This protective effect has been mainly attributed to its valuable bioactive components with antioxidant properties (Borguini and Torres, 2009 and Liu et al., 2010).

Tomatoes are rich sources of potentially bioactive compounds as health functional constituents including their high concentration of lycopene and excellent amounts of other conventional antioxidants like vitamin C and tocopherols, additional carotenoids (β-carotene, lutein, and zeaxanthin), trace minerals (selenium, copper, manganese and zinc) and phytonutrients including flavonoids (naringenin, rutin, kaempferol, and quercetin) and hydroxycinnamic acids (caffeic, ferulic, and coumaric acid) (Giovanelli and Paradise, 2002, Kaur et al., 2002, Periago and Garcia-Alonso, 2009, Capanoglu et al., 2010, Fernández-ruiz et al., 2011, Kalogeropoulos et al., 2012 and Hernández Suárez et al., 2013). Moreover, the lycopene, red pigment contains in tomatoes act as an antioxidant, neutralizing free radicals that can damage cells in the body inhibiting the lung, breast, and endometrial cancer cells and cut down the risk of developing prostate cancer by 45% (Eyiler and Oztan, 2011 and Jayathunge et al., 2012).

Consumer demands have increased for processed products that keep more of their sensory properties and their nutritional value, so that it has become necessary to optimize drying conditions in order to achieve certain characteristics related to chemical composition and sensory evaluation of tomatoes (Raiola et al., 2014).

To increase the shelf life of tomatoes, different preservation techniques are being employed; however the success of these methods depends on how it meets certain requirements of the product quality for consumption. Many developing countries still face enormous challenges of postharvest losses of tomatoes due to inadequate processing and storage facilities. Tomatoes produced in the peak seasons are either consumed fresh, sold at relatively cheap prices, or are allowed to go waste (Abano and Sam-Amoah, 2011).

Drying is a very common preservation method used in foodstuffs and the quality of the final products is strongly dependent on the technique and the process variables used (Doymaz, 2005). The reduction of water activity by moisture removal leads to significant reduction of weight and volume, minimizing packaging, transportation and storage costs (Okos et al., 1992). Drying also, alters other physical, biological and chemical properties of foods (Demirhan and Özbek, 2010). Hot-air drying is one of the most frequently used operations for food dehydration (Krokida and Maroulis, 1999 and Youssef and Mokhtar, 2014). A major disadvantage associated with hot-air drying is that it takes long time even at high temperature, which may cause serious damage to the flavour, colour and nutrients in dried products (Jing et al., 2010 and Youssef and Mokhtar, 2014).

Sun drying is a well known traditional method of drying agricultural commodities immediately after harvest since the existence of human. Adejumo

(2012) reported that a large percentage of tomatoes are usually sun dried on the bear ground to avoid wastages but such methods results in products with unattractive attributes, since the product is unprotected from the environmental factors and infestation by insects, rodents, animals etc. It then becomes expedient to produce solar dryers that would have added advantage of longer period residence, increased productivity and reliability through its ability to augment available heat during days with limited radiation as well as ability to operate during the night. Therefore, the product is saved from possible deterioration by microbial infestation (Hossain et al., 2010).

However, drying can accelerate some reactions that can adversely affect the product quality too (Akanbi and Oludemi, 2004 and Hussein et al., 2016). The interest in the production of dried tomatoes is increasing because of the possibility of using them in different purposes and drying efficiencies alone may not be adequate in qualifying this dryer for acceptance, except when the quality of the dried product is comparable to other alternatives in terms of lycopene, ß-carotene and ascorbic acid.

Pre-treatments with chemicals before drying have been used in order to minimize adverse changes during drying and subsequent storage tomatoes. The most common and least expensive method to prevent enzymatic browning in fresh prepared vegetables or tomatoes is by the use of sulphiting or salt agents such as metabisulphite and calcium chloride or sodium chloride since they have multiple functions (Mozumder et al., 2012). Dipping tomatoes in 10% sodium chloride combined with either 6 or 8% sodium metabisulfite for 10 minutes resulted the best red colour and bioactive compounds and improved the quality of stored sun-dried tomatoes (Shi and LeMaguer, 2000, Latapi and Barrett, 2006, Bareh et al., 2011 and Mozumder et al., 2012).

The purpose of this study was to determine the influence of different drying process, (sun drying and oven drying at 50 and 70℃) and pretreatments (5% sodium chloride and/or 1% sodium metabisulphite) on the bioactive compounds of three different Egyptian varieties of Tomatoes (Maleka, Elbasha 1077 and 186).

MATERIALS AND METHODS

1. Materials

1.1. Chemicals

All chemicals, solvents and standards were of analytical grade and purchased from Sigma (St. Louis, MO, USA).

1.2. Sample and preparation

In this study, 30 kg tomatoes of each one of three different varieties (Maleka, Elbasha1077 and 186) were obtained from specials farm in El Behera Governorate, Egypt. Tomatoes were selected based on colour and size uniformity. They were cleaned thoroughly by washing under tap water to remove dirt and soil (Owusu *et al.*, 2012). Each variety was divided into three equal portions of 10 kg each. Then, each portion was sliced with Hand Tomato Slicer to a thickness of approximately 10 mm and treated with dipping for 10

min in 5% sodium chloride (treatment one), 1% sodium metabisulphite (treatment two) and 5% sodium chloride + 1% sodium metabisulphite (treatment three) beside control (treatment four) as described by (Hameed *et al*., 2016). The first portion was sun dried where the second and third portions were oven dried at 50 ± 2 ℃ and 70 ± 2 ℃, respectively.

Methods

1. Drying methods

1.1. Open sun drying method

One treated portion of each tomato variety was spread on a single layer of white cloth and sun dried until equilibrium moisture content was achieved to 10%. During the sun drying of tomato slices, the air temperature and relative humidity were determined by using thermometer and hygrometer. The air temperature and relative humidity was recorded as 28-32^{o}C and 33- 44%, respectively. Open sun drying experiments were done in July, 2016 from sunrise to sunset for a period of from 18 to 20 days.

1.2. Oven drying method

Second and third treated portions of each variety were oven dried at 50 ± 2 ℃ for 80 – 85 hours and 70 ± 2 ℃ for 45 – 50 hours, respectively until equilibrium moisture content was achieved to 10%.

2. Proximate composition

The chemical analysis of moisture percentage, crude protein, crude fibre, ash, lipids and carbohydrate contents were carried out using the methods described by Ibitoye (2005).

The crude protein was obtained by determining the organic nitrogen content of the sample using micro-Kjeldah method and multiplying the nitrogen by a protein conversion which is usually 6.25.

The ash content of the sample was estimated by igniting the weighed sample in the weighed crucible at a temperature of 500℃ for about 3 hours in a muffle furnace, while the moisture content was determined using oven method.

The crude fibre and fat determination were done by hydrolyzing the sample with 0.128 ml of H_2SO_4 and 0.223 ml of KOH and Soxhlet extraction method, respectively. The carbohydrate content was determined by their differences (AOAC, 2012).

3. Determination of lycopene

Spectrophotometric determination of lycopene content was carried out by using Spectrophotometer (UV-VIS SPECORD Analytik Jena, Germany) as described by Alda *et al*. (2009). Lycopene in the fresh and dried tomatoes samples were extracted by adding 8.0 ml of the mixture of hexane–acetone–ethanol (2:1:1, v/v/v) wrapped with aluminum foil to exclude light. Tubes were cap and vortex immediately, and then incubate out of bright light. The mixture was extracted at room temperature for 30 min. This extract was reconstituted with 10 mL distilled water on a vortex mixer for 1 min.

The samples were allowed to stand for 10 min so as to allow phases to separate and all air bubbles to disappear. The cuvette was rinsed with the upper layer from one of the blank samples, then using hexane as a blank to zero at 503 nm determine the A503 of the upper layers of the lycopene samples. Lycopene levels in the hexane extracts was calculate as follows:

$$\text{Lycopene (mg/100 g)} = (A_{503} \times 537 \times 8 \times 0.55) / (0.10 \times 172)$$

Where:
The molecular weight of lycopene = 537g/mole, the volume of mixed solvent = 8 ml, the volume ratio of the upper layer to the mixed solvent = 0.55, the weight of added tomato = 1.0 g, the extinction coefficient for lycopene in hexane = 172 mM^{-1}, The Spectrophotometer at 503nm = A_{503}.

4. Determination of β-carotene

B-carotene determination was carried out by using the method described by Onwuka (2005); this involves 200 µl of distilled water was placed in appropriate test tubes for blanks, samples and standard solution. Then 200 µl of alcoholic KOH was added to all tubes (including blanks) and mixed well on the vortex mixed for 10 to 20 s. Tubes were then placed in a water bath at approximately 55 to 60℃ for 20 min. After 20 min, samples were cooled to room temperature and 200 µl of xylene- kerosene mixture was added.

Retinol was extracted by vigorous mixing of each tube on the vortex for at least 30 sec. Centrifugation was done for 5 min at 600 to 1000 xg. Xylene-Kerosene supernatant was withdrawn by means of a constriction micropipette connected to a rubber tube (for mouth sucking) and placing this sample extract in the spectrophotometer cuvettes. Readings were done at 328 nm for retinol and 460 nm for total carotenoids. Sample extract was transferred from the cuvette to glass tubes for irradiation. All the samples and blanks were irradiated for 35 min using an ultraviolet for source. The irradiated samples extract were transferred to cuvettes and their optical absorbance was read at 328 nm.

$$Retinol\ (\mu g/dl) = A^{o}\ (328) - A'\ X\ 637$$
$$Carotenes\ (\mu g/dl) = A^{0}\ (460)\ X\ 480$$

Where: A^{o} = Initial optical absorbance reading. A^{-} = Optical absorbance after ultra violet irradiation.

5. Determination of Ascorbic acid

Ascorbic acid was determined using the method AOAC (2012) and modified by Hussein *et al*. (2016). An aliquot (10 g) of the sample was diluted to a fixed volume (100 ml) with 3% HPO_3, then titrated with 2, 6-dichlorophenolindophenol. A standard ascorbic acid solution of 5 mL was added to 5 mL of 3% HPO_3 and titrated with dye solution to a pink colour, which persisted for 15 sec. Triplicate determinations were carried out and the result averaged. Ascorbic acid (mg/100 g) of reconstituted juice was calculated using the following formula:

$$Ascorbic\ acid\ (mg/100\ g) = \frac{T \times DF \times V_1}{V_2 \times V_3}$$

Where, T = titre; DF = Dye factor; V1 = volume made up (100 ml); V2 = aliquot of extract taken for estimation (10 g) and V3= volume of sample taken for estimation (10 ml).

6. Determination of total phenolic content

The used procedure was based on using the Folin-Ciocalteu reagent (FCR), as described by Singleton *et al*. (1999) and modified by Mongi *et al*. (2015). A 20 µl sample were added to 100 µl FCR (diluted 1:10 with distilled water), mixed and incubated at 37°C for 60 s prior to addition of 80 µl 7.5% (w/v) sodium bicarbonate solution. The samples were again mixed and incubated at 37°C for 15 min prior to absorbance reading at 765 nm. TPC were assessed against a calibration curve of gallic acid, and the results presented as mg gallic acid equivalents (GAE) per 100 g dry weight (DW).

7. Determination of sensory evaluation

Sensory evaluation was carried out as described by Hussein *et al*. (2016). Assessed qualities included colour, flavour and overall acceptability. Ten untrained panelists were selected at random from Department of Food Science, Faculty of Agriculture Saba Basha, Alexandria University, Egypt. A standardized cooking procedure was employed. Twenty (20g) of each dried tomatoes sample plus 2g of dried pepper was weighed into 200ml pure water. The solution was stirred gently to allow it to rehydrate. Fifty (50ml) of vegetable oil, 1 cube of maggi (Monosodium glutamate) and 0.25g of table salt was used to cooked each sample for 10 minutes. Evaluation was based on the above named quality parameters and were assessed accordingly. A nine (9) point Hedonic scale described by Iwe (2010) was used (1 and 9 for extremely dislike and extremely like, respectively).

RESULTS AND DISCUSSION

1. Proximate composition

The results of the proximate composition, energetic value and some quality parameters of three fresh Egyptian tomato varieties (maleka, Elbasha 1077 and 186) are shown in Table 1. Moisture content ranges between ٩٢.٥0 to 95.11 g/100 g in the three varieties of tomatoes. Maleka variety recorded the highest moisture value, while ElBasha 1077 recorded the lowest value.

The moisture content of the fresh tomato is in conformity with the finding of many authors as Harry (1994), Romain (2001) and Abdullahi *et al*. (2016).

The highest levels of protein, and fiber were found in the ElBasha 1077 tomato variety (1.60 and 1.42 g/100 g fresh weight, respectively) and lowest were found in the Maleka variety (1.01 and 0.97 g/100 g fresh weight). The highest levels of ash were found in the 186 variety (0.74 g/100 g fresh weight) and lowest were found in the ElBasha 1077 variety (0.59 g/100 g fresh weight). The high water content might also contribute to the low level of protein, ash and fiber. Carbohydrates were the most abundant micronutrients and the highest levels were also found in the ElBasha 1077

tomato variety (3.74 g/100 g fresh weight). This variety also gave the highest energetic value (22.11 kcal/100 g fresh weight).

Tomato varieties have high moisture, proteins and carbohydrates contents, in contrast to low fat levels, which make them suitable to incorporate low caloric diets. These results of different Egyptian tomato varieties are in agreement to Spanish tomato varieties as reported by Guil-Guerrero and Rebolloso-Fuentes (2009) and Portuguese tomato varieties as described by Pinela *et al*. (2014).

Table (1). Proximate composition, energetic value and some bioactive compounds of three fresh Egyptian tomato varieties.

Parameters	Tomato Varieties		
	Maleka	**Elbasha 1077**	**186**
Moisture content(%)	95.11 ± 0.77	92.50 ± 1.02	93.10 ± 1.54
Proteins*	1.01 ± 0.02	1.60 ± 0.01	1.28 ± 0.01
Fat*	0.13 ± 0.00	0.15 ± 0.00	0.13± 0.00
Ash*	0.63 ± 0.03	0.59 ± 0.03	0.74 ± 0.04
Fiber*	0.97 ± 0.04	1.42 ± 0.03	1.36 ± 0.03
Carbohydrates*	2.15 ± 0.12	3.74 ± 0.42	3.39 ± 0.31
Energy (kcal/100 g fresh weight)	13.81 ± 0.12	22.11 ± 0.10	19.85 ± 0.05
Lycopene (mg/100g DW)	7.82 ± 0.13	6.32 ± 0.16	9.12 ± 0.22
β-carotene (mg/100g DW)	1.34 ± 0.08	2.12 ± 0.12	0.94 ± 0.08
Ascorbic acid (mg/100g DW)	33.15 ± 2.12	40.44 ± 2.62	35.16 ± 2.35
Total phenols (mg GAE/100 g DW)	205 ± 9	232 ± 10	264 ± 11

Data are mean of three determinations ± SE. * (g / 100 g fresh weight)

2. Lycopene content

Among the most prominent phytochemicals in tomatoes are the carotenoids of which lycopene is the most abundant in the red ripened fruit, accounting for approximately 80-90% of the total pigments (Helyes *et al*., 2009, Shi *et al*., 2009 and Hussein *et al*., 2016).

This compound is not only a pigment but also a strong antioxidant, which neutralizes the free radicals, and, especially, the oxygen derived ones. Its ability to inhibit the oxidative activity of the active oxygen is twice higher than in case of β-carotene and 10 times higher than in case of α- tocopherol (Shi and LeMaguer, 2000 and Pokharkar *et al*., 2016).

Lycopene content in fresh matter of selected Egyptian tomato varieties (Table 2) showed highest content in the most red 186 tomato variety (9.12 mg/100g DW) followed by Maleka variety (7.82 mg/100g DW) while El-Basha 1077 variety was found to contain lowest amount of lycopene (6.32 mg/100g DW).

Table (2). Changes in lycopene content (mg/100g dry weight) of sun and oven dried tomatoes pretreated with sodium chloride and sodium bisulphate before and after 3 month of storage at 25 °C.

Drying methods and pre-treatments	Tomatoes varieties					
	Maleka		El Basha 1077		186	
	Before	After	Before	After	Before	After
Sun drying						
Control	10.78 ± 0.2	6.62 ± 0.1	8.34 ± 0.1	5.22 ± 0.1	11.68 ± 0.1	7.94 ± 0.1
5% NaCl	11.23 ± 0.1	8.55 ± 0.1	9.63 ± 0.1	6.98 ± 0.1	14.03 ± 0.1	10.32 ± 0.1
1% $Na_2S_2O_5$	16.11 ± 0.2	13.64 ± 0.2	13.62 ± 0.2	11.46 ± 0.1	20.14 ± 0.2	18.05 ± 0.2
5% NaCl + 1% $Na_2S_2O_5$	15.66 ± 0.3	12.42 ± 0.2	13.12 ± 0.2	10.88 ± 0.1	19.45 ± 0.2	17.62 ± 0.2
Oven drying at 50 °C						
Control	12.18 ± 0.3	7.88 ± 0.1	10.25 ± 0.1	6.55 ± 0.1	14.04 ± 0.1	8.47 ± 0.1
5% NaCl	13.04 ± 0.2	10.55 ± 0.1	11.02 ± 0.1	8.85 ± 0.1	15.22 ± 0.1	11.82 ± 0.1
1% $Na_2S_2O_5$	17.01 ± 0.3	14.64 ± 0.2	15.23 ± 0.2	12.90 ± 0.2	22.02 ± 0.2	19.88 ± 0.2
5% NaCl + 1% $Na_2S_2O_5$	16.55 ± 0.2	14.22 ± 0.2	15.02 ± 0.2	12.42 ± 0.1	20.65 ± 0.2	19.24 ± 0.1
Oven drying at 70 °C						
Control	12.88 ± 0.2	8.22 ± 0.1	10.55 ± 0.1	7.16 ± 0.1	14.18 ± 0.2	11.13 ± 0.1
5% NaCl	13.14 ± 0.3	8.86 ± 0.1	11.22 ± 0.1	7.85 ± 0.1	15.68 ± 0.2	12.61 ± 0.1
1% $Na_2S_2O_5$	17.21 ± 0.2	14.12 ± 0.1	15.82 ± 0.2	12.22 ± 0.1	22.16 ± 0.3	19.18 ± 0.1
5% NaCl + 1% $Na_2S_2O_5$	17.04 ± 0.3	15.82 ± 0.2	15.24 ± 0.2	12.65 ± 0.1	21.15 ± 0.2	19.03 ± 0.1

Data are mean of three determinations ± SE.

Red tomato is the richest source of lycopene and orange or yellow tomato is rich in carotene (Butnariu and Samfira, 2012).

The content of lycopene depends on variety, cultivating area, variable climate conditions and cultivation technology (Abushita *et al*., 2000, Binoy *et al*., 2004 and Correia *et al*., 2015). The results obtained in this study are in agreement with the results of Sharma and Le Maguer (1996) who found lycopene content in fresh tomato fruits originating from Canada was in the amount of 5.4 mg/100g DW. Martínez-Valverde *et al*. (2002) found in various commercial varieties of Spanish tomato lycopene content at 4.8-9.5 mg/100g DW. Toor and Savage, (2006) indicated that lycopene in three commercial varieties of tomatoes reached the amount of 5.7 to 9.7 mg/100g DW in fresh matter. Moreover, Mendelová *et al*. (2012) monitored the content of lycopene in tomato varieties for industrial processing and their found lycopene content from 5.11 to 8.11 mg/100g DW.

The influence of drying methods (sun drying and oven drying at 50 and 70 ℃) and pretreatments (5% NaCl, 1% $Na_2S_2O_5$ and combination of 5% NaCl + 1% $Na_2S_2O_5$) on lycopene contents of the dried tomatoes varieties were studied.

The results presented in Table (2) showed that the lycopene contents of fresh tomatoes increased after drying. All drying methods allowed to increase the lycopene bioassimilation by destructing the tomato cells and breaking the connection between lycopene and matrix, damaging the lycopene-protean complex and releasing free lycopene by cis isomerisation (Shi and LeMaguer, 2000).

The base phenomena, which result in changing lycopene during tomato processing, are isomerisation and oxidation. While oxidation is a process leading to lycopene decomposition, isomerisation has a positive effect. Lycopene is found in tomatoes in the *trans*-steric form. Thermal processes, including drying, lead to lycopene isomerisation and its change from *trans* steric to *cis* form. The quantity of cis isomers grows once with the increase in temperature and duration of heat treatment. The bioassimilation of lycopene cis isomers is greater than of *trans*- isomers (Hussein *et al*, 2016).

The results obtained in this study are in agreement with Abano *et al.* (2013) who found that The lycopene levels of the dried tomatoes significantly increased from an initial value of 2.96 mg/100 g dry matter to a maximum value of 25.44 mg/100 g dry matter after microwave-vacuum drying. Moreover, Azeez *et al* (2017) indicated that the increase in lycopene contents is related to drying time and drying temperature which result from the improved extractability of bioaccessible lycopene released from cell matrix. Heat treatment converts cis-lycopene conformation to trans conformation which increases its detection and subsequently its higher quantity (Jorge *et al*., 2014).

The results in this study indicated that the lycopene contents has increased in after different drying methods of tomatoes varieties compare with lycopene contents in fresh tomatoes. Oven drying at 70 ℃ followed by drying at

50 ℃ showed highest lycopene contents, while sun drying showed lowest level of lycopene.

One possible reason for higher lycopene degradation with sun-drying is that tomatoes are exposed to solar radiation for a longer period of time than with heated air-drying. The result is similar to what was reported by Roldan-Gutierrez and Luque de Castro (2007) and Aktas *et al*. (2011).

The effects of different pre-treatments (5% NaCl, 1% $Na_2S_2O_5$ and combination of 5% NaCl + 1% $Na_2S_2O_5$) on lycopene contents of the dried tomatoes varieties are shown in Table (2). The highest lycopene contents in the three dried different tomatoes varieties were detected in the samples pretreated with 1% $Na_2S_2O_5$ and combination of 1% $Na_2S_2O_5$ + 5% NaCl.

Results regarding the effect of $Na_2S_2O_5$ were qualitatively similar to those reported by Sharma and LeMaguer (1996), Ismail and Akyol (2016) and Seth and Chatterjee (2016).

After three month of storage at 25 ℃, lycopene content decreased to about 15% to 35% for all dried samples depending on drying methods and pretreatments.

Akanbi and Oludemi (2004) reported that lycopene in stored tomato degraded with the storage temperature and storage time. The main cause of lycopene degradation during storage was oxidation. Low oxygen content, low temperature, low moisture content of sun-dried tomato prevents oxidation as well as lycopene degradation (Shi and LeMaguer, 2000).

Sodium metabisulfite and combined 1% $Na_2S_2O_5$ + 5% NaCl pretreatments reduced the rate of lycopene oxidation during storage of sun-dried and oven drying tomatoes compared with the 1% NaCl pretreatment.

These results are in agreement with those published by Lewicki *et al*. (2002), Pokharkar *et al*. (2016) and Hameed *et al*. (2016).

3. β-carotene content

Red tomato is the richest source of lycopene and yellow tomato is rich in carotene (Butnariu and Samfira, 2012).

The average value of β-carotene content of fresh tomatoes before drying was ranged from 0.94 to 2.12 mg/100 g dry weight. The variety of El-Basha 1077 showed highest level (2.12 mg/100 g dry weight) followed by Maleka (1.34 mg/100 g dry weight) while 186 variety, the most red one, showed the lowest level (0.94 mg/100 g dry weight). The quantity and quality of phytochemicals detected in tomato fruits is known to depend greatly on genotype and environmental conditions (Giuntini *et al*., 2005).

The values of β-carotene obtained for oven dried tomatoes at 70 ℃ were in highest levels followed by oven dried at 50 ℃ and the lowest levels were obtained for sun dried tomatoes (Table 3).

Table (3). Changes in β-carotene content (mg/100g dry weight) of sun and oven dried tomatoes halves and slides pretreated with sodium chloride and sodium bisulphate before and after 3 month of storage at 25 ℃.

Drying methods and pre-treatments	Tomatoes varieties					
	Maleka		El Basha 1077		186	
	Before	After	Before	After	Before	After
Sun drying						
Control	1.42 ± 0.02	0.58 ± 0.01	1.96 ± 0.02	0.64 ± 0.02	1.33 ± 0.02	0.52 ± 0.01
5% NaCl	2.52 ± 0.02	0.82 ± 0.02	3.44 ± 0.02	1.27 ± 0.02	1.82 ± 0.02	0.78 ± 0.02
1% $Na_2S_2O_5$	2.92 ± 0.03	1.44 ± 0.02	4.40 ± 0.03	1.95 ± 0.03	2.52 ± 0.02	0.95 ± 0.02
5% NaCl + 1% $Na_2S_2O_5$	2.87 ± 0.02	1.33 ± 0.02	3.93 ± 0.03	1.74 ± 0.03	2.72 ± 0.03	0.91 ± 0.02
Oven drying at 50 ℃						
Control	1.88 ± 0.02	0.88 ± 0.02	2.95 ± 0.02	1.56 ± 0.02	1.44 ± 0.02	0.66 ± 0.02
5% NaCl	3.04 ± 0.03	1.68 ± 0.02	4.15 ± 0.02	2.45 ± 0.02	2.11 ± 0.02	0.98 ± 0.02
1% $Na_2S_2O_5$	4.15 ± 0.02	2.69 ± 0.03	4.87 ± 0.03	2.83 ± 0.03	3.02 ± 0.03	1.64 ± 0.02
5% NaCl + 1% $Na_2S_2O_5$	4.12 ± 0.05	2.32 ± 0.03	4.53 ± 0.04	2.62 ± 0.02	3.04 ± 0.03	1.22 ± 0.02
Oven drying at 70 ℃						
Control	2.74 ± 0.05	1.55 ± 0.02	4.36 ± 0.03	2.85 ± 0.03	1.86 ± 0.02	0.85 ± 0.02
5% NaCl	4.14 ± 0.07	2.86 ± 0.03	6.64 ± 0.03	4.26 ± 0.03	2.54 ± 0.02	1.44 ± 0.02
1% $Na_2S_2O_5$	6.27 ± 0.04	4.22 ± 0.03	8.88 ± 0.04	5.73 ± 0.04	3.42 ± 0.03	2.28 ± 0.03
5% NaCl + 1% $Na_2S_2O_5$	5.90 ± 0.07	3.76 ± 0.03	8.08 ± 0.05	5.32 ± 0.03	3.14 ± 0.03	1.88 ± 0.03

Data are mean of three determinations ± SE.

The values of β-carotene obtained for control oven dried tomatoes at 70 ℃ without no pretreatments were in highest level and reached to 4.36 mg/100 g dry weight in ElBasha 1077 variety and it was in lowest level at 1.86 mg/100 g dry weight was in 186 tomato variety.

These values were increased more by sodium metabisulfite and combined 1% $Na_2S_2O_5$ + 5% NaCl pretreatments in all drying methods. Sarkar *et al*. (2015) reported that treatment with preservatives as metabisulphite recorded highest β-carotene.

Similar results were observed by Muratore *et al*. (2008) and Yusuf *et al*. (2013). They reported that degradation of lycopene and β -carotene in tomatoes was highly influenced by the length of drying. The β-carotene content of open sun dried tomato was in lower value than other drying methods. These results are in agreements with the results of Hussein *et al*. (2016).

Other publications reported that the β-carotene content of dried tomato decreased with increasing the period of drying and thickness of the tomatoes (Idah *et al*., 2010 and Kim and Chin, 2016).

The selection of the drying techniques and the processing parameters seems to be essential in order to preserve high carotenoids concentrations; as carotenoids being sensitive to heat (Tran *et al*., 2008).

After three months storage, β-carotene contents decreased in control samples without pretreatments more than pretreated samples. Anjum *et al*. (2008) found that storing the vegetables for longer time at room temperature gradually decreases β-carotene content of vegetables.

Sarkar *et al*. (2015) published that β-carotene was reduced during storage periods for all samples. Decreased of β-carotene (48.8%) was observed through the storage period. Variation of loss of β-carotene might be due to various processing treatments and storage condition. Freezing storage at -10℃ retained β-carotene for long time compared to other storage conditions.

4. Ascorbic acid content

Tomatoes are a rich source of ascorbic acid (Abushita *et al*., 2000, Kaur *et al*., 2002 and Hussein *et al*., 2016)**.**

Ascorbic acid content in fresh matter of selected Egyptian tomato varities (Table 1) showed highest content in El-Basha 1077 tomato variety (40.44 mg/100g dry weight) followed by 186 variety (35.16 mg/100g dry weight) while Maleka variety was found to contain lowest amount of ascorbic acid (33.15 mg/100g dry weight).

These results are in agreement with Sharma and Le Maguer (1996) who reported variation in ascorbic acid content ranging from 11.21 to 53.29 mg/100g dry weight in tomato genotypes and Latapi and Barrett (2006) who found that ascorbic acid contents in fresh tomatoes ranged from 13.37 to 43.15 mg/100g

dry weight as well as Hussein *et al*. (2016) who determined that the ascorbic acid content for the fresh sample was 40.15 mg/100 g dry weight.

Ascorbic acid is one of the most thermo labile components of food products, fact also confirmed at tomato drying.

The influence of drying methods (sun drying and oven drying at 50 and 70 ℃) and pretreatments (5% NaCl, 1% $Na_2S_2O_5$ and combination of 5% NaCl + 1% $Na_2S_2O_5$) on ascorbic acid contents of the dried tomatoes varieties are shown in Table (4). Ascorbic acid declined after drying of tomatoes varieties.
The values obtained for open sun dried tomatoes (control) ranged from 6.24 to 10.72 mg/100 g dry weight, oven dried at 50 ℃ ranged from 6.64 to 11.25 mg/100 g dry weight and oven dried at 70 ℃ ranged from 2.81 to 5.17 mg/100 g dry weight.

Table (4). Changes in ascorbic acid content (mg/100g dry weight) of sun and oven dried tomatoes pretreated with sodium chloride and sodium bisulphate before and after 3 month of storage at 25 ℃.

Drying methods and pre-treatments	Tomatoes varieties					
	Maleka		El Basha 1077		186	
	Before	After	Before	After	Before	After
Sun drying						
Control	3.31 ± 0.1	1.28 ± 0.1	5.17 ± 0.2	1.88 ± 0.1	3.86 ± 0.1	1.58 ± 0.1
5% NaCl	5.92 ± 0.2	2.44 ± 0.1	7.82 ± 0.2	3.28 ± 0.1	6.30 ± 0.2	2.86 ± 0.2
1% Na2S2O5	8.64 ± 0.3	4.19 ± 0.2	10.37 ± 0.3	4.86 ± 0.2	9.41 ± 0.3	4.87 ± 0.3
5% NaCl + 1% Na2S2O5	8.32 ± 0.2	4.11 ± 0.2	10.11 ± 0.3	4.51 ± 0.2	9.22 ± 0.3	4.59 ± 0.2
Oven drying at 50 ℃						
Control	10.82 ± 0.2	4.58 ± 0.1	11.25 ± 0.2	4.74 ± 0.2	9.58 ± 0.2	4.39 ± 0.2
5% NaCl	12.15 ± 0.3	5.82 ± 0.2	14.52 ± 0.3	7.11 ± 0.2	11.68 ± 0.2	5.62 ± 0.2
1% Na2S2O5	13.41 ± 0.3	7.11 ± 0.3	16.64 ± 0.3	8.42 ± 0.3	14.47 ± 0.3	7.52 ± 0.3
5% NaCl + 1% Na2S2O5	13.15 ± 0.4	6.05 ± 0.3	16.22 ± 0.4	8.10 ± 0.3	14.11 ± 0.3	6.44 ± 0.3
Oven drying at 70 ℃						
Control	7.88 ± 0.3	3.22 ± 0.1	10.72 ± 0.3	4.58 ± 0.2	7.85 ± 0.2	3.64 ± 0.1
5% NaCl	9.35 ± 0.3	4.52 ± 0.2	13.13 ± 0.3	6.88 ± 0.3	8.90 ± 0.3	4.66 ± 0.2
1% Na2S2O5	13.44 ± 0.4	7.45 ± 0.3	16.88 ± 0.4	8.93 ± 0.3	14.45 ± 0.4	7.74 ± 0.2
5% NaCl + 1% Na2S2O5	12.18 ± 0.4	6.12 ± 0.2	15.58 ± 0.4	8.37 ± 0.3	13.22 ± 0.4	6.75 ± 0.3

Data are mean of three determinations ± SE.

During sun-drying and oven drying at 70 ℃, all tomatoes varieties lost ascorbic acid more than that of oven drying at 50 ℃, supporting previous studies of ascorbic acid retention.

Gupta and Nath (1984) and Gallali *et al*. (2000) discovered that sun drying results in more ascorbic acid losses.

It was observed that there was a continuous decrease in the value of ascorbic acid as the drying time and the temperature increased which was expected because of the sensitivity of ascorbic acid to heat (Rajkumar, 2007).

From the obtained results, it was observed that the ascorbic acid was very sensitive to oxidative heat damages. This variation in retention of ascorbic acid was observed due to variations in temperature and period of drying. This observation confirm with the results obtained by Lavelli *et al*. (1999) and Giovanelli *et al*. (2002) and that the reduction in ascorbic acid content was mainly due to the temperature, time of exposure to direct sun light, thickness and the presence of air. This reduction may also be due to leaching of the vitamin being water soluble and oxidation due to longer period of drying. This is in agreement with the works of Shi *et al*. (1999).

Bano *et al*. (2012) investigated the ascorbic acid degradation of air dried tomato at temperatures of 50℃, 60℃ and 70℃ and reported that the ascorbic acid in the tomatoes after dehydration reduced from 4.00 mg/g to 2.19 mg/g dry matter, representing 35% reduction.

Njoku *et al*. (2011) and Isiaka (2013) showed that there was substantial drop in ascorbic acid content from 28.2mg/100g for fresh ripe tomato to as low as 13.6mg/100g for dried tomato of 25mm slice thickness.

A similar trend was also observed for tomatoes dried at 90℃ for more than 8 h (Yusuf *et al*., 2013). This result supports the concept that ascorbic acid is more sensitive to longer time of exposure than to higher temperature shorter times, which implies that a greater reduction in time at the cost of slight increase in temperature results in better retention of nutrients (Teixeira, 2012). Similar decline in ascorbic acid content was noticed in other studies with tomato by Kadam *et al*. (2012) and Qadri and Srivastava (2014). Hence, the higher drying exposure time, thickness and temperature resulted in considerable reduction in the values of nutrients in dried tomatoes.

In this study, the greatest ascorbic acid loss occurred in the control samples without any treatments, The type of sulfuring process seems to have a positive effect on ascorbic acid because tomatoes pretreated with 5% $Na_2S_2O_5$ and 1% $Na_2S_2O_5$ + 5% NaCl lost less that pretreated with only 5% NaCl or control samples.

It has been reported that tomatoes products treated with sulfur dioxide have reduced ascorbic losses during processing, as well as during storage (Latapi and Barrett, 2006 and Sheshma and Raj, 2014). Results from this study support this observation; sulfur dioxide not only reduced the ascorbic acid loss rate during processing, but it also gave added protection during storage.

The highest losses of ascorbic acid after three months storage were observed again in the control and 5% NaCl sun-dried and oven dried at 70 ℃

tomatoes, whereas all tomatoes sulfured dipping lost less levels. Using sulfur dioxide as a preservative through pretreatments in dried tomatoes can minimize the loss of ascorbic acid both during processing and storage.

5. Total phenolic content

Total phenol content in fresh tomatoes has been reported to range from 300 to 400 mg GAE/100 g DM (Veillet *et al*., 2009 and Mongi *et al*., 2015) while Toor and Savage (2006) and Kim and Chin (2016) reported that the total phenol content in fresh tomatoes ranged from 169 mg GAE/100 g DW to 579 mg GAE/100 g DW, the lowest values corresponding to tomatoes grown in winter and early spring.

In this study, total phenol content values in fresh tomatoes were in highest levels in fresh 186 tomato variety (264 mg GAE/100 g DW) followed by El-Basha1077 tomato variety (232 mg GAE/100 g DW) and the lowest level was recorded in Malika variety (205 mg GAE/100 g DW).

The effect of drying methods and pretreatments on total phenolic compounds has been well studied. When tomato products are heated and dried, the total polyphenol content is affected and increases with increasing drying temperatures (Kerkhofs *et al*., 2005 and Santos-Sánchez *et al*., 2012).

Heating and drying has positively affects the bioaccessiblity of total phenolics, resulting in release of phenolic compounds from the cell wall (Tulipani *et al*., 2012). They reported that phenolic composition of tomato sauces significantly differed from the raw tomatoes in their higher contents of phenolic compounds. This indicates that heat treatments may provide energy to break the linkage between phenolics and the insoluble polyesters of tomato fiber, potentially improved polyphenol bioaccessibility (Laguna *et al*., 1999). Vallverdú-Queralt *et al*. (2014) observed that major phenolic compounds of tomato sauce were ferulic acid, chlorogenic acid and caffeic acid. In addition, major flavonoids in tomato are rutin, quercetin and naringenin (Vega-Galvez *et al*., 2009).

In this study, the high drying temperature at 70 ℃, have influenced the content of total phenol content, showed highest total phenol contents followed by drying at 50 ℃ and sun drying methods in all tomatoes varieties (Table 5).

Table (5). Changes in total phenolic compound content (mg GAE/100 g dry weight) of sun and oven dried tomatoes pretreated with sodium chloride and sodium bisulphate before and after 3 month of storage at 25 °C.

Drying methods and pre-treatments	Tomatoes varieties					
	Maleka		El Basha 1077		186	
	Before	After	Before	After	Before	After
Sun drying						
Control	236 ± 5	231 ± 5	251 ± 6	255 ± 5	311 ± 6	321 ± 5
5% NaCl	233 ± 7	231 ± 4	233 ± 5	242 ± 4	312 ± 6	315 ± 6
1% $Na_2S_2O_5$	227 ± 4	223 ± 4	262 ± 6	265 ± 5	335 ± 5	338 ± 6
5% NaCl + 1% $Na_2S_2O_5$	236 ± 5	239 ± 5	266 ± 5	262 ± 6	337 ± 6	332 ± 5
Oven drying at 50 °C						
Control	245 ± 6	241 ± 5	277 ± 6	272 ± 6	341 ± 6	344 ± 6
5% NaCl	241 ± 5	233 ± 4	293 ± 5	297 ± 5	333 ± 5	331 ± 4
1% $Na_2S_2O_5$	255 ± 6	250 ± 6	298 ± 6	293 ± 6	372 ± 7	366 ± 5
5% NaCl + 1% $Na_2S_2O_5$	258 ± 7	251 ± 6	292 ± 7	295 ± 6	377 ± 6	372 ± 6
Oven drying at 70 °C						
Control	325 ± 6	326 ± 5	364 ± 5	361 ± 5	437 ± 8	435 ± 7
5% NaCl	332 ± 5	335 ± 4	368 ± 6	364 ± 6	444 ± 7	441 ± 8
1% $Na_2S_2O_5$	344 ± 6	341 ± 4	378 ± 6	372 ± 4	448 ± 8	443 ± 8
5% NaCl + 1% $Na_2S_2O_5$	339 ± 5	333 ± 5	393 ± 7	388 ± 6	455 ± 5	451 ± 7

Data are based on triplicate values ± SE.

In agreement to the results of our study, Gahler *et al*. (2003) reported an increase of 44% in total phenolic content on a fresh weight basis during drying at high temperatures (80 to 120℃ for three hours), and Chang *et al*. (2006) reported increases about 30% after processing at average temperatures (80 and 60℃ for 8 h) with a 190% increase after drying at a low temperature (40℃ for 20 h).

Mechlouch *et al*. (2012) reported that in fresh tomatoes, total phenolic contents (TPC) were lower than dried samples. The highest phenolics content was found in tomatoes dried by direct solar dryer and microwave 3W/g at 57℃.

Mongi *et al*. (2015) concluded that the higher total phenolic contents in tunnel dried tomato than fresh samples could be attributed to the release of more bound phenolic compounds from breakdown of cellular constituents due to high drying temperature (Boateng *et al*., 2008).

Similar increase in polyphenolic contents after drying has been reported in sweet potatoes (Mao *et al*., 2010), tomatoes (Dewanto *et al*. 2002 and Chang *et al*., 2006) and Shitake mushroom (Choi *et al*., 2006). In general, the significant effect of different drying methods on total phenolic compound of fruits, vegetables and herbs has widely been reported (Hamrouni-Sellami *et al*., 2012 and Zhang *et al*., 2012).

In this study, after three months storage at room temperature, there were little differences in total phenolic contents in stored dried tomato samples (Table 5).

Park *et al*. (2016) and Tilahun *et al*. (2017) published that no significant differences in total phenolics content were observed between varieties and between storage durations. No significant differences in total phenolics content were observed between 0 and 20 days of storage, indicating that storage period has no effect on the overall antioxidant content of tomatoes.

6. Sensory evaluation

Isiaka (2013) reported that to determine the wholesomeness of dried tomatoes, the organoleptic properties in terms of colour (appearance) and taste (flavour) were the two major quality attributes which play important roles in tomato acceptability.

Sensory evaluation was carried out on three dried tomatoes varieties as well as fresh dried of each variety (El-Basha 1077, Malika and 186). Assessed qualities include colour, flavour and overall acceptability. Ten untrained panelists were selected at random from Food Science Department, Faculty of Agriculture, Saba Basha, Alexandria University, Egypt.

Mean sensory score of sensory attributes are shown in Table (6) for the overall acceptability of the tomatoes samples.

The tomato variety 186 was in highest score followed by El-Basha 1077 variety, while Malika variety was in lowest score.

The panelists ranked fresh variety sample 186 as the highest with mean score of 8.70 which corresponds to like very much on the 9-points hedonic scale. This was followed by oven dried sample at 70 ℃ with mean score of 7.80 followed by oven dried at 50 ℃ with mean score 7.10 which corresponds to like moderately on the 9-points hedonic scale. Sun dried sample was scored least with mean score 5.75 which correspond to like slightly on the 9-points hedonic scale.

On the other hand, the panelists ranked fresh Malika variety sample highest with mean score of 6.90 which corresponds to like moderately on the 9-points hedonic scale. This was followed by oven dried sample at 70 ℃ with mean score of 5.60 followed by oven dried at 50 C with mean score 5.10 which corresponds to like slightly on the 9-points hedonic scale. Sun dried sample was scored least with mean score 4.25 which correspond to like very slightly on the 9-points hedonic scale.

These scores of overall acceptability decreased from 30 to about 50% after 3 month storage in all tomato varieties.

The changes in colour tomatoes are due to the degradation of lycopene and other pigments during storage (Nguyen and Schwartz, 1999 and Hussein *et al*., 2016).

The colour, flavour and overall acceptability of sun dried tomatoes secured the lowest score due to the elongation of drying time and the presence of contaminants and other factors affects the appearance and taste of tomatoes.

Table (6). Mean sensory scores of sun and oven dried tomatoes pretreated with sodium chloride and sodium bisulphate before and after 3 month of storage at 25 °C.

Drying methods and pre-treatments	Tomatoes varieties					
	Maleka		El Basha 1077		186	
	Before	After	Before	After	Before	After
Sun drying						
Control	4.25	2.50	5.20	3.10	5.75	3.30
5% NaCl	4.50	2.65	5.30	3.15	6.15	3.80
1% $Na_2S_2O_5$	4.80	2.80	5.80	3.55	6.70	4.35
5% NaCl + 1% $Na_2S_2O_5$	4.60	2.70	5.70	3.40	6.50	4.30
Oven drying at 50 °C						
Control	5.10	2.75	6.40	3.55	7.10	3.90
5% NaCl	5.20	2.80	6.55	3.70	7.50	4.20
1% $Na_2S_2O_5$	5.50	2.90	6.90	3.85	7.90	4.70
5% NaCl + 1% $Na_2S_2O_5$	5.30	2.80	6.70	3.75	7.80	4.60
Oven drying at 70 °C						
Control	5.60	3.10	7.50	4.05	7.80	4.10
5% NaCl	5.60	3.25	7.60	4.30	7.90	4.50
1% $Na_2S_2O_5$	5.90	3.40	7.90	4.60	8.25	4.80
5% NaCl + 1% $Na_2S_2O_5$	5.80	3.25	7.70	4.50	8.10	4.60

Score 1= extremely dislike, 9= extremely like

Samples pretreated with sodium thiosulphite or both sodium chloride and sodium thiosulphite showed the better color and flavour than other samples.

These results are in agreement with the findings of Isiaka (2013) who reported that oven dried tomatoes was superior to open sun dried tomatoes. The same trend was obtained for colour, taste and overall acceptability from that study.

CONCLUSION

Dehydration were carried out for three Egyptian tomatoes varieties slices, pretreated with three different treatments, i.e. 5% NaCl, 1% $Na_2S_2O_5$ and combination of 1% $Na_2S_2O_5$ + 5% NaCl and control using different dehydration methods (sun drying and oven drying at 50 and 70 ℃). The dehydrated tomato slices were made into powder and stored for three months at ambient temperature.

Bioactive compounds in this study included lycopene, β-carotene, ascorbic acid and total phenol contents were varied in tomatoes varieties.
Lycopene content in fresh Egyptian tomatoes showed highest content in the most red tomato variety 186 and the lowest content in orange red El-Basha 1077 variety. The results were adverse for β-carotene. The highest levels of lycopene and carotene were found in sun dried tomatoes pretreated with 1% $Na_2S_2O_5$ and combination of 1% $Na_2S_2O_5$ + 5% NaCl.

After three month of storage of dried tomatoes at room temperature, lycopene, β-carotene and ascorbic acid contents decreased to about 15% to 50% for all samples depending on drying methods and pretreatments.Highest content of ascorbic acid was recorded in El-Basha 1077 tomato variety. During sun-drying and oven drying at 70 ℃, all tomatoes lost ascorbic acid more that oven drying at 50 ℃.

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الملخص العربي

تأثير طرق التجفيف المختلفة ومعاملات ما قبل التجفيف على المركبات الحيوية الفعالة لبعض اصناف الطماطم المصرية

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تعتبر الطماطم ضمن الأغذية الوظيفية لتركيبها المتميز وإحتواءها على المركبات الحيوية الفعالة والتي لها أهمية في الوقاية للعديد من الأمراض. وحيث أن فترة صلاحية الطماطم الطازجة قصيرة على درجة حرارة الغرفة لذا فإنه من الضرورى إيجاد طرق تجفيف ومعاملات ما قبل التجفيف ملائمة للحفاظ على محتوى الطماطم من المركبات الكيماوية والحسية الهامة.

تم إختبار ثلاثة أصناف من الطماطم المنزرعة في البحيرة بمصر وهى مليكة والباشا ١٠٧٧ وصنف ١٨٦ وتم غسيل وتقطيع هذه الأصناف الى قطع بسمك ١٠ مم ومعاملتها بالغمر لمدة ١٠ دقائق سواء في ٥% محلول ملح الطعام أو ١% محلول صوديوم بيتاباى سلفيت أو مخلوط الإثنين معاً ثم التجفيف الشمسى أو في الفرن على ٥٠ أو ٧٠ م°.

شملت الدراسة المركبات الحيوية الفعالة مثل الليكوبين والبيتا كاروتين وحمض الإسكوربيك ومحتوى الفينولات الكلية بجانب الإختبارات الحسية والعضوية.

أوضحت النتائج إختلاف محتويات المركبات الحيوية الفعالة في أصناف الطماطم الثلاثة. إحتوى صنف ١٨٦ على أعلى محتوى من الليكوبين وصنف الباشا ١٠٧٧ على أقلهم وأنعكست تلك النتائج في محتوى البيتا كاروتين. وقد ارتفعت محتويات الليكوبين والبيتا كاروتين إلى أعلى مستوى بعد التجفيف على درجة ٧٠ م° والمعاملة ٥ % محلول ملح الطعام أو ١% محلول صوديوم بيتاباى سلفيت أو مخلوط الإثنين معاً. وقد إنخفضت مستويات كل من الليكوبين والبيتا كاروتين وحمض الإسكوربيك من ١٥ – ٥٠% بعد ٣ شهور تخزين على درجة حرارة الغرفة . وقد إحتوى صنف الباشا ١٠٧٧ على أعلى مستوى من حمض الإسكوربيك وإنخفض محتوى هذا الحمض خلال مراحل التجفيف المختلفة وإنخفض إلى أقل مستوى في الطماطم المجففة شمسيا. وجد أن محتوى الفينولات الكلية في أعلى مستوى في صنف ١٨٦ وقد إرتفعت مستويات الفينولات الكلية بالتجفيف على ٧٠ م°. ولم يؤثر التخزين على محتوى تلك الفينولات الكلية. كما أوضحت الدراسات الحسية والعضوية قبول صنف ١٨٦ المجفف بمعدل أعلى من الصنفين الأخريين وقد إنخفضت تلك المعدلات كتيرا بعد التخزين لمدة ٣ شهور على درجة حرارة الغرفة.

يتضح من ذلك أن معاملات ماقبل التجفيف وكذا طرق تجفيف الطماطم وتخزينها تلعب دورا هاما في القيمة الغذائية للطماطم ومحتواها من المركبات الفعالة الحيوية مثل الليكوبين والبيتا كاروتين وحمض الإسكوربيك.

Libyan Food Security of Cereals and Meat

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ABSTRACT: The research aims mainly to study the food gap and food security of cereals and meat in Libya through studying of several sub-goals represented in: estimating models of general trends function for some economic indicators of cereals and meat in Libya during the period (1995- 2014), estimating the size of the food gap of cereals and meat, and estimating the coefficient of food security of cereals and meat in Libya. Descriptive and quantitative analysis were used. The study depends on secondary data, which collected from local and foreign sources during the period (1995-2014). The models of the general trend function for economic indicators of cereals group showed that each of the total domestic consumption, and the average per capita consumption, the amount of imports, food gap , daily consumption and periods of coverage of imports for daily consumption from cereals, and found that all of these variables has taken a general trend upward morally statistically significant at the level of probability (0.01) with the exception of a variable of coverage period of local production for daily consumption which took a general trend decreasing, and also did not identify the statistical significance of the variables of domestic production and the period of coverage of production for daily consumption , while the annual growth rates differed according to each variable. The models of the general trend function for economic indicators of meat group showed that each of the total domestic production, domestic consumption, and the average per capita consumption, daily consumption and periods of coverage of production for daily consumption from meat, and found that all of these variables has taken a general trend upward morally statistically significant at the level of probability (0.01) and also did not identify the statistical significance of the variables of imports quantity and the period of coverage of imports for daily consumption , while the annual growth rates differed according to each variable. The study showed that the strategic stock for cereals is estimated at 1396.47 thousand tons and the average local consumption of cereals is estimated at about 1046.1 thousand tons during the study period (1995-2014), thus estimated food security of about 1.3 , so it manes that strategic stock for cereals is enough for more than year and it is related to increasing cereals imports .The study showed that the strategic stock for meat is estimated at about -25.5 thousand tons and the average local consumption of meat is estimated at about 261.5 thousand tons during the study period (1995-2014), thus estimated food security of about -0.2 , it means the state must take different arrangements to increase strategic stock to suffice the consumption requirements from meat is therefore required to take various actions which lead to increase the size of the strategic stock of sugar enough for half of it needs for domestic consumption even come close to the value of suitable coefficient of sugar food security to approach to the food security coefficient of one. Some recommendations from this research had been discussed to improve Libyan food gap and food security of cereals and meat.

جدول (٤) معامل الأمن الغذائي لمجموعة اللحوم خلال الفترة (١٩٩٥-٢٠١٤)

السنوات	مقدار الاستهلاك القومي (ألف طن)	المخزون الاستراتيجي (ألف طن)	معامل الأمن الغذائي
١٩٩٥	٢١٩,٥	٩,٨٤-	٠,٠٤٥-
١٩٩٦	٢٢٣,٤	٤١,٤٤-	٠,١٨٥-
١٩٩٧	٢٢٧,٥	٣٦,٣٥-	٠,١٦٠-
١٩٩٨	٢٣١,٥	٢٩,٠٢-	٠,١٢٥-
١٩٩٩	٢٣٥,٧	٥٨,٨٥-	٠,٢٥٠-
٢٠٠٠	٢٤٠,٠	٤٠,٧-	٠,١٧٠-
٢٠٠١	٢٤٤,٠	١٤٩,١٢-	٠,٦١١-
٢٠٠٢	٢٤٨,٦	٤٢,٢٧-	٠,١٧٠-
٢٠٠٣	٢٥٣,١	١٤٥,٤٣-	٠,٥٧٥-
٢٠٠٤	٢٥٧,٧	٤,٣٥-	٠,٠١٧-
٢٠٠٥	٢٦٢,٥	١٦,٧٨	٠,٠٦٤
٢٠٠٦	٢٦٧,٢	٧,٠٨-	٠,٠٢٦-
٢٠٠٧	٢٧٢,٠	٣,١٧	٠,٠١٢
٢٠٠٨	٢٧٧,٠	١٨,٤٦	٠,٠٦٧
٢٠٩	٢٨٢,٠	١٤,٥٤-	٠,٠٥٢-
٢٠١٠	٢٨٧,٠	١٦,٤	٠,٠٥٧
٢٠١١	٢٩٢,٧	١,٣	٠,٠٠٤
٢٠١٢	٢٩٨,٠	٠,٣-	٠,٠٠١-
٢٠١٣	٣٠٣,٠	٦,٧	٠,٠٢٢
٢٠١٤	٣٠٩,٠	٦,٠١	٠,٠١٩
المتوسط	**٢٦١,٦**	**٢٥,٥-**	**٠,١٠٧-**

المصدر: حسبت من بيانات جدول(٢).

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رابعاً: بعض مؤشرات الأمن الغذائي الليبي لمجموعة اللحوم خلال الفترة (١٩٩٥-٢٠١٤): يتناول هذا الجزء من الدراسة أهم مؤشرات الأمن الغذائي لمجموعة اللحوم الغذائية الرئيسية في ليبيا خلال فترة الدراسة ، وذلك لحساب معامل الأمن الغذائي بناء علي كل من الإنتاج والاستهلاك وفترة لتغطية الإنتاج والواردات للاستهلاك القومي والفائض والعجز في المخزون الاستراتيجي لهذه المجموعة الغذائية في ليبيا وذلك كما يلي:

(١) الاستهلاك اليومي الليبي من مجموعة اللحوم : باستعراض بيانات جدول (٢) السابق يتضح أن الإستهلاك اليومي الليبي من مجموعة اللحوم قد تراوح بين حد أدنى بلغ حوالي ٦٠١,٤ طن/يوم وحد أعلى بلغ حوالي ٨٤٦,٦ طن/يوم وبمتوسط يومي بلغ حوالي ٧١٦,٦ طن/يوم ، واخذ الاستهلاك اليومي الليبي من اللحوم إتجاهاً عاما تصاعدياً معنوياً إحصائياً عند ١% بلغ حوالي ١٢,٨٦ طن يوميا، وبمعدل نمو سنوي معنوياً إحصائياً عند ١% بلغ حوالي ١,٨%.

(٢) فترة تغطية الإنتاج الليبي للاستهلاك اليومي من مجموعة اللحوم: باستعراض بيانات جدول (٢) السابق يتضح أن فترة تغطية الإنتاج الليبي للاستهلاك اليومي من مجموعة اللحوم خلال السنوات (١٩٩٥-٢٠١٤) قد تراوحت بين حد أدنى بلغ حوالي ١٢٢,٦ يوم عام ٢٠٠٣ وحد أعلى بلغ حوالي ٣٥١,٧ يوم عام ٢٠١١ بمتوسط سنوي بلغ حوالي٢٨٩,٧ يوم ، وبلغ معدل النمو السنوي حوالي ٢,٣% وبمقدار تغير سنوي بلغ حوالي ٦,٣٨ يوم.

(٣) فترة تغطية الواردات الليبية للاستهلاك اليومي من مجموعة اللحوم: باستعراض بيانات جدول (٢) السابق يتضح أن فترة تغطية الواردات الليبية للاستهلاك اليومي من مجموعة اللحوم قد تراوحت بين حد أدنى بلغ حوالي ١٥يوم عام ٢٠١١ وحد أعلى بلغ حوالي٧٧,١ يوم عام ١٩٩٥ ومتوسط بلغ حوالي ٣٦,٣ يوم ، وتبين عدم معنوية معادلة الاتجاه الزمني العام لفترة تغطية الواردات للاستهلاك اليومي من مجموعة اللحوم خلال فترة الدراسة (١٩٩٥-٢٠١٤) ويرجع ذلك إلي عدم إستقرار فترة تغطية الواردات الليبية للاستهلاك اليومي من مجموعة اللحوم خلال فترة الدراسة .

(٤) تقدير المخزون الاستراتيجي الليبي من مجموعة اللحوم: بإستعراض بيانات جدول (٤) يتبن إن هناك عجز كبير في المخزون الاستراتيجي قد تراوح بين حد أدنى بلغ حوالي ٠,٣- ألف طن لعام ٢٠١٢ وحد أعلى بلغ حوالي ١٨,٤٦ ألف طن لعام ٢٠٠٨ ، وبذلك كان هناك عجز وفائض في المخزون الاستراتيجي لمجموعة اللحوم خلال سنوات فترة الدراسة (١٩٩٥-٢٠١٤).

(٥) تقدير معامل الأمن الغذائي لمجموعة اللحوم في ليبيا خلال فترة الدراسة (١٩٩٥-٢٠١٤): باستعراض بيانات جدول(٤) والذي يبين قيمة معامل الأمن الغذائي لمجموعة اللحوم خلال الفترة (١٩٩٥-٢٠١٤) يلاحظ إن هذا المعامل يتراوح بين حد أدنى بلغ حوالي ٠,٠٠١- لعام ٢٠١٢ وحد أعلى بلغ حوالي ٠,٦١ – لعام ٢٠٠١، ومتوسط سنوي بلغ حوالي ٠,١٠٧- .

والتي يظهر فيها عجز في الاستهلاك المحلي (أمل أبو زايدة ٢٠١٤) ، ولهذا يعتبر الاحتفاظ بمخزون استراتيجي من مجموعة الحبوب من أهم مقومات الأمن الغذائي الليبي، ويتم تكوين المخزون الاستراتيجي من خلال الإنتاج المحلي أو من خلال الواردات أو كلاهما معا . ويحسب المخزون الاستراتيجي من المعادلة التالية :

المخزون الاستراتيجي = (مجموع فترتي تغطية الإنتاج والواردات −٣٦٥) * الاستهلاك اليومي

وكما هو وارد بالجدول (٣) يتبن إن المخزون الاستراتيجي قد تراوح بين حد أدنى بلغ حوالي ٢٨٦ ألف طن لعام ٢٠٠٣ وحد أعلى بلغ حوالي ٢٥٢٢,٨ ألف طن لعام ٢٠١٠ بمتوسط سنوي بلغ حوالي ١٣٩٦ ألف طن، وبذلك لم يكن هناك أي عجز بل كان هناك فائض في جميع سنوات فترة الدراسة (١٩٩٥–٢٠١٤).

(٥) تقدير معامل الأمن الغذائي لمجموعة الحبوب في ليبيا خلال فترة الدراسة (١٩٩٥–٢٠١٤): قيمة معامل الأمن الغذائي عبارة عن نسبة المخزون الاستراتيجي من سلعة ما إلي الاستهلاك القومي منها لنفس السنه (أمل أبو زايدة ٢٠١٤) ، وتتراوح قيمة هذا المعامل بين الواحد الصحيح وبين الصفر فإذا اقترب من الصفر دل ذلك علي انخفاض معامل الأمن الغذائي ، أما أذا اقترب من الواحد دل ذلك علي زيادة معامل الأمن الغذائي من السلعة ،أما أذا زاد هذا المعامل عن الواحد الصحيح فمعني ذلك انه هناك فائض في المخزون الاستراتيجي من السلعة الغذائية عن السنة الحالية يكفي للسنة التالية أو للسنة التي بعدها علي حسب قيمة معامل الأمن الغذائي الأكبر من الواحد الصحيح أما أذا انخفض هذا المعامل لأقل من الصفر أي بإشارة سالب يعنى ذلك أن العجز في المجزون الاستراتيجي للسعلة لأكثر من سنة مقبلة علي حسب قيمة هذا الانخفاض. ومن خلال بيانات الجدول رقم (٣) يلاحظ أن هذا المعامل تراوح بين حد أدنى بلغ حوالي ٠,٢٨ لعام ٢٠٠٣ وحد أعلى بلغ حوالي ٢,٢ لعامي ٢٠٠٦,٢٠١٠ . ومتوسط سنوي بلغ حوالي ١,٣ مما يعني ذلك أن المخزون الاستراتيجي يكفي سنة كاملة ومعها جزء من السنه التي تليها .

جدول (٣) معامل الأمن الغذائي لمجموعة الحبوب خلال الفترة (١٩٩٥-٢٠١٤)

السنوات	مقدار الاستهلاك القومي ألف طن	المخزون الاستراتيجي ألف طن	معامل الأمن الغذائي
١٩٩٥	٨٧٨	٧٥٨,٨	٠,٨٦
١٩٩٦	٨٩٤	٣٧١,٦	٠,٤٢
١٩٩٧	٩١٠	١٢٧٢,٧	١,٤٠
١٩٩٨	٩٢٦	١٦٢١,٩	١,٧٥
١٩٩٩	٩٤٢	٤٠٩,٧	٠,٤٣
٢٠٠٠	٩٦٠	١٢٩١,٧	١,٣٥
٢٠٠١	٩٧٧	١١٧٩,٠	١,٢١
٢٠٠٢	٩٩٥	١٥٦٥,١	١,٥٧
٢٠٠٣	١٠١٢	٢٨٦,٠	٠,٢٨
٢٠٠٤	١٠٣١	٩٨٨,٤	٠,٩٦
٢٠٠٥	١٠٥٠	١٢٧٧,٢	١,٢٢
٢٠٠٦	١٠٦٩	٢٣٥٦,١	٢,٢٠
٢٠٠٧	١٠٨٨	١٦١٧,٠	١,٤٩
٢٠٠٨	١١٠٨	١٣٠٦,٦	١,١٨
٢٠٩	١١٢٨	١٦٧٨	١,٤٩
٢٠١٠	١١٤٩	٢٥٢٢,٨	٢,٢٠
٢٠١١	١١٦٧	١٣٢٣,٤	١,١٣
٢٠١٢	١١٩١	٢٠٢١,٤	١,٧٠
٢٠١٣	١٢١٣	٢٥١٢,٠	٢,٠٧
٢٠١٤	١٢٣٥	١٥٧٠,٠	١,٢٧
المتوسط	**١٠٤٦,١٥**	**١٣٩٦,٤٧**	**١,٣٠**

المصدر: تحليل بيانات جدول (١).

جدول (٢) تطور أهم مؤشرات الأمن الغذائي الليبي من مجموعة اللحوم خلال الفترة (١٩٩٥-٢٠١٤)

السنوات	الإنتاج (ألف طن)	الواردات (ألف طن)	الاستهلاك (ألف طن)	الفجوة الغذائية (ألف طن)	الاستهلاك اليومي (طن / يوم)	فترة تغطية الإنتاج والواردات للاستهلاك المحلي اليومي		
						الإنتاج	الواردات	المجموع
١٩٩٥	١٦٣,٣	٤٦,٤	٢١٩,٥	٥٦,٢	٦٠١,٤	٢٧١,٥	٧٧,١	٣٤٨,٦
١٩٩٦	١٦٣,٤	١٨,٦	٢٢٣,٤	٦٠,٠	٦١٢,١	٢٦٧,٠	٣٠,٣	٢٩٧,٣
١٩٩٧	١٦٨,٢	٢٣,٠	٢٢٧,٥	٥٩,٣	٦٢٣,٣	٢٦٩,٩	٣٦,٨	٣٠٦,٧
١٩٩٨	١٦٧,٠	٣٥,٥	٢٣١,٥	٦٤,٥	٦٣٤,٢	٢٦٣,٣	٥٥,٩	٣١٩,٢
١٩٩٩	١٦٦,٠	١٠,٩	٢٣٥,٧	٦٩,٧	٦٤٥,٨	٢٥٧,١	١٦,٨	٢٧٣,٩
٢٠٠٠	١٧٠,٠	٢٩,٣	٢٤٠,٠	٧٠,٠	٦٥٧,٥	٢٥٨,٥	٤٤,٦	٣٠٣,١
٢٠٠١	٨٤,١	١٠,٨	٢٤٤,٠	١٥٩,٩	٦٦٨,٥	١٢٥,٨	١٦,١	١٤١,٩
٢٠٠٢	١٨٩,٠	١٧,٣	٢٤٨,٦	٥٩,٦	٦٨١,١	٢٧٧,٥	٢٥,٤	٣٠٢,٩
٢٠٠٣	٨٥,٠	٢٢,٧	٢٥٣,١	١٦٨,١	٦٩٣,٤	١٢٢,٦	٣٢,٧	١٥٥,٣
٢٠٠٤	٢٣٠,٠	٢٣,٤	٢٥٧,٧	٢٧,٧	٧٠٦,٠	٣٢٥,٨	٣٣,١	٣٥٨,٨
٢٠٠٥	٢٥٠,٠	٢٩,٣	٢٦٢,٥	١٢,٥	٧١٩,٢	٣٤٧,٦	٤٠,٧	٣٨٨,٣
٢٠٠٦	٢٣٢,٠	٢٨,١	٢٦٧,٢	٣٥,٢	٧٣٢,١	٣١٦,٩	٣٨,٤	٣٥٥,٣
٢٠٠٧	٢٤٥,٠	٣٠,٢	٢٧٢,٠	٢٧,٠	٧٤٥,٢	٣٢٨,٨	٤٠,٥	٣٦٩,٣
٢٠٠٨	٢٦٠,٠	٣٥,٥	٢٧٧,٠	١٧,٠	٧٥٨,٩	٣٤٢,٦	٤٦,٧	٣٨٩,٣
٢٠٠٩	٢٣٠,٠	٣٧,٥	٢٨٢,٠	٥٢,٠	٧٧٢,٦	٢٩٧,٧	٤٨,٥	٣٤٦,٢
٢٠١٠	٢٧٠,٠	٣٣,٤	٢٨٧,٠	١٧,٠	٧٨٦,٣	٣٤٣,٤	٤٢,٥	٣٨٥,٩
٢٠١١	٢٨٢,٠	١٢,٠	٢٩٢,٧	١٠,٧	٨٠١,٩	٣٥١,٧	١٥,٠	٣٦٦,٦
٢٠١٢	٢٨٤,٠	١٣,٧	٢٩٨,٠	١٤,٠	٨١٦,٤	٣٤٧,٩	١٦,٨	٣٦٤,٦
٢٠١٣	٢٨٤,٠	٢٥,٧	٣٠٣,٠	١٩,٠	٨٣٠,١	٣٤٢,١	٣١,٠	٣٧٣,١
٢٠١٤	٢٨٤,٠	٣١,٠	٣٠٩,٠	٢٥,٠	٨٤٦,٦	٣٣٥,٥	٣٦,٦	٣٧٢,١
المتوسط	٢١٠,٤	٢٥,٧	٢٦١,٦	٥١,٩	٧١٦,٦	٢٨٩,٧	٣٦,٣	٣٢٥,٩
حد أعلى	٢٨٤,٠	٤٦,٤	٣٠٩,٠	١٦٨	٨٤٦,٦	٣٥١,٧	٧٧,١	٣٨٩,٣
حد أدنى	٨٤,١	١٠,٨	٢١٩,٥	١٠,٧	٦٠١,٤	١٢٢,٦	١٥,٠	١٤١,٩
مقدار التغير السنوي	٨,٤٤**	غير معنوي	٤,٦٩**	غير معنوي	١٢.٨٦**	٦,٣٨**	غير معنوي	٥,٦*
معدل النمو السنوي	٤,١**	غير معنوي	**	غير معنوي	١,٨**	٢,٣**	غير معنوي	غير معنوي

المصدر : جمعت وحسبت من:-

وزارة الزراعة، قسم الاقتصاد الزراعي، نشرات إحصائية متفرقة وغير منشورة، طرابلس – ليبيا .

جامعة الدول العربية، المنظمة العربية للتنمية الزراعية، الكتاب الإحصائي السنوي خلال السنوات (١٩٩٥-٢٠١٤م)،الخرطوم –السودان.

مصرف ليبيا المركزي، تقارير السنوات (١٩٩٥-٢٠١٤م)، طرابلس –ليبيا.

(٣) فترة تغطية الواردات الليبية للاستهلاك اليومي من مجموعة الحبوب: تعرف هذه الفترة بأنها الفترة التي يمكن أن تغطي فيها الواردات السنوية من مجموعة الحبوب الاحتياجات الغذائية اليومية للسكان وباستعراض بيانات الجدول رقم (١) السابق تبين إن هذه الفترة قد تراوحت بين حد أدنى بلغ حوالي ٣٦٢,٥ يوم عام ٢٠٠٣ وبين حد أعلى بلغ حوالي١٠٨٩,٩ يوم عام ٢٠١٠ ومتوسط سنوي بلغ حوالي ٧٤١,٢ يوم ، وبمقدار تغير سنوي معنوي عند مستوي ١% بلغ حوالي١٦ يوم ، وبلغ معدل النمو السنوي لهذه الفترة حوالي ٢,٤% مما يعني زيادة هذا المعدل عن معدل النمو السنوي للاستهلاك المحلي اليومي والذي بلغ حوالي ١,٨%.

(٤) تقدير المخزون الاستراتيجي الليبي من مجموعة الحبوب: يعرف المخزون الاستراتيجي لسلعة ما بأنه الكميات التي تحتفظ بها الدولة والقطاع الخاص لمواجهة الطلب المحلي المتوقع علي هذه السلعة خلال فترة زمنية مستقبلية ، ويقدر المخزون الاستراتيجي خلال فترة زمنية معينة بأنه محصلة كل من الفائض الموجه لتنمية المخزون الاستراتيجي في بعض السنوات ومقدار العجز الذي يتم سحبه من ذلك المخزون خلال السنوات الأخرى

(١) تطور الإنتاج المحلي من مجموعة اللحوم : باستعراض بيانات جدول (٢) يتبين أن الطاقة الإنتاجية من هذه المجموعة الغذائية قد تراوحت بين حد أدنى بلغ حوالي ٨٤,١ ألف طن عام ٢٠٠١، وحد أعلى بلغ حوالي ٢٨٤ ألف طن عام ٢٠١٣ بمتوسط سنوي بلغ حوالي ٢١٠ ألف طن وبلغ مقدار التغير السنوي حوالي ٨,٤٤ ألف طن ومعدل النمو السنوي ٤,١% ، ولقد ثبتت المعنوية الإحصائية لكل منهما عند مستوي معنوية ٠,٠١.

(٢) تطور الاستهلاك المحلي من مجموعة اللحوم : أما فيما يتعلق بالاستهلاك المحلي من مجموعة اللحوم ومن خلال بيانات جدول (٢) تبين أنه تراوح بين حد أدنى بلغ حوالي ٢١٩,٥ ألف طن عام ١٩٩٥ وحد أعلى بلغ حوالي ٣٠٩ ألف طن عام ٢٠١٤ وبمتوسط سنوي بلغ حوالي ٢٦١,٥ ألف طن وبلغ مقدار التغير السنوي حوالي ٤,٦٩ ألف طن، وبلغ معدل نمو سنوي معنوي حوالي ١,٨% ولقد ثبتت المعنوية الإحصائية لكل منهما عند مستوي معنوية ٠,٠١.

(٣) تطور الفجوة الغذائية من مجموعة اللحوم : فيما يتعلق بالفجوة الغذائية من مجموعة اللحوم فقد تراوحت بين حد أدني بلغ حوالي ١٠,٧ ألف طن عام ٢٠١١ وحد أعلي بلغ حوالي ١٦٨ ألف طن عام ٢٠٠٣ وبمتوسط سنوي بلغ حوالي ٥١,٩ ألف طن ، ولم تثبت المعنوية الإحصائية لكل من مقدار التغير السنوي ومعدل النمو السنوي خلال فترة الدراسة (١٩٩٥-٢٠١٤).

ثالثاً: بعض مؤشرات الأمن الغذائي الليبي لمجموعة الحبوب خلال الفترة (١٩٩٥-٢٠١٤) : يتناول هذا الجزء من البحث مؤشرات الأمن الغذائي لمجموعة الحبوب الغذائية الرئيسية في ليبيا خلال فترة الدراسة، وذلك لحساب معامل الأمن الغذائي بناء علي كل من الإنتاج والاستهلاك وفترة التغطية لكل من الإنتاج والواردات للاستهلاك والفائض والعجز في المخزون الاستراتيجي لهذه المجموعة الغذائية في ليبيا (أمل أبو زايدة ٢٠١٤) وذلك كما يلي:-

(١) الاستهلاك اليومي الليبي من مجموعة الحبوب: باستعراض بيانات جدول (١) السابق يتضح أن الاستهلاك اليومي الليبي من مجموعة الحبوب تراوح بين حد ادني بلغ حوالي ٢٤٠٥,٥ طن/يوم وحد اعلي بلغ حوالي ٣٣٨٣,٦ طن/ يوم، واخذ الاستهلاك اليومي من الحبوب اتجاها تصاعديا معنويا إحصائياً عند ١% بلغ حوالي ٥١,٣ طن يوميا، وبمعدل نمو سنوي معنوي بلغ حوالي ١,٨%.

(٢) فترة تغطية الإنتاج الليبي للاستهلاك اليومي من مجموعة الحبوب: تعرف هذه الفترة بأنها الفترة التي يمكن أن يغطي فيها الإنتاج المحلي الليبي من الحبوب الاحتياجات الغذائية اليومية للسكان ، ومن خلال البيانات الواردة بالجدول رقم (١) والذي يبين فترة هذه التغطية خلال السنوات (١٩٩٥ -٢٠١٤) أنها قد تراوحت بين حد أدنى بلغ حوالي ٥٨,٥ يوم عام ١٩٩٥ وحد أعلى بلغ حوالي ١٥١ يوم عام ١٩٩٩ بمتوسط سنوي بلغ حوالي٩٣,٣ يوم وتبين عدم معنوية معادلة الاتجاه الزمني العام لفترة تغطية الإنتاج للاستهلاك اليومي من مجموعة الحبوب خلال فترة الدراسة عند مستويات المعنوية المألوفة.

الصحة العالمية) (حمد وبسيوني ٢٠٠٣) . وتعكس الفجوة الغذائية من الحبوب الفرق بين الإنتاج المحلي والاستهلاك المحلي منها وتشير بيانات جدول (١) أنها تراوحت بين حد ادني بلغ حوالي ٥٥٢ ألف طن لعام ١٩٩٩ وبين حد اعلي بلغ حوالي ٩٤٦,٦ ألف طن عام ٢٠١١ وبمتوسط سنوي بلغ حوالي ٧٧٩ ألف طن وبعدل نمو سنوي معنوي إحصائيا عند ٠,٠١ بلغ حوالي ١,٩%.

جدول (١). تطور أهم مؤشرات الأمن الغذائي الليبي من مجموعة الحبوب خلال الفترة (١٩٩٥-٢٠١٤)

السنوات	الإنتاج (ألف طن)	الواردات (ألف طن)	الاستهلاك (ألف طن)	الفجوة الغذائية (ألف طن)	الاستهلاك اليومي (طن / يوم)	فترة تغطية الإنتاج والواردات للاستهلاك المحلي اليومي		
						الإنتاج	الواردات	المجموع
١٩٩٥	١٤٠,٨	١٤٩٦	٨٧٨	٧٣٧,٢	٢٤٠٥,٥	٥٨,٥	٦٢١,٩	٦٨٠,٤
١٩٩٦	١٥٢,٢	١١١٣,٤	٨٩٤	٧٤١,٨	٢٤٤٩,٣	٦٢,١	٤٥٤,٦	٥١٦,٧
١٩٩٧	١٦١,٧	٢٠٢١	٩١٠	٧٤٨,٣	٢٤٩٣,٢	٦٤,٩	٨١٠,٦	٨٧٥,٥
١٩٩٨	٢٦٤	٢٢٨٣,٩	٩٢٦	٦٦٢	٢٥٣٧	١٠٤,١	٩٠٠,٢	١٠٠٤,٣
١٩٩٩	٣٩٠	٩٦١,٧	٩٤٢	٥٥٢	٢٥٨٠,٨	١٥١,١	٣٧٢,٦	٥٢٣,٧
٢٠٠٠	٣٢٨	١٩٢٣,٧	٩٦٠	٦٣٢	٢٦٣٠,١	١٢٤,٧	٧٣١,٤	٨٥٦,١
٢٠٠١	٢٧٨	١٨٧٨	٩٧٧	٦٩٩	٢٦٧٦,٧	١٠٣,٩	٧٠١,٦	٨٠٥,٥
٢٠٠٢	٣١٧,١	٢٢٤٣	٩٩٥	٦٧٧,٩	٢٧٢٦	١١٦,٣	٨٢٢,٨	٩٣٩,١
٢٠٠٣	٢٩٣	١٠٠٥	١٠١٢	٧١٩	٢٧٧٢,٦	١٠٥,٧	٣٦٢,٥	٤٦٨,٢
٢٠٠٤	٢٥٦,٦	١٧٦٢,٨	١٠٣١	٧٧٤,٤	٢٨٢٤,٧	٩٠,٨	٦٢٤,١	٧١٤,٩
٢٠٠٥	٣٠١,٢	٢٠٢٦	١٠٥٠	٧٤٨,٤	٢٨٧٦,٧	١٠٤,٧	٧٠٤,٣	٨٠٩,٠
٢٠٠٦	٢٧٤,٨	٣١٥٠,٣	١٠٦٩	٧٩٤,٢	٢٩٢٨,٨	٩٣,٨	١٠٧٥,٦	١١٦٩,٥
٢٠٠٧	٢٤٢,٨	٢٤٦٢,٢	١٠٨٨	٨٤٥,٢	٢٩٨٠,٨	٨١,٥	٨٢٦,٠	٩٠٧,٥
٢٠٠٨	٢٦٧,٦	٢١٤٧,٠	١١٠٨	٨٤٠,٤	٣٠٣٥,٦	٨٨,٢	٧٠٧,٣	٧٩٥,٤
٢٠٠٩	٢٩٠,٥	٢٥١٥,٥	١١٢٨	٨٣٧,٥	٣٠٩٠,٤	٩٤,٠	٨١٤,٠	٩٠٨,٠
٢٠١٠	٢٤٠,٨	٣٤٣١	١١٤٩	٩٠٨,٢	٣١٤٧,٩	٧٦,٥	١٠٨٩,٩	١١٦٦,٤
٢٠١١	٢٢٠,٤	٢٢٧٠	١١٦٧	٩٤٦,٦	٣١٩٧,٣	٦٨,٩	٧١٠,٠	٧٧٨,٩
٢٠١٢	٣١٢,٤	٢٩٠٠	١١٩١	٨٧٨,٦	٣٢٦٣	٩٥,٧	٨٨٨,٧	٩٨٤,٥
٢٠١٣	٣١٠	٣١٤٥	١٢١٣	٩٠٣	٣٣٢٣,٣	٩٣,٣	١٠٢٧,٦	١١٢٠,٩
٢٠١٤	٣٠٢	٢٥٠٣,٣	١٢٣٥	٩٣٣	٣٣٨٣,٦	٨٩,٣	٧٣٩,٨	٨٢٩,٠
المتوسط	**٢٦٧,١**	**٢١٧٥,٤**	**١٠٤٦,١**	**٧٧٩**	**٢٨٦٦**	**٩٣,٣**	**٧٤١,٢**	**٨٤٢,٦**
حد أعلى	**٣٩٠**	**٣٤٣١**	**١٢٣٥**	**٩٤٦,٦**	**٣٣٨٣,٦**	**١٥١,١**	**١٠٨٩,٩**	**١١٦٩,٥**
حد أدنى	**١٤٠,٨**	**٩٦١,٧**	**٨٧٨**	**٥٥٢**	**٢٤٠٥,٥**	**٥٨,٥**	**٣٦٢,٥**	**٤٦٨**
مقدار التغير السنوي	**غير معنوي**	**٤,٢****	**١٨,٧٥****	**١٤,٩****	**٥١,٣****	**غير معنوي**	**١٦***	**١٦***
معدل النمو السنوي	**غير معنوي**	**٤,٢****	**١,٨****	**١,٩****	**١,٨****	**غير معنوي**	**٢,٤***	**٢,١***

المصدر: جمعت وحسبت من :-
وزارة الزراعة، قسم الاقتصاد الزراعي، نشرات إحصائية متفرقة وغير منشورة، طرابلس – ليبيا .
جامعة الدول العربية، المنظمة العربية للتنمية الزراعية، الكتاب الإحصائي السنوي خلال السنوات (١٩٩٥-٢٠١٤م)، الخرطوم – السودان.
مصرف ليبيا المركزي، تقارير السنوات (١٩٩٥-٢٠١٤م)، طرابلس –ليبيا.
(**) معنوي عند مستوي معنوية (٠,٠١) (*) معنوي عند مستوي معنوية (٠,٠٥) .

ثانياً: بعض المؤشرات الاقتصادية للمجموعة الغذائية من اللحوم خلال فترة الدراسة (١٩٩٥-٢٠١٤): تشمل هذه المجموعة الغذائية كل من اللحوم الحمراء والبيضاء، وتعد المصدر الأول والأساسي للبروتين الحيواني الذي يستهلكه سكان ليبيا، ونتيجة لذلك تعد هذه المجموعة الغذائية ذات أهمية عالية في الوجبة الغذائية للفرد الليبي، فلابد من أن تحتوي الوجبة الغذائية على الحد الأدنى منها، وفيما يلي بعض المؤشرات الاقتصادية لهذه المجموعة الغذائية.

١- دراسة بعض المؤشرات الاقتصادية من إنتاج واستهلاك وفجوة غذائية لكل من الحبوب واللحوم خلال الفترة (١٩٩٥-٢٠١٤).

٢ – دراسة بعض مؤشرات الأمن الغذائي لكل من الحبوب واللحوم خلال الفترة (١٩٩٥-٢٠١٤).

الإسلوب البحثي ومصادر البيانات:

يستند هذا البحث على كلا من أسلوبي التحليل الوصفي والتحليل الكمي ممثلاً في تقدير بعض النماذج الاتجاهية للمتغيرات الاقتصادية موضع البحث في صورتها الخطية ونصف اللوغاريتمية في المتغير التابع لاحتساب معدلات النمو السنوية لتلك المتغيرات ، كما تم استخدام بعض المؤشرات الاقتصادية لتقدير المخزون الإستراتيجي ومعامل الأمن الغذائي الليبي من السلع موضع الدراسة. **و**لقد اعتمدت الدراسة على بيانات الإنتاج والاستهلاك المحلي والواردات للسلع الغذائية موضع الدراسة خلال الفترة (١٩٩٥ – ٢٠١٤م) الصادرة عن الجهات الرسمية في ليبيا مثل الهيئة الوطنية للمعلومات والتوثيق وسجلات ووثائق متوفرة لدى مصرف ليبيا المركزي، ووزارة الزراعة والاستصلاح الزراعي وتعمير الأراضي، ومركز البحوث الزراعية وبعض النشرات والمصادر الدولية، كذلك الاستعانة بالدراسات السابقة للاطلاع على ما توصلت إليه من نتائج في هذا الخصوص.

النتائج والمناقشـة

أولا:التحليل الإحصائي لبعض المؤشرات الاقتصادية للمجموعة الغذائية من الحبوب خلال فترة الدراسة (١٩٩٥-٢٠١٤): تعد محاصيل حبوب القمح والشعير من أهم محاصيل الغذاء الأساسية في ليبيا، لذا تبذل الدولة والجهات التنفيذية جهوداً كبيرة لتحسين إنتاجية الحبوب لتحقيق أعلى نسبة من الاكتفاء الذاتي من هذه السلع الغذائية المهمة وبالتالي خفض ما يستورد منها إلى حده الأدنى حتى لا يوثر ذلك سلبا علي الميزان التجاري الزراعي الليبي في حالة زيادة قيمة الواردات الغذائية بمعدلات تفوق زيادة قيمة الصادرات الغذائية الليبية، وفيما يلي بعض أهم المؤشرات الاقتصادية لهذه المجموعة الغذائية :

١- **تطور الإنتاج المحلي من مجموعة الحبوب** : باستعراض بيانات جدول (١) يتبين أن الطاقة الإنتاجية لمجموعة الحبوب قد تراوحت بين حد ادني بلغ حوالي ١٤٠ ألف طن لعام ١٩٩٥ وبين حد اعلي بلغ حوالي ٣٩٠ ألف طن لعام١٩٩٩ ، وبمتوسط سنوي بلغ حوالي إلي ٢٦٧,٢ ألف طن ، وقد تبين عدم ثبوت معنوية معامل الاتجاه العام الزمني للطاقة الإنتاجية من هذه المجموعة الغذائية عند مستويات المعنوية المألوفة والمتعارف عليها وهي(٠,٠٥ ،٠,٠١) حيث يرجع سبب ذلك إلي عدم ثبات مستويات الإنتاج والتذبذب من سنة لآخري خلال فترة الدراسة (١٩٩٥ – ٢٠١٤).

٢- **تطور الاستهلاك المحلي من مجموعة الحبوب** :_وفيما يتعلق بالاستهلاك المحلي من هذه المجموعة الغذائية تبين إن الاستهلاك المحلي تراوح بين حد ادني بلغ حوالي ٨٧٨ ألف طن لعام ١٩٩٥ وبين حد اعلي بلغ حوالي ١٢٣٥ ألف طن لعام ٢٠١٤ ، وبمعدل نمو سنوي معنوي عند مستوي معنوية ١% بلغ حوالي ١,٨%، وبمتوسط سنوي بلغ حوالي ١٠٤٦,١ ألف طن خلال فترة الدراسة (١٩٩٥ -٢٠١٤).

٣- **تطور الفجوة الغذائية من مجموعة الحبوب:** أما بالنسبة لوضع الفجوة الغذائية من مجموعة الحبوب خلال الفترة (١٩٩٥-٢٠١٤) فهي تعتبر اعلي عناصر فجوة الأمن الغذائي المعياري (تعكس الفجوة الغذائية المعيارية ما يحصل عليه الفرد من السعرات الحرارية في اليوم مقارنة مع المتطلبات الأساسية منها والتي توصي بها منظمة

وفي ضوء ما أوضحته الدراسة من نتائج بحثية فقد أمكن التوصل لبعض التوصيات التالية:

١- ضرورة تكثيف جهود الإرشاد الزراعي ومراكز البحوث الزراعية بتوعية الزراع بأهمية مقاومة الآفات والأمراض التي تصيب الحبوب ، ومساعدتهم في الحصول على المبيدات غير الضارة بالبيئة اللازمة لذلك.

٢- زيادة الجدارة الإنتاجية لمحاصيل الحبوب من خلال تعميم الأصناف المرتفعة الإنتاجية والتي تناسب كل منطقة زراعية في ليبيا.

٣- ترشيد استهلاك الحبوب من خلال تقليل حجم الفاقد منها أثناء المراحل التسويقية المختلفة.

٤- لتحقيق الأمن الغذائي لابد من ضرورة إعداد برامج توعية للمستهلكين حيث أنها من أهم العوامل المحددة للطلب على واردات الحبوب واللحوم في ليبيا..

تمهيد:

تعتبر مجموعة الحبوب واللحوم من السلع الغذائية الإستراتيجية الأساسية الهامة في الأهمية الإستهلاكية للمستهلك الليبي ، وقد أصبح تحقيق الأمن الغذائي من المحاصيل الغذائية الرئيسية بصفة عامة والحبوب واللحوم بصفة خاصة هدفاً قومياً لارتباطه بالنواحي السياسية والاقتصادية والاجتماعية خاصة في ظل العولمة. ويتصدر موضوع الأمن الغذائي اهتمامات العديد من الدول والمنظمات والهيئات الدولية والمؤسسات العلمية وغيرها، حيث يمثل الغذاء الحاجة الأساسية لاستمرار حياة الإنسان، فهو مصدر الطاقة اللازمة لنشاطه والذي بدوره يتوقف على نوع وكمية الغذاء التي يحصل عليها . لذلك تأتي أهمية موضوع الأمن الغذائي لجميع دول العالم في المرتبة الأولى للموضوعات التي تواجه سكان دول العالم لما لها من أهمية في حاضرهم ومستقبلهم الاقتصادي والسياسي ، فعندما لا يتوفر لديهم الغذاء بالقدر الكافي وبالنوعية المناسبة يكونون أمام حالة فقدان للأمن الغذائي (بسيوني ١٩٩٨، ٢٠١٥، ٢٠١٧).

مشكلة البحث:

تعد مشكلة تحقيق الأمن الغذائي محلياً من أهم المشاكل التي تواجه الاقتصاديين في ليبيا في حاضرهم ومستقبلهم الاقتصادي والسياسي، ويرتبط تحقيق الاستقلال السياسي لها من خلال ممارسة السيادة على أرضها بما تحققه من استقلال اقتصادي، وبمدى تحقيقها لأهداف وخطط التنمية الاقتصادية النابعة من واقعها الاقتصادي والاجتماعي، والتي من أهمها تحقيق نسبة عالية من الاكتفاء الذاتي في إنتاج المحاصيل الغذائية الضرورية للسكان بغية تحقيق الأمن الغذائي للمجتمع. وحيث تتأثر كمية ونوعية المعروض من السلع الغذائية في ليبيا، بالعديد من المحددات الطبيعية والتي تؤثر على أداء القطاع الزراعي بليبيا والتي من أهمها المياه ومساحة وجودة التربة الصالحة للزراعة، وإن استمرار العجز في الميزان الغذائي للمواطن الليبي مقارنة بالإنتاج المحلي والاعتماد على الاستيراد لأهم المكونات الغذائية الأساسية، يشكل مشكلة أمنية غذائية لليبيا، تثير القلق وعدم الشعور بالأمن والطمأنينة لدى المواطن في ليبيا .

أهداف البحث:

تهدف هذه الدراسة بصفة عامة إلى التعرف على وضع الأمن الغذائي في ليبيا ودراسة المحددات التي تؤثر بشكل واضح على توفير السلع الغذائية محليا ،ويمكن تحقيق ذلك الهدف الرئيسي من خلال تحقيق الأهداف الفرعية التالية :

الأمن الغذائي الليبي للحبوب واللحوم

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الملخص: يستهدف هذا البحث بصفة رئيسية التحليل الاقتصادي للفجوة الغذائية والأمن الغذائي الليبي من مجموعة الحبوب واللحوم من خلال دراسة عدة أهداف فرعية تمثلت في : تقدير نماذج الاتجاهات العامة الزمنية لبعض المؤشرات الاقتصادية لمجموعة الحبوب واللحوم في ليبيا خلال الفترة (١٩٩٥– ٢٠١٤) ودراسة أهم مؤشرات الأمن الغذائي الليبي للسلع موضع الدراسة، وتقدير حجم الفجوة الغذائية منها.

تبين من دراسة نماذج الاتجاه العام الزمني المقدرة للمؤشرات الاقتصادية موضع البحث أن كل من الواردات والاستهلاك المحلي والفجوة الغذائية والاستهلاك اليومي وفترة تغطية الواردات للاستهلاك المحلي اليومي من مجموعة الحبوب قد أخذت اتجاها عاماً تصاعدياً معنوياً إحصائياً عند المستوى الاحتمالي (٠.٠١) فيما عدا متغير وفترة تغطية الواردات للاستهلاك المحلي كانت معنوية عند ٠,٠٥، وكذلك لم تتبين المعنوية الإحصائية لفترة تغطية الإنتاج للاستهلاك اليومي عند مستويات المعنوية المألوفة (٠,٠٥ ، ٠.٠١) ، بينما اختلفت معدلات النمو السنوي وفقا لكل متغير، وتبين من دراسة نماذج الاتجاه العام الزمني المقدرة للمؤشرات الاقتصادية موضع البحث أن كل من الإنتاج المحلي والاستهلاك المحلي والاستهلاك اليومي وفترة تغطية الإنتاج للاستهلاك المحلي اليومي من مجموعة اللحوم قد أخذت اتجاها عاماً تصاعدياً معنوياً إحصائياً عند المستوى الاحتمالي (٠,٠١) فيما عدا متغير مجموع فترتي تغطية الإنتاج والواردات للاستهلاك المحلي اليومي كانت معنوية عند ٠,٠٥، وكذلك لم تتبين المعنوية الإحصائية لكمية الواردات من اللحوم لفترة تغطية الواردات للاستهلاك اليومي عند مستويات المعنوية المألوفة (٠,٠٥ ، ٠,٠١) ، بينما اختلفت معدلات النمو السنوي وفقا لكل متغير.

وأوضحت الدراسة أن المخزون الإستراتيجي للحبوب يقدر بحوالى١٣٩٦,٤٧ ألف طن ومتوسط الاستهلاك القومي للحبوب يقدر بحوالي ١٠٤٦,١٥ ألف طن خلال فترة الدراسة (١٩٩٥–٢٠١٤) ، بالتالي يقدر الأمن الغذائي بحوالي ١,٣ ولذلك ويعني ذلك أن المخزون الإستراتيجي للحبوب يكفي سنه كاملة ومعها جزء من السنه التي تليها ، ويرجع ذلك إلي زيادة المتوسط السنوي لكمية الواردات أكثر من احتياجات الأفراد السنوية لضمان تواجد مخزون إستراتيجي باستمرار.

كما أوضحت الدراسة أن المخزون الإستراتيجي للحوم كان سالبً وقدر بحوالي –٢٥,٥ ألف طن ومتوسط الاستهلاك القومي للحوم يقدر بحوالي ٢٦١,٥ ألف طن خلال فترة الدراسة (١٩٩٥–٢٠١٤) ، بالتالي يقدر الأمن الغذائي بحوالي – ٠,٢ ولذلك ويعني ذلك أن المخزون الإستراتيجي للحبوب يكفي سنه كاملة ومعها جزء من السنه التي تليها ولذلك يتطلب الأمر اتخاذ مختلف الإجراءات التي تؤدى إلى زيادة حجم المخزون الاسترتيجى للحوم لتكفى نصف الاحتياجات منها للاستهلاك المحلى حتى تقترب قيمة معامل الأمن الغذائي على الأقل من الواحد الصحيح .

An Economical Analysis for Affecting Factors on Quality of some Food and Industrial Commodities (Case Study: Kalubia Governorate)

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ABSTRACT: The research aims to study the factors affecting the cost of quality, namely the costs of prevention and evaluation, internal and external failure costs, budget for quality, loss of quality (poor quality costs), and estimation of general trend function, and the quality budget in terms of the time element, where there is a general trend of the cost of prevention and the costs of external failure, while a general trend of time was found to contradict the other variables. It has been used analysis methods of statistical quantitative to determine the most independent variables affect the actual costs of quality and show that Poor quality costs are more effective in the actual total cost of quality variables, and this is consistent with the logic where the poor quality costs reflect both internal and external costs of failure, therefore, they mask the effect of both the actual total cost of quality, and the results indicate that the increase in poor quality by one thousand pounds costs lead to increase the overall quality of the actual costs by 510 pounds, has multiple regression equation estimates suggested using the analysis method only. The logistic regression is used to estimate the effect of factors influencing the consumer choice of quality of agricultural and food commodities after excluding the profession variable because of strong correlation between the profession and the consumer's income to a positive relationship at a significant level of 0.01 between consumer income and preference for high quality goods. Education degree to consumers by 1% greater the degree of orientation to buy high quality goods by 1.45%. The results also showed that independent factors combined explain about 74% of the changes occurring in the dependent variable. The study recommended that the budget allocations for prevention and evaluation costs should be increased, thus reducing the cost of poor quality (internal and external failure). The gap between the quality budget and the total actual quality costs will be reduced, thus reducing quality loss resulting from poor quality. Assessments such as tests and experiments conducted in order to ensure the safety and quality of products and compliance with standards and quality standards to reduce the size of the returns costs.

وتشير تقديرات المعادلة إلى وجود علاقة طردية عند مستوى ٠,٠١ بين دخل المستهلك وتفضيله للسلع العالية الجودة ، إذ كلما زاد دخل المستهلك ١% كلما زاد تفضيله لشراء السلع الجيدة بنسبة ٤,٨٤% ،أى قرابة خمسة أضعاف ، كما يشير معامل الانحدار أنه كلما زادت درجة التعليم للمستهلكين بنسبة ١% كلما زادت درجة توجهه لشراء السلع المرتفعة الجودة بحوالى ١,٤٥% ، وقد تبين أيضاً من تقديرات المعادلة أن العوامل المستقلة مجتمعه تفسر نحو ٧٤% من جملة التغيرات الحادثة في المتغير التابع .

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سجلات شركة قها للصناعات الغذائية " مدينة قها " محافظ القليوبية.

العلاقة بين الجودة والمتغيرات المستقلة المدروسة:

لتقدير الجودة وعلاقتها بالمتغيرات المستقلة موضع الدراسة والسابق الإشارة إليها تم دراسة مصفوفة معاملات الارتباط البسيطة لسبيرمان بين الجودة كمتغير تابع وكل من المتغيرات المستقلة وهى دخل المستهلك ومهنة المستهلك بالإضافة إلى الحالة التعليمية وذلك للتحقق من مدى وجود ازدواج خطى بين المتغيرات المستقلة من عدمه فضلاً عن دراسة الارتباط بين الجودة وكل من هذه المتغيرات .

وتشير البيانات الواردة بالجدول (٦) والخاص بمصفوفة معاملات الارتباط البسيطة أن هناك ارتباط موجب بين الجودة وكل من الدخل ومهنة المستهلكين وكذلك الحالة التعليمية.

جدول (٦) مصفوفة معاملات الارتباط لسبيرمان بين الجودة والمتغيرات المستقلة المدروسة

المتغيرات	الجودة	الحالة التعليمية	المهنة	المساحة
الجودة	١			
الحالة التعليمية	٠,٣٣٦	١		
المهنة	٠,٤٧٠	٠,٢١٢	١	
الدخل	٠,٥٤٠	٠,٢٨٢	٠,٨٠٣	١

المصدر : نتائج تحليل بيانات استمارة الاستبيان الخاصة بالدراسة.

التقدير الكمي للجودة:

لتحديد دور كل متغير من المتغيرات المستقلة على أهمية جودة السلع الزراعية والغذائية فقد تم استخدام أسلوب تحليل الانحدار اللوجستى لتقدير معادلة الانحدار المتعدد لتقدير أثر تلك العوامل في التأثير على إختيار المستهلك لجودة السلع الزراعية والغذائية وذلك بعد إستبعاد متغير المهنة لوجود إرتباط قوى بين المهنة ودخل المستهلك حيث بلغ نحو ٠,٨٠٣ وكانت النتائج على النحو المبين بالمعادلة (٢) التالية :-

$$\hat{Y}_i = -1.99 + 4.84\,X_1 + 1.45\,X_2 \quad \text{..... ....(2)}$$
$$(-.934)^{**} \qquad (5.83)^{**} \quad (2.04)^{*}$$

$$F = 17.07 \qquad R^2 = 0.74$$

(Y):تعبر عن جودة السلع الزراعية والغذائية كمتغير صوري يأخذ القيمة (١) في حالة الجودة والقيمة (صفر) في حالة عدم الجودة .

(X_1) : يعبر عن الدخل حيث يأخذ القيمة (١) للدخول المثلى والقيمة (صفر) للدخول الأخرى .

(X_2) :تعبر عن الحالة التعليمية للمزارعين كمتغير صوري يأخذ القيمة (صفر) في حالة الحاصلين على درجه تعليمية دون المتوسط بالإضافة إلى المؤهل المتوسط وفوق المتوسط ، والقيمة (١) للحاصلين على مؤهل عالي .

(i): ١,٢ ،٣ ،٤ ، ١١٠

٢- الحالة التعليمية :

يتضح من الجدول (٤) أن قرابة ١١% من مبحوثى العينة حصلوا على درجة تعليمية دون التعليم المتوسط والتي تشمل الحاصلين على الإعدادية والابتدائية وما دون ذلك ، في حين مثل المبحوثين الحاصلين على درجة تعليم متوسط وفوق المتوسط حوالى٤٠% من العينة، أما المبحوثين الحاصلين على مؤهل عالي فيمثلون نحو ٤٩% من حجم العينة ٠وقد بلغ أقصى نسبة لتكرار إختيار الجودة بالعينة للجاصلين على مؤهل عالى حيث بلغت حوالى ٤٧% ، ويمكن تفسير ذلك إلى أنه كلما زادت درجة التعليم كلما ارتفعت درجة الوعي والمعرفة بالأخطار الاقتصادية والصحية التي تسببها المنتجات الزراعية والغذائية ذات الجودة المنخفضة ، ومن ثم الحرص على شراء المنتجات الجيدة في أضيق الحدود٠

جدول (٤). العلاقة بين الحالة التعليمية وجودة السلع الزراعية والغذائية

الفئة	حجم العينة	% للعينة	تكرار إختيار الجودة	% للتكرار
دون التعليم المتوسط	١٢	١٠,٩	٩	١٢,٨٦
متوسط – فوق المتوسط	٤٤	٤٠,٠٠	٢٨	٤٠,٠٠
مؤهل عالي	٥٤	٤٩,٠٠	٣٣	٤٧,١٤
الإجمالي	١١٠	١٠٠,٠٠	٧٠	١٠٠,٠٠

المصدر : جمعت وحسبت من بيانات استمارة الاستبيان

٣- المهنة:

باستعراض بيانات الجدول(٥) يتضح ارتفاع نسبة المبحوثين فى حالة احتراف مهنة إضافية إلى جانب المهنة الأساسية حيث قدرت بنحو ٥٧% عن إمتهان مهنة أساسية فقط والبالغ نسبتهم ٤٣%، وذلك يتوافق مع المنطق حيث تظهر حاجة الأسر إلى زيادة الدخل لمواجهة إرتفاع الأسعار الناتج عن زيادة معدلات التضخم ، وإرتفاع أسعار العملة الأجنبية والتى تؤثر على أسعار الواردات من السلع الغذائية، ومن ثم تتناقص القدرة الشرائية لدخولهم الحالية ولذا كان عليهم البحث عن مهن أخرى لمضاعفة دخولهم حتى يتثنى لهم الحصول على إحتياجاتهم الأساسية من السلع الغذائية .

جدول (٥) العلاقة بين المهنة وجودة السلع الزراعية والغذائية

المهنة	العدد	للعينة %	تكرار إختيارالجودة %	للتكرار
مهنة أساسية	٤٧	٤٣,٠٠	٣١,٤٣	٢٢
المهنة الأساسية +مهنة أخرى	٦٣	٥٧,٠٠	٤٨,٠٠	٦٨,٥٧
الإجمالي	١١٠	١٠٠,٠٠	٧٠,٠٠	١٠٠

المصدر : جمعت وحسبت من بيانات استمارة الاستبيان

ومما هو جدير بالذكر أن ارتفاع نسبة الجودة للمستهلكين الذين يمتهنون مهنة اضافية عن نظرائهم الذين يمتهنون مهنة أساسية فقط ، ويمكن تفسيره في حالة العمل بمهنة أخرى إلى وجود مصدر إضافي للدخل يتمكن المستهلك من خلاله توفير إحتياجاتة من السلع الزراعية والغذائية ذات الجودة المناسبة وخصوصاً وأن السلع العالية الجودة تتسم بارتفاع أسعارها .

جدول (٢) مصفوفة معاملات الإرتباط البسيط بين تكاليف الجودة الكلية الفعلية والمتغيرات المدروسة

المتغير	تكاليف الجودة	ميزانية الجودة	فقد الجودة	تكاليف المنع	تكاليف التقييم	تكاليف الفشل الداخلى	تكاليف الفشل الخارجى	كمية الإنتاج	تكاليف مستلزمات الإنتاج	المبيعات
تكاليف الجودة	1									
ميزانية الجودة X1	0.542**	1								
فقد الجودة X2	0.549**	0.311-	1							
تكاليف المنع X3	0.151	0.729-**	0.761	1						
تكاليف التقييم X4	0.345-	0.322-	0.041-	0.101	1					
تكاليف الفشل الداخلى X5	0.313	0.991**	0.594-	0.746-	0.317-	1				
تكاليف الفشل الخارجى X6	0.107	0.399-	0.518	0.526-	0.024	0.426-	1			
كمية الإنتاج X7	0.250-	0.124-	0.025-	0.108	0.166-	0.131-	0.063	1		
تكاليف ستلزمات الإنتاج X8	0.05	0.35	0.23-	0.272-	0.301-	0.348	0.056-	0.097	1	
المبيعات X9	0.165-	0.265	0.294-	0.212-	0.280-	0.222	0.321	0.075	0.493	1

جمعت وحسبت من بيانات عينة الدراسة

ثالثاً:التحليل الإحصائى لجودة السلع الزراعية والمصنعة للمستهلك:

يتناول هذا الجزء التحليل الإحصائى الوصفي والكمي لمتغيرات عينة الدراسة ، حيث تم دراسة بعض المتغيرات الإقتصادية والإجتماعية وتأثيرها على إختيار المستهلك لجودة السلع الزراعية والغذائية ، وهى دخل المستهلك ، والحالة التعليمية ، ومهنة المستهلك (بسيونى، سوزان ،٢٠١٠)، وقد تمثلت شاملة هذا البحث فى جميع الأسر القاطنيين فى محافظة المنوفية(جهة سكن وعمل الباحثة)، وقد تم أخذ عينة عمدية عشوائية تمثلت فى مركزى منوف وشبين الكوم وذلك بواقع ٦٠،٥٠ مبحوث على الترتيب، وقد اعتمد على الإستبيان بالمقابلة الشخصية لأرباب الأسر بصفتهم مسئولين عن أسرهم ويعبرون عن {رائهم ، وقد تم إختيارة مبدئياً لمعرفة أوجة القصور بغرض تعديلها. وتم الإستعانة ببعض الأساليب والادوات الإجصائية لتحليل البيانات الأولية المستمدة من الدراسة الميدانية، وإنحصرت هذة الأساليب فى التكرارات والأهمية النسبية كتحليل وصفى ، والإنحدار اللوجستى كتحليل كمى وفيما يلي استعراض لمتغيرات الدراسة المتوقع أن يكون لها تأثير على درجة إختيار المستهلك لجودة السلع الزراعية والغذائية .

١ – الدخل:

تم تصنيف مبحوثى العينة تبعاً لدخل الأسرة إلى ثلاث فئات ، الأولى منها المبحوثين الذين تبلغ دخلهم الأسرى أقل من ألفين جنية ، والثانية تبلغ دخول الأسرة لديهم من ألفين إلى أقل من أربعة آلاف، أما الفئة الثالثة فتبلغ الدخول لديهم من أربعة الاف جنيه فأكثر كما هو موضح بالجدول (٣) ، والتى تمثل ٥٠% من عدد إختيارات جودة السلع الزراعية والمصنعة لمستهلكى العينة .

جدول (٣) العلاقة بين دخل المبحوثين وجودة السلع الزراعية والغذائية

الفئة	حجم العينة	% للعينة	تكرار إحتيار الجودة	% للتكرار
اقل من ألفين	٣٠	٢٧,٣	٥	٧,١٤
من ٢ لأقل من ٤ألف	٥٥	٥٠,٠٠	٣٠	٤٢,٨٦
من ٤ آلاف فأكثر	٥٢	٢٢,٧	٣٥	٥٠,٠٠
الإجمالي	١١٠	١٠٠,٠٠	٧٠	١٠٠,٠٠

المصدر : جمعت وحسبت من بيانات استمارة الاستبيان

(١) مصفوفة معاملات الإرتباط بين تكاليف الجودة الفعلية والمتغيرات المدروسة

تم تقدير معاملات الإرتباط البسيط بين تكاليف الجودة الفعلية ومتغيرات الدراسة فى عينة الدراسة خلال الفترة من يوليو٢٠١٣ إلى يونيه ٢٠١٥ لمعرفة مدى تأثير تلك المتغيرات على تكاليف الجودة بالإضافة الى التحقق من مدى ارتباط تلك المتغيرات وبعضها البعض ، وذلك لعدم تعرض النموذج لوجود مشكلة الازدواج بين المتغيرات المستقلة . وقد تبين من الجدول (٢) أن تكاليف الجودة الكلية (Y) ترتبط إرتباطاً معنوياً مع كل من ميزانية الجودة (X_1)،فقد الجودة (X_2) حيث بلغت قيمة معاملات الإرتباط حوالى ٠,٥٤٢، ٠,٥٩٤ على التوالى. كما بين الجدول (٢) عدم ثبوت معنوية الإرتباط بين تكاليف الجودة وكل من تكاليف المنع (X_3) ، تكاليف التقييم (X_4) تكاليف الفشل الداخلى(X_5) تكاليف الفشل الخارجى(X_6) ، كمية الإنتاج (X_7) ، تكاليف مستلزمات الإنتاج (X_8) ، المبيعات(X_9) ، حيث بلغ معامل الإرتباط البسيط نحو ٠,١٥١ ، ٠,٣٤٥ ، ٠,٣١٣ ، ٠,١٠٧ ، ٠,٠٥٠،٠,٢٥٠ ، ٠.١٦٥ على الترتيب. كما أوضحت مصفوفة معاملات الإرتباط العلاقة بين المتغيرات المستقلة وبعضها البعض ، حيث تبين وجود إرتباطاً بين فقد الجودة وتكاليف المنع وتكاليف الفشل الداخلى والخارجى حيث بلغ معامل الإرتباط البسيط بينهماحوالى ٠,٧٦١ ٠,٥٩٤ ، ٠,٥١٨ على الترتيب وذلك على النحو المبين بالجدول (٢)

٢) النموذج القياسى لدالة تكاليف الجودة الكلية الفعلية

تم تقدير دالة انحدار تكاليف الجودة الكلية الفعلية كمتغير تابع (Y) لبعض العوامل المستقلة ذات التأثير على تكاليف الجودة الفعلية كما اتضح من مصفوفة معاملات الإرتباط وهى ميزانية الجودة (X_1) ، فقد الجودة (X_2) ، وقد تم تطبيق اسلوب الإنحدار Step wise method لتحديد أكثر المتغيرات المستقلة تأثيراً فى تكاليف الجودة الفعلية وتبين أن تكاليف الجودة الرديئةهى أكثر المتغيرات تأثيراً فى تكاليف الجودة الكلية الفعلية، وهذا ما يتفق مع المنطق حيث ان تكاليف الجودة الرديئة (فقد الجودة) تعكس كل من تكاليف الفشل الداخلى والخارجى كما سبق الإشارة الية سابقاً ، ولذا فإنها تحجب تأثير كلا من تكاليف الفشل الداخلى والخارجى فى المتغير التابع (تكاليف الجودة الكلية الفعلية) ،إلا ان إنخفاض معاملات الإرتباط بين تكاليف الجودة الكلية الفعلية وتكاليف المنع والتقييم يشير إلى ضرورة الإهتمام بتطبيق أنظمة وممارسات الجودة الشاملة بالمصنع وذلك بالرغم من ثبوت المعنوية لإتجاة الشركة لزيادة تكاليف المنع بنحو ٠,٧% شهرياً كما أوضحتة المعادلة السابقة رقم (١) وهذا يعتبر مؤشر جيد لأداء إدارة الشركة ، إلا أن ثبوت المعنوية لإتجاة الشركة لخفض ميزانية الجودة بمعدل يقدر بنحو ١,٣% شهرياً يقلل من فاعلية الإتجاة الأول ، ومن ثم يتوجب زيادة المخصصات الموجهة لبنود تكاليف التقييم والمنع لخفض حالات عدم التطابق ومن ثم تناقص تكاليف الفشل الداخلى والخارجى . وتشير تقديرات المعادلة (٤) السابقة أن زيادة تكاليف الجودة الرديئة بمقدار ألف جنيه تؤدى إلى زيادة تكاليف الجودة الفعلية بمقدار ٥١٠ جنيه ، وقد تبين أيضاً من تقديرات المعادلة أن تكاليف الجودة الرديئة تفسر نحو ٩٢% من جملة التغيرات الحادثة في المتغير التابع .

$$\hat{Y}_i = 1007131 + 0.51\ X2 \quad \text{.....(1)}$$
$$(20.08)^{**} \qquad (3.02)^{*}$$
$$R^2 = 0.93 \qquad R^{\backslash 2} = 0.92 \qquad F = 129.98$$

ويشير معامل التحديد أن عنصر الزمن يفسر نحو ١٥% من التغيرات التى تحدث لميزانية الجودة خلال فترة الدراسة والباقى يرجع إلى عوامل أخرى غير مرتبطة بالزمن ولم يشملها النموذج المقدر.

هـ- الإتجاه العام لفقد الجودة: وبدراسة الاتجاه الزمني العام لتطور تكاليف الجودة الرديئة خلال فترة الدراسة باستخدام النماذج الرياضية المختلفة تبين أن الشكل التربيعى هو أفضل النماذج الرياضية لشرح تلك العلاقة كما هو موضح بالمعادلة (٥).

جدول (١) معادلات الاتجاه الزمني العام لتطور فئات تكاليف الجودة الكلية بشركة قها للصناعات الغذائية

رقم المعادلة	البيـان	معادل الاتجاه الزمني العام	معامل التحديد R^2	قيمة F
١	تكاليف المنع	$\text{Ln } \hat{Y}_1=79811+0.007\ X_i$ (28.74) ** (29)*	٠,٢٤	٨,٤٣
٢	تكاليف الفشل الداخلي	$\text{Ln } \hat{Y}_2= 1030044\ 0 - .016$ (10.85)** (-2.4)*	٠,١٨	٥,٨٨
٣	تكاليف الفشل الخارجي	$\hat{Y}_3= 88464+4370\ X_i$ (5.70)* (4.02)*	٠,٤٠	١٦,٤
٤	ميزانية الجودة	$\text{Ln } \hat{Y}_4=1038-0.031\ X_i$ (10.85) (-2.4)	٠,١٥	٤,٩٤
٥	فقد الجودة	$\hat{y} = 315.24-33.83X_i+1.69X^2_i$ (3.03)* (-1.76) (2.27)*	٠,٢٢	٤,٣٠

**: معنوي عند مستوى ٠,٠١

*: معنوي عند مستوى ٠,٠٥

جمعت وحسبت من بيانات الدراسة، سجلات شركة قها للصناعات الغذائية، مدينة قها بمحافظة القليوبية.

حيث: Y^1 تشير إلى القيمة التقديرية لتكاليف المنع بالجنية في الشره (i)

Y^2 تشير إلى القيمة التقديرية لتكاليف الفشل الداخلي بالجنية في الشهر (i)

Y^3 تشير إلى القيمة التقديرية لتكاليف الفشل الخارجي بالجنية في الشهر (i)

Y^4 تشير إلى القيمة التقديرية لتكاليف ميزانية الجودة بالألف جنية في الشهر (i)

Y^5 تشير إلى القيمة التقديرية لتكاليف فقد الجودة بالألف جنية في الشهر (i)

تشير إلى متغير الزمن خلال فترة الدراسة (i) X

القيم بين الأقواس تشير إلى قيمة t المحسوبة

ثانياً: التقدير القياسى لدالة الإنحدار لتكاليف الجودة الكلية الفعلية:-

سوف يتم تقدير دالة الان حدار لتكاليف الجودة الكلية الفعلية وذلك بإستخدام اسلوب الانحدار التدريجى Step wise method باستخدام برنامج التحليل الإحصائى SPSS V.20 ، ويسبقه تقدير معاملات الإرتباط البسيط بين كل من فئات تكاليف الجودة والمتغيرات المدروسة لكل منها على حدة ، مع إدخال بعض المتغيرات التى يمكن أن يكون لها تأثير على تكاليف الجودة الكلية وهى كمية الإنتاج ، قيمة مستلزمات الإنتاج ، وقيمة المبيعات .

المعاد تشغيله ، ثم فاقد العبوات وعلب المشغولات وإعدامات الإنتاج وساعات الأعطال (٤) – تكاليف الفشل الخارجى وتنحصر بنود تكاليف الفشل الخارجى بمصنع دراسة الحالة على مرتجعات المبيعات للوكلاء والمستهلك النهائى نتيجة العيوب التصنيعية والتلف أثناء التخزين والنقل والتداول (عبد الرازق، ٢٠١٣).

(١) الإتجاه العام لفئات تكاليف الجودة:

يتناول هذا الجزء تقدير معادلات الإتجاة الزمنى العام لفئات تكاليف الجودة ، لدراسة مدى تأثر تكاليف الجودة بشركة قها بعنصر الزمن خلال الفترة من السنة المالية (٢٠١٣/٢٠١٤) إلى السنة المالية (٢٠١٤/٢٠١٥)حيث لم تثبت معنوية تأثير عنصر الزمن على تكاليف التقييم عند المستويات المعنوية المألوفة(٠,٠١،٠,٠٥)، فى حين تم ثبوتها لكل من تكاليف المنع وتكاليف الفشل الداخلى وتكاليف الفشل الخارجى.

أ- **الإتجاه العام لتكاليف المنع :** بدراسة الاتجاه الزمني العام لتطور تكاليف المنع خلال فترة الدراسة باستخدام العديد من النماذج الرياضية تبين ثبوت معنوية تأثير عنصر الزمن على تلك التكاليف وأن الدالة الأسية تعد أفضل النماذج الرياضية لتوضيح تلك العلاقة كما هو موضح بالجدول (١)، وتوضح تقديرات المعادلة رقم (١) أن تكاليف المنع تزداد زيادة معنوية بمعدل تغير شهرى بلغ حوالى ٠,٧% خلال الفترة من يوليو ٢٠١٣ حتى يونيه ٢٠١٥ ، ويشير معامل التحديد أن نحو ٢٤% من التغيرات الحادثة فى تكاليف المنع خلال فترة الدراسة تعزى إلى عنصر الزمن والباقى يرجع إلى عوامل أخرى لم يشملها النموذج.

ب- **الإتجاه العام لتكاليف الفشل الداخلى :**تبين من خلال دراسة الاتجاه الزمني العام لتطور تكاليف الفشل الداخلى خلال فترة الدراسة وباستخدام النماذج الرياضية ثبوت معنوية تأثير عنصر الزمن على تلك التكاليف وأن الدالة الأسية تعد أفضل الأشكال الرياضية لتوضيح تلك العلاقة وذلك كما توضحه تقديرات المعادلة (٢) بالجدول(١) ، حيث يتضح أن تكاليف الفشل الداخلى تتناقص بمعدل ١,٦% شهرياً خلال الفترة من يوليو ٢٠١٣ حتى يونيه ٢٠١٥ ، وهذا يعتبر مؤشر جيد ، ويشير معامل التحديد أن عنصر الزمن يفسر نحو ١٨% من التغيرات التى تؤثر على تكاليف الفشل الداخلى خلال فترة الدراسة والباقى يعزى إلى عوامل أخرى لم يشملها النموذج.

ج- **الإتجاه العام لتكاليف الفشل الخارجى(المرتجعات):** وبدراسة الاتجاه الزمني العام لتطور تكاليف الفشل الخارجى خلال فترة الدراسة باستخدام العديد من النماذج الرياضية المختلفة تبين ثبوت معنوية تأثير عنصر الزمن على تلك التكاليف وأن الدالة الخطية تعد أفضل النماذج الرياضية لتوضيح تلك العلاقة عند مستوى معنوية (٠,٠١) ، وأن تكاليف الفشل الخارجى تزداد زيادة معنوية بمقدار تغير حوالى ٤٣٧٠جنية شهرياً خلال الفترة من يوليو ٢٠١٣ حتى يونيه ٢٠١٥ ، ويشير معامل التحديد إلى أن نحو ٤٠% من التغيرات الحادثة فى قيمة المرتجعات خلال فترة الدراسة يفسرها عنصر الزمن ونحو٦٠% ترجع إلى عوامل أخرى وذلك كما توضحه المعادله (٣) بالجدول (١)

د- **الإتجاه العام لميزانية الجودة:** وبدراسة الاتجاه الزمني العام لتطور مخصصات الجودة بالموازنة خلال فترة الدراسة باستخدام العديد من النماذج الرياضية أوضحت تقديرات المعادلة رقم (٤) بجدول (١) ثبوت معنوية تأثير عنصر الزمن على تلك التكاليف، وأن الدالة الأسية تعد أفضل النماذج الرياضية لتوضيح تلك العلاقة. وتوضح المعادلة (٤) أن ميزانية الجودة تتناقص بمعدل ١,٣% شهرياً خلال الفترة من يوليو ٢٠١٣ حتى يونيه ٢٠١٥ ،

دور شبكات الإتصالات والمعلومات والإنترنت والتى تتسم بشدة التغيير والتعقيد، وحفاظاً على صحة الإنسان من السلع الغذائية الملوثة أو المغشوشة فقد أصبح موضوع جودة المنتجات الزراعية للحاصلات الزراعية والسلع المصنعة من أهم الموضوعات التى يجب أن تؤخذ فى الإعتبار (بسيونى، ٢٠٠٧).

المشكلة البحثية

تبلورت أهمية تطبيق نظام إدارة الجودة الشاملة للإرتفاع بمستوى جودة الإنتاج وزيادة حجمه وتحسين اقتصادياته بالتقليل من الفاقد والانتاج غير المطابق للمواصفات القياسية ، ولكى تكون الشركات المصرية فى موقف تنافسى متميز يجب أن توظف كل إمكانياتها لإيجاد سلع وخدمات ذات جوده عالية وبسعر يلبى إحتياجات المستهلك ورغباته فى الأسواق المحلية والعالمية والتوجه بالصناعة المصرية نحو الإنتاج بغرض التصدير لغزو الاسواق الخارجية بصفة عامة والعربية والافريقية بصفة خاصة.

أهداف البحث

يهدف البحث إلى دراسة العوامل المؤثرة على فئات تكاليف الجودة لتحديد المستوى الأمثل للجودة، والتى يتساوى عندها مقدار الزيادة فى تكاليف المنع والتقييم مع الخفض فى تكاليف الفشل الداخلى والخارجى ، وشرح سلوك تكاليف الجودة ، بالإضافة إلى دراسة وتحليل العلاقة بين بعض الخصائص الإقتصادية والإجتماعية للمستهلك ودرجة تفضيل الجودة للسلع الغذائية الاستهلاكية.

الاسلوب البحثي ومصادر البيانات

تم إستخدام بعض الأساليب الإحصائية الوصفية المتمثلة فى النسب المؤية والمتوسطات والكمية المستمدة من الإقتصاد القياسى مثل إستخدام نماذج الاتجاه العام الزمني لرصد الاتجاه الزمني العام لمتغيرات الدراسة والعوامل المؤثرة فى كلٍ منها، واستخدم الصور الرياضية المختلفة وتم اختيار أفضلها وفقاً لقيمة F, T, R2، وكذلك تم استخدام بعض المؤشرات الاقتصادية الخاصة باقتصاديات الجودة، بالإضافة إلى استخدام أسلوب الانحدار الخطى بشقيه البسيط والمرحلى المتعدد (Step Wise regression Analysis) لتقدير بعض العلاقات الاقتصادية الخاصة بموضوع الدراسة، وتحديد أهم العوامل المؤثرة فى كل حالة. كما تم استخدام أسلوب تحليل الانحدار اللوجستى(Logistic Regression Analysis) لشرح سلوك المستهلك.

وتم الإعتماد على بيانات عينة بحثية لتحقيق أهداف الدراسة وتم إختيارها بطريقة عمدية عشوائية من إحدى الشركات الرائدة فى مجال التصنيع الزراعى ، وهى شركة قها للصناعات الغذائية بمدينة قها بمحافظة القليوبية حيث تم تجميع بيانات تفصيلية عن فئات تكاليف الجودة ، بالإضافة إلى عينة عشوائية بسيطة لدراسة تأثير الجودة على قرارات المستهلكين.

النتائج والمناقشة

أولاً: العوامل المؤثرة على تكاليف الجودة الكلية: تتكون التكاليف الكلية للشركة من (١) – تكاليف المنع حيث تشتمل على(الأجور – معايرة وصيانة معدات الإنتاج– مراجعة الجودة – البرامج التدريبية للجودة – معايرة وصيانة أدوات الإختبار) (٢) – تكاليف التقييم وتشمل تلك التكاليف الإختبارات والتجارب والأبحاث التى تجرى لإختبار الجودة أثناء المراحل التصنيعيه المختلفة ، يليها تكاليف إهلاك معدات وأدوات الإختبار ، بالإضافة إلى المستلزمات المستخدمة فى الإختبار.(٣)– تكاليف الفشل الداخلى وتتكون من فاقد الخامات ، يليها تكلفة الإنتاج

تحليل إقتصادى للعوامل المؤثرة على جودة بعض السلع الغذائية والمصنعة (دراسة حالة : محافظة القليوبية)

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الملخص: يهدف البحث إلى دراسة العوامل المؤثرة على تكاليف الجودة والمتمثلة فى تكاليف المنع والتقييم وتكاليف الفشل الداخلى والخارجى والميزانية المخصصة للجودة ،وفقد الجودة (تكاليف الجودة الرديئة) ، وبتقدير معادلات الإتجاه الزمنى العام تبين ثبوت معنوية كل من تكاليف المنع وتكاليف الفشل الداخلى وتكاليف الفشل الخارجى وتكاليف الجودة الرديئة وميزانية الجودة فى تأثرها بعنصر الزمن، حيث تبين وجود إتجاه عام زمنى تصاعدى لكل من تكاليف المنع وتكاليف الفشل الخارجى ،فى حين تبين إتجاه عام زمنى تناقصى لباقى المتغيرات ، فى حين لم تثبت معنوية تأثير عنصر الزمن على تكاليف التقييم . وقد تم إستخدام أساليب التحليل الإحصائى الكمى لتحديد أكثر المتغيرات المستقلة تأثيراً فى تكاليف الجودة الكلية الفعلية وتبين أن تكاليف الجودة الردئية هى أكثر المتغيرات تأثيراً فى تكاليف الجودة الكلية الفعلية، وهذا ما يتفق مع المنطق حيث ان تكاليف الجودة الرديئة تعكس كل من تكاليف الفشل الداخلى والخارجى، ولذا فإنها تحجب تأثير كلاهما فى تكاليف الجودة الكلية الفعلية، وتشير النتائج أن زيادة تكاليف الجودة الرديئة بمقدار ألف جنيه تؤدى إلى زيادة تكاليف الجودة الكلية الفعلية بمقدار ٥١٠جنيه ، وقد أشارت تقديرات معادلة الانحدار المتعدد باستخدام أسلوب تحليل الانحدار اللوجستى لتقدير أثر العوامل المؤثرة على إختيار المستهلك لجودة السلع الزراعية والغذائية وذلك بعد إستبعاد متغير المهنة لوجود إرتباط قوى بين المهنة ودخل المستهلك إلى وجود علاقة طردية عند مستوى معنوية ٠,٠١ بين دخل المستهلك وتفضيلة للسلع العالية الجودة ، كما يشير معامل الانحدار أنه كلما زادت درجة التعليم للمستهلكين بنسبة ١% كلما زادت درجة توجهه لشراء السلع المرتفعة الجودة ١,٤٥% ، وقد أظهرت النتائج أيضاً أن العوامل المستقلة مجتمعه تفسر نحو ٧٤% من جملة التغيرات الحادثة في المتغير التابع. وقد أوصت الدراسة بضرورة العمل على زيادة مخصصات الميزانية لتكاليف المنع والتقييم مما يعمل على تقليل تكاليف الجودة الرديئة (الفشل الداخلى والخارجى) فتتقلص الفجوة بين ميزانية الجودة وتكاليف الجودة الكلية الفعلية ، وبالتالى ينخفض فقد الجودة الناتج عن الجودة الرديئة. كما أوصت الدراسة بتوجيه الإهتمام ببنود تكاليف التقييم مثل تكاليف الإختبارات والتجارب التى تجرى بهدف التأكد من سلامة وجودة المنتجات ومطابقتها لمقاييس ومعايير الجودة لتقليل حجم المرتجعات .

تمهيد

تعد إدارة الجودة الشاملة الأساس فى نجاح الأعمال فى القرن الواحد والعشرين ، فقد أصبحت عنصراً متميزاً هاماً فى تحقيق نتائج أعمال المنظمات على أختلاف أنواعها ، والإستجابة لمتطلبات وإحتياجات زبائنها وعملائها ، خصوصاً وأن النظر للعالم أصبح يتم من خلال ما يسمى بالقرية الكونية فى عصر العولمة وتنامى

Evaluation of Some Ground Water Wells of Some Regions in Al-Jabel Al-Akhder–Libya

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ABSTRACT: The present study is concerned with evaluating the quality of ground water in some regions of Al-Jabel Al-Akhder located in the east of Libya. Ten wells from different regions were selected for this purpose. Samples were brought to the laboratory to investigate their water quality parameters such as : TDS , ECiw , pHiw , concentration of soluble ions (major cations . Ca++, Mg++ , Na+, and K+) and anions as (Cl ,CO3+ HCO3 , and SO4) , and given theoretical equations as SAR, AdjSAR , SSP and RSC tests were all conducted on each samples.Data obtained concludes that, groundwater of all the wells water could be used for agriculture irrigation on different soils for normal crops and does not effect on soil properties due to low EC, and SAR, also there's no problem of bicarbonate and sodium ratio ions is expected in irrigation water and %Mg in average were 46.72 % was suitable for plants and soils. However, agriculture lands in these areas require a good management and suitable drainage systems to increase the productivity of crops and protect the groundwater from pollution. The present study recommends strongly further studies with different types of soil and plants.

Keywords: irrigation water, Well water, Sodium Adsorption Ratio (SAR), irrigation water quality.

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ضرر الماغنيسيوم Mg hazard

المغنيسيوم من العناصر الغذائية المهمة للنبات التي تصنف تحت العناصر الغذائية المتوسطة إلى الكبرى وذلك يعنى أن النبات يحتاجه بكميات متوسطة وتكمن أهميته في الدور المهم الذي يلعبه في حياة النبات باعتباره مكوناً أساسيا في اليخضور " *Chlorophyll* " وهى الصبغة الخضراء التي تمكن النبات من إستخدام الطاقة الشمسية في إنتاج المواد الكربوهيدراتية بالنبات حيث يدخل في حوإلى " ١٥– ٢٠ % " من الماغنيسيوم الكلى في تركيب الكلوروفيل (البشبيشى وشريف، ١٩٩٨). من خلال النتائج المتحصل عليها في الجدول (٤) ، يتضح أن قيم الماغنيسيوم تتراوح في المدى " ٢٦,٩٦– ٥١,٠٤ % " بمتوسط عام " ٣٦.٧٦ % "، حيث كانت اقل وأعلى قيمة للبئر(٤ و٨) لكل من منطقتى " قندولة وشحات " على التوالي .وهو يقع في المعدل المقبول الذي لايسبب خطراً على النبات باستثناء الآبار رقم (٤,٣,٢)، تشير أغلب المراجع العلمية إلى خطورة الماغنيسيوم على النبات إذا زادت كميته في مياه الري عن " ٥٠–٦٠ % " (Kovda ., 1973).

الحموضة المعدلة pHc

يقصد بالحموضة المعدلة " pHc . قيمة تركيز ايون الهيدروجين " pH " النظرية للماء عند تلامسها مع حبيبات الجزء الصلب في التربة وهى تحسب حسب المعادلة الموضحة سابقا. من خلال النتائج المتحصل عليها في الجدول يتضح أن قيمة " pHc " تتراوح في المدى "٥.٦٠–٧.٧٠ " بمتوسط عام " ٦.٩٢" بحيث كانت أقل وأعلى قيمة عند البئر رقم (١ و٥) لمنطقتى " الحنية وقندولة " على التوالي .وجميع القيم تقل عن " ٨.٤ " وذلك يؤدى إلى ترسب كربونات الكالسيوم في التربة عند إضافة مياه الري ، بينما إذا كانت القيمة أكبر من " ٨.٤ " فأن إضافة مياه الري تؤدى إلى ذوبان كربونات الكالسيوم في التربة (خليل، ١٩٩٨).

الخلاصـــة

من خلال معايير الجودة القياسية المستخدمة في تقييم جودة وصلاحية مياه الري ، ومقارنة ذلك بالنتائج المتحصل عليها للعينات تحت الدراسة ، فإنه يمكن اعتبار مياه هذه الآبار في مناطق الدراسة يمكن استعمالها للري دون التخوف من حدوث أي مشاكل للتربة أو النبات. ويمكن التوصية باستكمال الدراسة وربط ذلك بالتربة المروية بهذه المياه والنبات المزروع في التربة والمروى بهذه النوعية من مياه الري وذلك لمعرفة التأثير المباشر لها على التربة والنبات.

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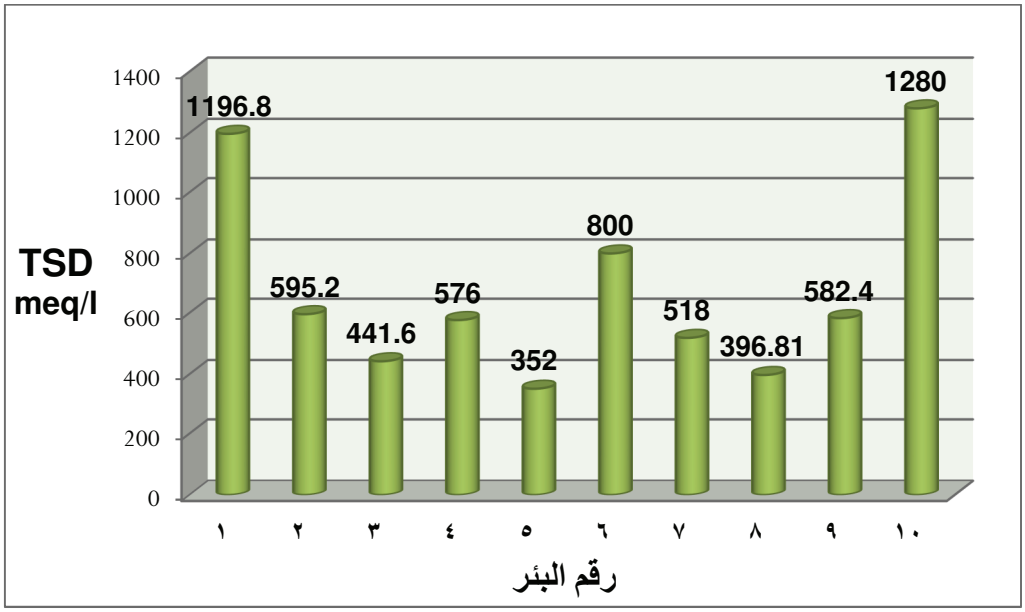
كربونات الصوديوم المتبقية " RSC " Residual Sodium Carbonate

تؤثر البيكربونات على التربة والنبات بطرق مختلفة لذلك تعتبر أحد عوامل التركيب الكيميائي لمياه الري الداخلة في تقييم نوعية مياه الري. وتمثل " RSC " كمية كربونات وبيكربونات الصوديوم في المياه عندما تكون كمية الكربونات والبيكربونات الكلية تزيد عن الكمية الكلية للكالسيوم والمغنيسيوم. ويعبر عنها عادة بوحدة الميللمكافيء / لتر. أوضحت النتائج المتحصل عليها في الجدول (٤) بأن قيم كربونات الصوديوم المتبقية قد تراوحت في المدى " ٠.٣٤ –١.٢٠ " ميلليمكافيء / لتر ، بمتوسط عام " 1.0 meq/l " بحيث كانت اقل و أعلى قيمة البئر رقم (٨ و3) واللذين يمثلان منطقتى "شحات و سيدي محمد الحمري" على التوالي. تعتبر المياه ذات صلاحية جيدة للاستخدام في الري كما هو موضح بالجدول (٤). في العموم ، من الضروري أن يؤخذ في الاعتبار صفات التربة المروية عند تقييم أثر الكربونات والبيكربونات ، حيث أن بعض مكونات التربة تلعب دورا في مقاومة تأثير كربونات الصوديوم على التربة وذلك من خلال ترسيها بتفاعلها مع الكالسيوم والماغنسيوم (Alzubaidi, 1979) ومن جهة أخرى فإن البيكربونات تؤثر على نمو النبات ليس من خلال تأثيرها السمي وإنما كذلك تؤثر على نمو النبات إذا ما استخدمت المياه بواسطة الرش حيث تتجمع البيكربونات على سطوح الأوراق مكونة كربونات الكالسيوم (Harivandi,1992).

مجموع الاملاح الذائبة الكلية Total Dissolved Salts TDS

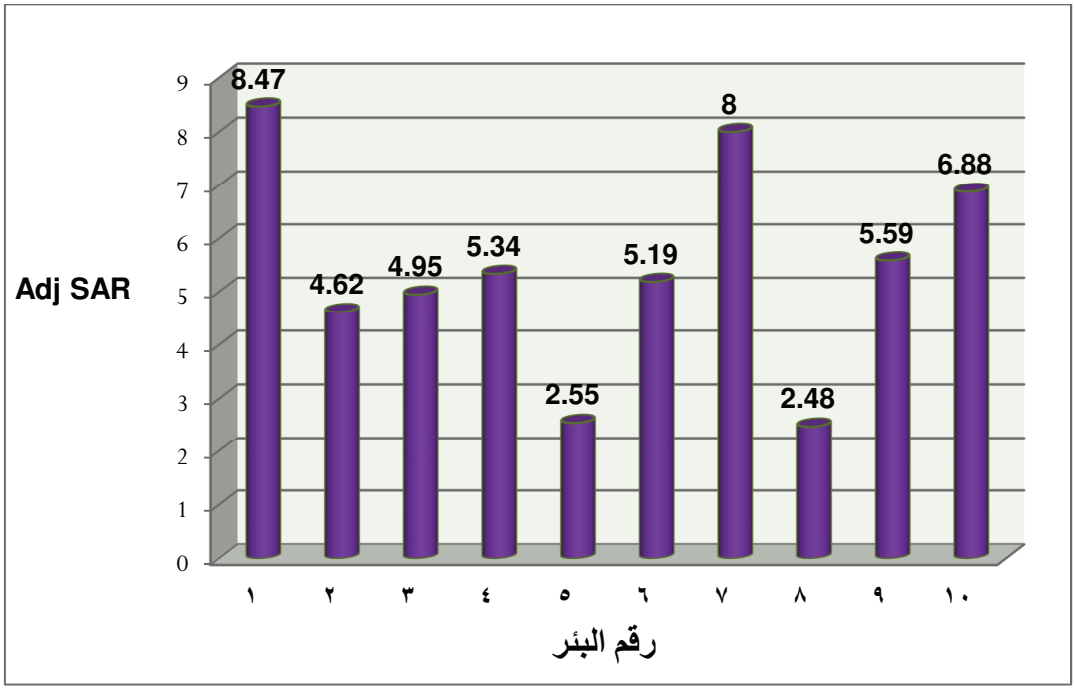
اشارت النتائج المتحصل عليها فى الشكل " ٥ " ان مدى الاملاح الكلية الذائبة " TDS " يقع فى المدى " ٣٥٢ –١٢٨٠ " مجم/ لتر بمتوسط عام " ٦٧٣.٨٨١ " مجم/ لتر وهى تقع فى المدى المسموح به فى مياه الرى (FAO., 2006) والتى اشارت الى ان المدى المسموح به للأملاح الكلية الذائبة " TDS فى مياه الرى يقع فى المدى " ٠.٠ – ٢٠٠٠ " مجم/ لتر . وبالتالى فان هذه المياه تعتبر صالحة للرى ومناسبة لنمو النباتات .



شكل (٥). قيم الاملاح الكلية الذائبة " Total Dissolved Salts لمياه الابار

قيم نسبة الصوديوم المعدلة AdjSAR

يشير اختصارAdjSAR الى نسبة ادمصاص الصوديوم المعدلة وهو تعبير يتضمن التغيرات المتوقع الحصول عليها فى تكوين المياه الناتجة عن اتحاد المياه والاملاح وما ينتج عن ذوبان الاملاح فى التربة وعن زيادة فى عنصر الكالسيوم او ترسيب الاملاح فى مياه الرى والتربة وينتج عنه نقص فى الكالسيوم ، فلذلك فان نسبة إدمصاص الصوديوم المعدلة AdjSAR تعتبر هامة لمعرفة تاثير ايونات الكربونات والبيكربونات على ترسيب الكالسيوم والمغنيسيوم فى التربة (المثنانى واخرون، ٢٠١٦) وتستخدم من ناحية تأثيرها على تملح التربة وذلك لانها دليل جيد للمشاكل الناتجة عن ارتفاع قيمة AdjSAR . وقد قسمت مياه الرى وفقا لـ (Ayers and Westcot, 1994) على اساس نسبة AdjSAR الى ثلاث مجموعات وهى عندما تكون اقل من " ٦.٠ " فانها تعتبر مياه صالحة للرى وعندما تقع فى المدى " ٦.٠ – ٩.٠ " فان مياه الرى تعتبر متوسطة الصلاحية وعندم تكون اكبر من " ٩.٠ " تعتبر مياه غير صالحة للرى . ومن خلال النتائج المتحصل عليها فى الشكل " ٤ " يتضح ان قيمة AdjSAR تقع فى المدى " ٢.٠ – ٨.٤٧ "ولذا فانها عموما تعتبر مياه صالحة للرى .



شكل (٤). قيم نسبة إدمصاص الصوديوم المعدلة " AdjSAR لمياه الابار

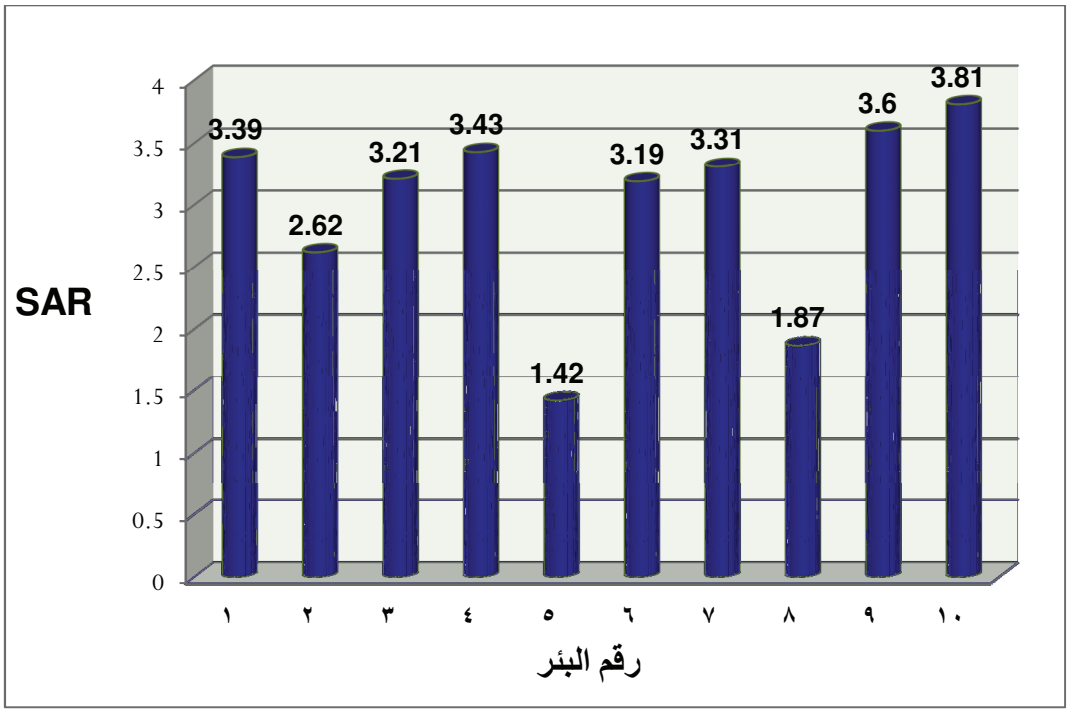
النسبة المئوية للصوديوم الذائب SSP

أوضحت النتائج المتحصل عليها في الجدول (٤) ، أن النسبة المئوية للصوديوم الذائب قد تراوحت في المدى " ٤٤.٠٨ – ٦٩.٤٥ " % ، بمتوسط عام " ٥١.٩٠ % ". بحث كانت اقل وأعلى قيمة في البئر (١ و ٤)اللذين يمثلان منطقتى سيدي محمد الحمري و قندولة على التوالي. تعتبر النسبة المئوية للصوديوم في عينات المياه غير ضارة لأغراض الري ويمكن استخدامها بدون أي ضرر يمكن حدوثه ، حيث أشارت المراجع أنه عند زيادة النسبة المئوية للصوديوم عن " ٦٠ % " في مياه الري يعتبر ضاراً للتربة والنبات (MamRasoul, 2000).

Feldspar " وعادة يقل تركيز البوتاسيوم " K^+ " بمقدار " ١٠ – ٢٠ % " وهذا ما يوجد فعلا في مياه آبار بعض المناطق. البوتاسيوم " K^+ " يمتص بدرجة اكبر من " Na^+ " وترجع هذه الزيادة إلى القدرة الإدمصاصية للبوتاسيوم بالنسبة للصوديوم ويمكن أن نستنتج من ذلك أن وجود تركيز منخفض من البوتاسيوم " K^+ "في ماء الري يساعد على خفض نسبته الصوديوم المدمص على معقد التربة (خليل، ١٩٩٨) وتتفق هذه النتائج مع (ادريس، ٢٠٠٠).

نسبة إدمصاص الصوديوم Sodium Adsorption Ratio

تعتبر نسبة إدمصاص الصوديوم " SAR " من المعايير الهامة المستعملة في تحديد صلاحية المياه للري، أوضحت النتائج المتحصل عليها في الجدول (٤) أن قيم " SAR " في مياه الآبار قيد الدراسة قد تراوحت في المدى "١.٤٢ – ٣.٨١ " بمتوسط عام " ٢.٩٨ " وكانت أقل وأعلى قيمة للبئر رقم (٨ و ١٠) وهما يمثلان منطقتى " شحات والحنية " على التوالي . وحسب قيم " SAR "فهي تصنف من المنخفضة إلى المتوسطة (Ayers and Westcot, 1994) كما هو موضح بالجدول (٤) وبمقارنة قيم الـ " SAR " مع قيم " Adj SAR " التي كانت في المدى " ٢.٤٨–٨.٤٧ " بمتوسط عام " ٥.٤٠ " فإن جميع هذه المياه من الآبار المختلفة تعتبر صالحة للري ولا تسبب أي مشاكل للتربة أو للنبات وعادة تزيد مع زيادة التوصيل الكهربائي كما هو موضح في الشكل (٤) ويؤكد ذلك وجود علاقة ارتباط موجبة بحدود " 0.61 " .وهذا يتفق مع ما أكده (Kamza, 2012) ويمكن استعمالها مع المحاصيل الحساسة للصوديوم (Mohamed, 2013) .



شكل (٣). قيم نسبة إدمصاص الصوديوم " Sodium Adsorption Ratio" لمياه الابار

يتواجد الماغنيسيوم بكثرة في المياه الطبيعية في العيون المعدنية والبحار بتركيز أقل مما في المياه الجوفية وأملاح الماغنيسيوم أكثر ذوبانية في الماء من أملاح الكالسيوم(نسيم .، ٢٠٠٧) .

أوضحت النتائج المدونة في الجدول (٣) أن تركيز الماغنيسيوم في مياه الري تحت الاختبار كانت أقل وأعلى قيمة للبئر رقم (٣ ، ١٠)اللذين يمثلان منطقتى" سيدي محمد الحمري والحنية " على التوالي. وهى تقع في المدى الطبيعي للمغنيسيوم في مياه الرى، و المدى الطبيعي للمغنيسيوم في مياه الري " 0 – 5 meq/l " (خليل، ١٩٩٨). ربما يعود وجود الماغنيسيوم إلى وجود معادن الدولومايت " كربونات الكالسيوم والماغنيسيوم " . اغلب المراجع العلمية تشير أنه عند ارتفاع الكالسيوم والماغنيسوم اكبر من " 10 meq/l " لا يمكن استخدامها في الاغراض الزراعية " الري(Khodapanah *et al.*, 2009، Alobaidy *et al.*, 2010، Al–Shmmiri *et al.*, 2005) وهى بالتالي تقع في المدى الطبيعي للماغنيسيوم في مياه الري دون أي ضرر للتربة او النبات . يتواجد عنصرا الصوديوم والبوتاسيوم في معادن " Feldspar " والمعادن القلوية ويكون تواجد البوتاسيوم " K^+ " اعتياديا في مياه الري واقل بكثير من تركيز الكالسيوم والمغنيسيوم والصوديوم (الحيانى .، ٢٠٠٩). بالرغم من أن جميع أيونات مياه الري تعتبر ذات أهمية في تحديد نوعية مياه الري وصلاحيتها للزراعة إلا أن تركيز ايون الصوديوم " Na^+ "من المقاييس المهمة في تحديد نوعية وصلاحية مياه الري باعتباره مصدر ضرر القلوية " Alkaline " والصودية " Sodicity " في التربة إضافة إلى تأثيره السام المباشر على نمو معظم المحاصيل الزراعية(الزبيدى، ١٩٨٩). "الصوديوم " Na^+" كغيره من الأيونات الموجبة عند دخوله إلى التربة من خلال مياه الري فإنه يدمص بواسطة تفاعلات التبادل مع المكونات الطبيعية الموجودة في التربة مسببا بذلك ظروفاً فيزيائية غير مرغوب فيها.

أشارت النتائج المتحصل عليها في الجدول (٤) إن محتوى المياه من أيونات الصوديوم قد تراوح في المدى " ٢.٢٣– ٨.٢٥ ملليمكافيء/ لتر " بمتوسط عام " ٥.١٣ ميللمكافيء / لتر "وهى بذلك تقع ضمن الحدود الطبيعية لتركيز ايون الصوديوم في مياه الري(Ayers and Westcot, 1994) فى المدى " ٠.٠ – ٤٠ " ميللمكافيء / لتر . بحيث كانت اقل وأعلى قيمة عند البئر رقم (٨ و ١٠) واللذين يمثلان منطقتى" شحات و الحنية "على التوالي. وربما تعود الزيادة في تركيز الصوديوم في العينات المأخوذة من منطقة الحنية إلى التداخل مع مياه البحر باعتبارها منطقة غير مرتفعة عن سطح البحر مقارنة بباقي المناطق. وقد أشار(Karavoltsos *et al.*, 2008) أنه من أهم الأسباب الطبيعية التي تسبب زيادة تركيز الأملاح بالمياه الجوفية هو تداخل مياه البحر مع المياه الجوفية. وإن كانت عينات المياه تصنف على انها ذات مستوى منخفض من ايونات الصوديوم ولا تسبب ضررا للتربة أو النبات.

يعد البوتاسيوم العنصر السابع من حيث وجوده في المياه الطبيعية(عوض، ١٩٩٠) ويتميز البوتاسيوم بتركيزه المنخفض مقارنة بتركيز الايونات الأخرى . والمصدر الرئيسي له معادن "Feldspar" وراسب المتبخرات(Todd, 1980). ومحتوى مياه الري من البوتاسيوم يتراوح في المدى " ٠.٠٠٤ – ٠.٩١ ميللمكافيء/ لتر " بحيث كانت أقل وأعلى قيمة عند البئر (١ و ١٠) لكل من سيدي محمد الحمري والحنية على التوالي وهو يعتبر مرتفعاً نسبيا ويقع في المدى المسموح به في مياه الري حسب ماشارت له (FAO ,2006) والتى ذكرت ان تركيز البوتاسيوم فى مياه الرى يقع فى المدى " ٠.٠ – ٢٠ " ميللمكافيء / لتر. وربما الارتفاع النسبي إلى وجود معادن "

جدول (٤). يوضح نتائج تحاليل مياه الري محل الدراسة

Well No	pH	EC dS/m	Ca	Mg	Na	K	Cl	HCO_3	SO_4	TSD	SAR	RSC meq/l	Mg (%)	pHc /	adj SAR	SSP (%)
			meq/l													
1	7.9	1.87	6.30	3.25	7.50	0.03	9.15	5.25	2.10	1196.8	3.39	/	34.03	5.60	8.47	44.08
2	8.1	0.86	3.10	1.80	4.10	0.06	5.30	2.60	0.٥0	595.2	2.62	/	36.73	6.90	4.62	45.91
3	8.3	0.69	2.15	1.15	4.11	0.10	4.5	1.25	1.15	441.6	3.21	1.20	34.84	7.20	4.95	56.05
4	8.10	0.90	3.25	1.20	5.12	0.05	6.12	2.80	0.10	576.0	3.43	/	26.96	7.20	5.34	69.45
5	7.60	0.55	1.40	1.20	2.30	0.04	1.02	3.40	0.10	352.0	1.42	1.4	46.15	7.70	2.55	47.36
6	8.30	1.25	3.25	2.80	5.56	0.04	6.27	3.11	1.25	800.0	3.19	/	46.28	7.10	5.19	48.06
7	8.10	0.81	3.50	1.50	6.02	0.08	2.47	4.24	1.20	518.0	3.31	1.08	30.0	6.40	8.0	54.95
8	7.67	0.62	1.40	1.46	2.23	0.35	0.83	3.20	1.32	396.8	1.87	0.34	51.04	7.50	2.48	51.68
9	7.99	0.91	4.14	1.63	6.12	0.11	1.36	5.0	1.50	582.4	3.60	/	28.24	6.80	5.59	51.90
10	8.25	2.0	6.20	3.10	8.25	0.91	10.2	6.80	0.90	1280.0	3.81	/	33.33	6.85	6.88	49.62
Average	**8.01**	**1.04**	**3.64**	**1.90**	**5.13**	**0.177**	**4.72**	**3.76**	**1.02**	**673.9**	**2.98**	**1.00**	**36.76**	**6.92**	**5.40**	**51.90**

تعتبر عمليات التجوية التي تحدث للصخور المحتوية على كربونات الكالسيوم والماغنيسيوم المصدر الرئيسي لأيونات البيكربونات في المياه الجوفية (Gill, 1997). تشير النتائج المتحصل عليها في (الجدول ٤) أن معدل ايون البيكربونات تراوح في المدى١.٢٥ – ٦.٨٠ ملليمكافيء/ لتر بمتوسط عام ٣.٧٦ ملليمكافيء /لتر وكانت أقل وأعلى قيمة عند البئر (٣ و١٠) اللذين يمثلان منطقة " سيدى محمد الحمري والحنية " على التوالي. ولذلك يمكن أن تصنف على أنها منخفضة إلى متوسطة التأثير على النبات حسب تصنيف (Harivandi,1992). وذلك يعنى أنها تقع في المدى الطبيعي لمياه الري حسب تصنيف (Ayers and Westcot, 1994) و منظمة الاغذية والزراعة (FAO, 2006) . وإن كانت تشكل خطورة على بعض النباتات.

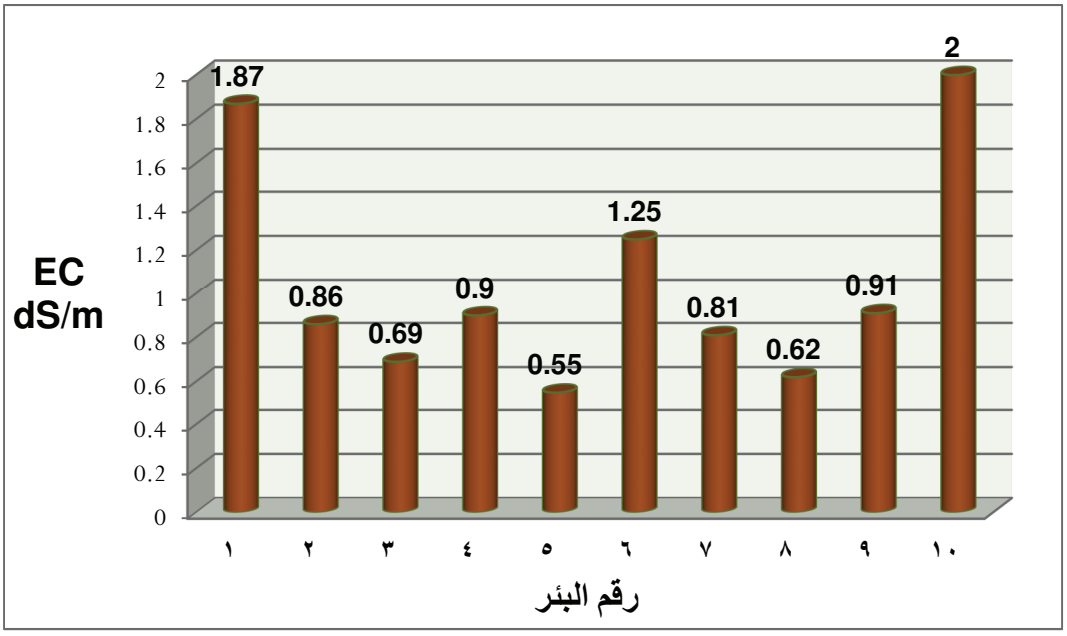
يشتق أيون الكبريتات في المياه من تكسر المواد العضوية المحتوية على الكبريت ومن اختزال الكبريت بفعل البكتريا اللاهوائية وعادة تتواجد الكبريتات بتركيزات بسيطة في المياه السطحية ويزداد تركيزها في المياه الجوفية (عبدالقادر، ٢٠٠٨). وعادة تركيزها في المياه الجوفية أقل من ١٠٠ مجم / لتر . وفي العموم عندما يرتفع تركيز أيون الكبريتات عن " ٤٠٠ مجم / لتر " فإنه يسبب زيادة في حموضة التربة مما يؤثر على صلاحية العديد من العناصر الغذائية ولكن عندما يقل تركيزها في مياه الري عن ٤٠٠ مجم / لتر وهو التركيز المرغوب في مياه الري لن يكون لها تأثير ضار على التربة وبالتالي على النبات (Hamza, 2012).

تحتوى المياه على تراكيز منخفضة جداً من أيونات الكبريتات حيث كان في المدى ٠.١٠–٢.١٠ ملليمكافيء/ لتر اللذين يمثلان منطقتى قندولة وسيدى محمد الحمرى ويمثل البئر رقم (٥) عينة مياه سطحية وبالتالي محتواه من الكبريتات أقل مقارنة بباقي الآبار الذي يتفق مع (عبد القادر، ٢٠٠٨) بمتوسط عام ١.٠٢ وبالتالي فهى تقع فى المدى الطبيعي لأيونات الكبريتات فى مياه الرى والذى يقع فى المدى ٠.٠ – ٢٠ ملليمكافىء / لتر (FAO,2006). ولا يوجد تأثير يذكر للكبريتات على صلاحية مياه الري ولكن يكون تأثيرها من خلال التأثير الكلى للأملاح الذائبة على درجة تفاعل التربة وبالتالي على صلاحية بعض العناصر الغذائية.

الكاتيونات Cations

تم تقدير كاتيونات الكالسيوم والماغنيسيوم والصوديوم والبوتاسيوم معبراً عنها بالملليمكافيء / لتر كما هو موضح في (الجدول ٤). من خلال النتائج المتحصل عليها في الجدول يتضح أن قيمة الكاتيونات كانت تتراوح في المدى ١.٤٠– ٦.٣٠ " ١.١٥–٢.٢٥ " ، ٢.١٥ – ٨.٢٥ " و " ٠.٠٣ – ٠.٩١ ملليمكافيء/لتر لكل من الكالسيوم والماغنيسيوم والصوديوم والبوتاسيوم على التوالي. وهى تقع في المدى المناسب لمياه الري وتتفق مع ما توصل إليه (إدريس،٢٠٠٠).

يحتل الكالسيوم Ca^{++} المرتبة الخامسة بين العناصر من حيث وفرته في المياه الطبيعية ويتواجد بكثرة في المياه نتيجة ذوبان مركبات القشرة الأرضية الكلسية منها (عبد القادر، ٢٠٠٨). يتضح من ذلك أن محتوى المياه من الكالسيوم يقع في المدى الطبيعي للكالسيوم في مياه الري وذلك حسب (Ayers and Westcot,1994) حيث يشار إلى أن المدى الطبيعي للكالسيوم في مياه الري " 0 –20 meq/l " . كانت أقل وأعلى قيمة للبئر (٨ و ١) اللذين يمثلان منطقتى " شحات وسيدي محمد الحمري " على التوالي. تشير بعض المراجع إلى عدم إستخدام مياه الري التي يزيد فيها الكالسيوم عن " 10 meq/l " (خليل، ١٩٩٨).



شكل (٢) قيم التوصيل الكهربائى " EC " لمياه الابار

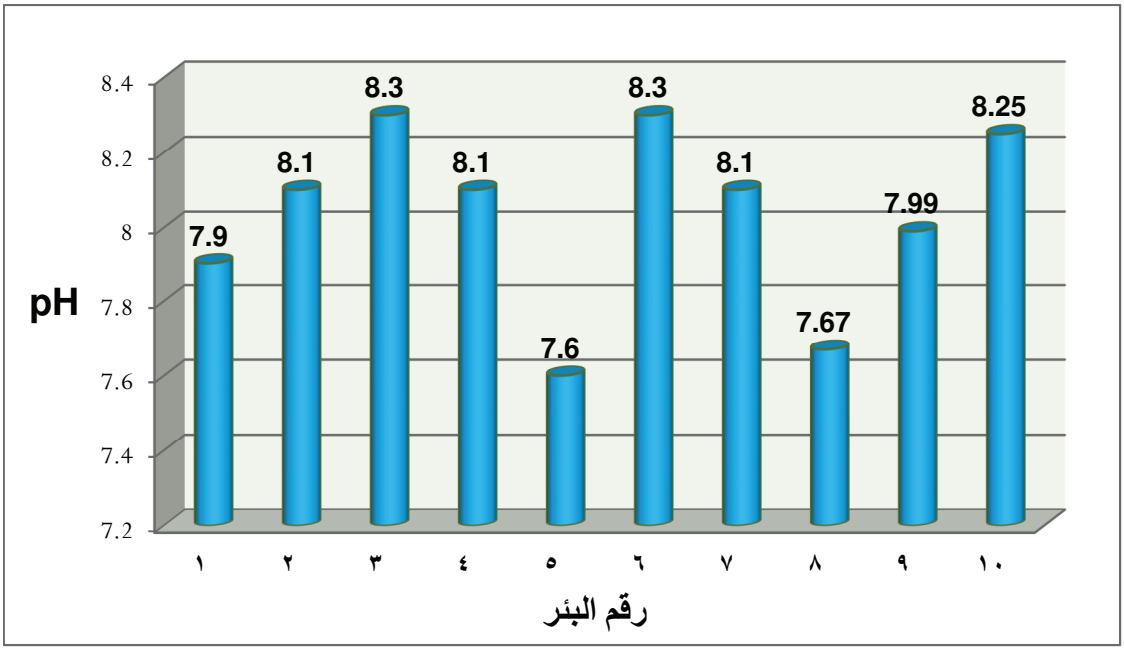
الايونات

وهو مصطلح يجمع الأنيونات anions التي تشير إلى الايونات ذات الشحنة السالبة الذائبة في المياه و الكاتيونات cations التي تشير إلى الايونات الموجبة الشحنة المتواجدة في المياه عموما وفي مياه الري بشكل خاص وعادة مصدر الأيونات في المياه الجوفية يعود إلى نوعية الصخور التي عند تحللها تحت عوامل مختلفة تنطلق منها المعادن المكونة لها في شكل أيونات ذائبة في المياه ولذلك يختلف تركيزها عادة حسب نوع الصخور المكونة لها .

الانيونات Anions

من خلال النتائج المدونة في (الجدول ٤) يتضح أن محتوى المياه من الأنيونات كان في المدى ٠.٨٣– ١٠.٢٠ ، ١.٢٥ – ٦.٨ ، ٠.١٠ – ٢.١٠ ملليمكافئ/ لتر لكل من ايونات الكلوريد والبيكربونات والكبريتات على التوالي وهى تقع فى الحدود المسموح بها فى مياه الرى حسب تصنيف منظمة الاغذية والزراعة (FAO ,2006).

يوجد ارتفاع نسبى لأيونات الكلوريد وان كانت القيم المتحصل عليها فى الجدول تقع فى المدى المسموح به فى مياه الرى ويقع فى المدى ٠.٠ – ٣٠ ميللمكافى / لتر (FAO,2006) حيث كانت اقل وأعلى قيمة ٠.٨٣ و ١٠.٢٠بمتوسط عام ٤.٧٢ وذلك للبئر رقم (٨ و١٠) اللذين يمثلان منطقتى (شحات و الحنية) على التوالي. عند المستوى المرتفع نسبيا للكلوريد فأن هذه المياه تستخدم للمحاصيل المتوسطة المقاومة للملوحة بالإضافة إلى أنه قد يزيد من مشاكل الملوحة في التربة . وعند هذا المعدل ١٠.٢٠ فإنه يصنف من القليل إلى المتوسط ويمكن أن يسبب مشاكل ملحية للتربة حسب تصنيف (Ayers and Westcot, 1994) كما هو موضح (بالجدول ٣).



شكل (١). قيم الاس الهيدروجينى " pH " لمياه الابار

التوصيل الكهربائي (EC)

قياس درجة التوصيل الكهربائي " EC Electrical Conductivity " من القياسات المهمة في تقييم جودة مياه الري حيث إنها تعكس المحتوى الكلى للأملاح الذائبة في الماء " المكونات الصلبة (Ayers and Westcot, 1994). وقد اعتبر (Nikos *et al.*, 2003) أن درجة التوصيل الكهربائي EC مؤشر جيد للأملاح المعدنية الذائبة في الماء والتي تستخدم غالبا في قياس مشاكل الملوحة المرتبطة برى المحاصيل. وعادة ماتكون الأملاح الذائبة في المياه الجوفية أعلى منها في المياه السطحية ويعتمد ذلك على نوع وتركيز الأملاح وعلى الخصائص الجيولوجية وحركة المياه (Chapman, 1996).

(الجدول ٤ والشكل ٢) أوضح أن ملوحة مياه الآبار المتمثلة في قيم التوصيل الكهربائي معبرا عنها بوحدة dS/m تراوحت في المدى 0.55– 2.0 dS/m وكانت أقل وأعلى قيمة عند البئر رقم (٥ و ١٠) اللذين يمثلان منطقتى "قندولة و الحنية " على التوالي . وكان المحتوى الكلى للأملاح TDS في المدى ٣٥٢ – ١٢٨٠ مجم / لتر لكل من منطقة قندولة والحنية على التوالي ويعود الانخفاض في الأملاح الكلية للبئر رقم (٥) ربما لأنها تمثل مياه سطحية والذي يتفق مع (Chapman, 1996) بمتوسط عام ٦٧٣.٨٨ مجم/لتر وهى تشمل الايونات الذائبة الكلية " الكاتيونات والأنيونات "وبالطبيعي أن تكون في زيادة مع ارتفاع قيم التوصيل الكهربائي وذلك حسب تصنيف منظمة الأغذية والزراعة (FAO,1989) . فإنها تصنف ضمن المياه المنخفضة الملوحة إلى الجيدة كما هو موضح (بالجدول ٣) وهى صالحة للاستخدام الزراعي لأنواع مختلفة من الترب والنبات. ولا يوجد لها تأثير سيئ على التربة أو خواصها الفيزيائية والكيميائية وتصلح في الترب جيدة الصرف مع احتمال ضعيف أن يحدث ضررُ لبعض المحاصيل الحساسة جدا للأملاح.

جدول (٣). المعايير القياسية لمياه الرى.

Salinity Hazard							
Irrigation water classification					Degree of restriction on use		
Parameters	**Excellent**	**Good**	**Permissible**	**Unsuitable**	**No**	**Slight to Moderate**	**Sever**
EC " dS/m "	<0.25	0.25 – 0.75	0.75 – 2.25	2.25 – 5.0	<0.70	3.0 – 0.7	>3.0
TDS " mg/l	<200	200 – 500	500 - 1500	1500 - 3000	<450	450 - 2000	>2000
Effect on plants	No detrimental effect	Sensitive plants show salt stress	Salt tolerant plant only	Very tolerant plant only			
Sodium Adsorption Ratio " SAR " Value							
SAR Value	Comments						
1 – 10	Use in sodium sensitive crops						
10 – 18	Amendments (such as gypsum) and leaching needed						
18 -26	Generally unsuitable for continuous						
>26	Generally unsuitable for use						
Irrigation water classification " Chloride , meq/l "							
Safe	<2.0						
Sensitive plants	2.0 – 4.0						
Moderate to tolerant plant	4.0 – 10						
Unsuitable for tolerant plant	>10						
Irrigation water classification " Residual Sodium Carbonate" RSC , meq/l "							
Safe	<1.25						
Permissible	1.25 – 2.50						
Unsuitable	>2.50						
Irrigation water pH							
Normal ranking	6.0 – 8.50						

Ayers and Westcot (1994)

النتائج والمناقشـة

أظهرت النتائج المتحصل عليها في (الجدول٤) وجود اختلاف في قيم مؤشرات جودة وصلاحية مياه الآبار التى تمت دراستها حسب الاتى :

الأس الهيدروجيني للمياه pHiw

أوضحت نتائج التحليل في (الجدول ٤ والشكل ١) أن قيم الأس الهيدروجين للمياه تقع ضمن الحدود المتوقعة والمسموح باستخدامه في مياه الري حسب مقاييس منظمة الاغذية والزراعة (FAO , 2006) والتى اشارت الى ان المدى الطبيعى المسموح به بمياه الرى يتراوح بين٦.٠ – ٨.٥ (الجدول ٣) حيث تراوحت في المدى ٧.٦ – ٨.٣٠ بمتوسط عام٨.٠١ للآبار المدروسة وكانت اقل وأعلى قيمة عند البئر رقم (٥ ، ٦) يمثلان منطقتى " قندولة وعين مارة " على التوالي. وهى قيم مناسبة جدا للري لا تسبب أي ضرر للنبات أو التربة وإن كان سيكون لها تأثير على صلاحية بعض العناصر الغذائية الصغرى مثل " الحديد– الزنك – المنجنيز– النحاس. حيث إن صلاحيتها للنبات تقل مع ارتفاع درجة التفاعل للتربة التي تتأثر بمياه الري المضافة وهذا يتوافق مع (Hagen,1987).

– حساب نسبة إدمصاص الصوديوم المعدلة حسب المعادلة :

$$AdjSAR=SAR\left(1+(8.4-pHc)\right)$$

- كربونات الصوديوم المتبقية "RSC " تم حسابها من المعادلة:

$$RSC = (CO_3^{=} + HCO_3^{-}) - (Ca^{2+} + Mg^{2+}) \quad meq/l$$

- ضرر الماغنيسيوم تم حسابه وفق المعادلة لتالية =

$$Mg(\%) = \frac{Mg^{2+}}{Ca^{2+}+Mg^{2+}} \times 100$$

– حساب نسبة الصوديوم الذتئب " SSP " حسب المعادلة :

$$SSP = \frac{Na^{+}}{Ca^{2+}+Mg^{2+}+Na^{+}+K^{+}} \times 100$$

– الأملاح الكلية الذائبة = تم حسابها حسب المعادلة التالية:

$$TDS(mg/l) = EC_{iw}\,(dS/m) \times 640$$

– درجة الأس الهيدروجيني المعدلة –pHC وفق المعادلة التالية مع الاستعانة بجداول خاصة تستخدم في الحسابات (خليل، ١٩٩٨):

$$pHc = P^{(Ca^{2+}+Mg^{2+}+Na^{+})} + P^{(Ca^{2+}+Mg^{2+})} + P^{(Alk)}$$

حيث:

– $P^{(Ca + Mg + Na)}$ = الأس اللوغارتمى لتركيز أيونات الكالسيوم والماغنيسيوم والصوديوم في الماء "meq/l"

– $P^{(Ca + Mg)}$ = الأس اللوغارتمي لتركيز أيونات الكالسيوم والماغتيسيوم " meq/l"

– $P^{(ALK)}$ = الأس اللوغارتمي لتركيز أيونات الكربونات والبيكربونات في الماء " meq/l"

جدول (٢). المؤشرات المتبعة لتقييم جودة مياه الرى

م	المـؤشر	الرمــز	الوحـدة
١	الأس الهيدروجيني للمياه	pH	/
٢	درجة التوصيل الكهربائي	ECiw	dS/m
٣	نسبة إدمصاص الصوديوم	SAR	/
٤	نسبة إدمصاص الصوديوم المعدلة	Adj SAR	/
٥	نسبة الصوديوم المعدلة	AdjRNa	/
٦	النسبة المئوية للصوديوم الذائب	SSP	%
٧	كربونات الصوديوم المتبقية	RSC	meq/l
٨	الملوحة الفعالة والمؤثرة	ES	meq/l
٩	جهد الملوحة	PS	meq/l
١٠	النسبة المئوية للصوديوم المتبادل	ESP	%
١١	تركيز البورون	B	mg/l
١٢	تركيز النترات	NO3	mg/l

المصدر: Ayers and Westcot (1994)

اختيار خمسة مواقع للدراسة شملت المناطق " سيدي محمدالحمري – قندولة – عين مارة – شحات– الحنية (جدول١) . أخذت العينة من البئر بعد تشغيل المضخة ١٥ دقيقة وذلك للتخلص من الماء الراكد الموجود في الأنابيب ثم جمعت العينات في قناني زجاجية.كانت درجة حرارة المياه في المدى ١٨.٦٠ – ٢٢.٥٠ م˚ تم قياس درجات حرارة مياه العينات في المواقع مباشرة بواسطة ترمومتر زئبقي ونقلت مباشرة إلى مختبر قسم التربة والمياه – كلية الزراعة جامعة عمر المختار. ووضعت في الثلاجة عند درجة حرارة ٤.٠ م لمنع نمو الفطريات إلى حين إجراء التحاليل المناسبة .

أجريت التحاليل التالية حسب الطرق والمؤشرات المتبعة فى تقييم جودة مياه الري والموضحة في جدول(٢) ومقارنتها بالبيانات الموجودة فى الجدول(٣).

الأس الهيدروجيني للماء (pHiw) والتوصيل الكهربائيEC باستعمال جهاز " pH–meter " موديل "Jenway . Model. 3310" وجهاز "Conductivity meter" "E/E. Model 470 " على التوالي وحسب الطرق الواردة فى (Page,1982).

جدول (١). يوضح مواقع اخذ العينات

رقم البئر	الموقـع	الارتفاع عن سطح البحر(متر)	الملاحظات
١	سيدي محمد الحمري	٨٣٠	مياه تستخدم للري للشرب
٢	سيدي محمد الحمري	٨٣٠	مياه تستخدم للشرب والري
٣	سيدي محمد الحمري	٨٣٠	مياه تستخدم للري
٤	قنــدولة	٦٢٣	مياه سطحية
٥	قنــدولة	٦٢٣	مياه تستخدم للري- سطحية
٦	عيــن مــارة	٥٢٠	مياه تستخدم للري
٧	عيــن مــارة	٥٢٠	مياه تستخدم للري
٨	شحــات	٦٣٦	مياه تستخدم للري
٩	شحــات	٦٣٦	مياه عين جارية تستخدم للري
١٠	الحنيــة	١١٥	مياه بئر للري

تم تقدير الكاتيونات فى عينات مياه الابار المختارة والتي شملت الكالسيوم والماغنيسيوم الذائب بطريقة المعايرة بمحلول الفيرسين 0.01M EDETA في وجود الدليل المناسب لكل منهما والصوديوم والبوتاسيوم باستخدام جهاز Flame photometer والذى يعتمد على قياس انبعاث اشعة مميزة لكل منهما عند اثارة اللهب حسب الطريقة الواردة فى (Black *et al.*,1965).

تم تقدير الأنيونات فى عينات مياه الابار المختارة، حيث قدر الكلوريد بطريقة " موهر " والتى تعتمد على المعايرة باستخدام " $0.01M\ AgNO_3$ " فى وجود دليل ثانى كرومات البوتاسيوم . والكربونات والبيكربونات " بالمعايرة بالحامض " 0.05M HCL " في وجود الدليل المناسب والكبريتات تم تقديرها حسابيا بالفرق في الحساب بين الكاتيونات والأنيونات. وقد تم تقدير بعض مؤشرات جودة وصلاحية مياه الرى حسابيا والتى شملت :–

– نسبة إدمصاص الصوديوم " SAR " تم حسابها من العلاقة التالية (Richards., 1954):

$$SAR=\frac{Na^{+}}{\sqrt{\frac{Ca^{2+}+Mg^{2+}}{2}}}$$

تتواجد المياه الجوفية في ليبيا ضمن خزانات جوفية متجددة وغير متجددة ، وتصل كميات المياه المتجددة إلى أكثر من ٥٠٠ مليون م^3 بالخزانات الواقعة شمال البلاد ، أماالأحواض المائية الكبرى فهي غير متجددة بقدر كبير ومستمر ، ويشكل المطر وما يتسرب منه من مياه سطحية أهم المصادر لتغذية المياه الجوفية . وفى ليبيا تستمد مياه الري بشكل رئيسي من المياه الجوفية . وتختلف نوعية المياه الجوفية حسب الطبقات الأرضية التي تنفذ خلالها المياه إلى المخزون الجوفي وحسب طبقات المخزون الجوفي. تعتبر المياه الجوفية المصدر الرئيسي للمياه في ليبيا وتساهم بأكثر من ٩٨% من إجمالي الاستهلاك (الباروني، ١٩٩٧). وتختلف نوعية المياه الجوفية المستخدمة للري اختلافا كبيرا من منطقة إلى أخرى وذلك حسب تكويناتها الجيولوجية ومواقعها وطرق وكيفية استغلالها والاختلاف في نوعية المياه ليس بين منطقة وأخرى فحسب ولكنه داخل المنطقة نفسها كما تختلف نوعية المياه في البئر الواحد مع مرور الزمن وخاصة في المناطق الساحلية التي تتعرض للتداخل مع مياه البحر(بن محمود،١٩٩٣). تعتبر مياه الرى احد الموارد الطبيعية الاساسية والمهمة فى العالم وخاصة فى المناطق الجافة وشبه الجافة ،حيث تعتبر العامل الرئيسي فى التنمية الزراعية ،لذلك تعتبر نوعية مياه الرى المتوفرة من الامور والمؤشرات الاساسية التى بجب ان تؤخذ فى الاعتبار عن التخطيط لاستخدام الموارد المائية فى المجالات الزراعية (الزبيدى،١٩٨٩). تحتوى مياه الآبار أي كان مصدرها على نسب متباينة من الأملاح الذائبة وآثار معادن أخرى بالإضافة إلى وجود نسبة من الطمي(Silt) ومواد عضوية أخرى وأكسجين ذائب ومن أهم المعادن الموجودة في مياه الري"الحديد – السيلكون– الألمونيوم " بالإضافة إلى أملاح " الصوديوم – البوتاسيوم – الماغنيسيوم – البيكربونات – الكبريتات– النترات – الفلوريد– الكلورات" ويمثل الصوديوم والبورون أهم العناصر المحددة لجودة المياه. وتتحدد جودة مياه الري بمعايير تختلف عن معايير قياس المياه المستخدمة في أغراض أخرى حيث تتحدد قيمتها في قدرتها على تحسين العلاقة بين التربة والنبات بالإضافة إلى مدى تحسينها للصفات الطبيعية للتربة التي ينعكس تأثيرها على الإنتاج والمحصول (الوكيل،٢٠١٣).

صلاحية مياه الري تعتمد على عدد من العوامل مثل الملوحة " Salinity " معبرا عنها بتركيز المكونات الصلبة (TDS) بوحدة mg/l وهى التي تؤثر على إنتاجية النبات من خلال تركيز بعض الايونات والتي قد تسبب سمية Toxicity ويمكن أن تؤثر على صحة الإنسان كذلك الصودية التي تشير إلى تركيز ايونات الصوديوم في مياه الري والتي قد تسبب خللاً في بناء التربة. وتختلف صلاحية مياه الري بناء على نوع المحصول ونفاذية التربة والمناخ (Khalil and Arther, 2010).

تتميز منطقة الجبل الأخضر بمخزون جوفي كبير في حوض وادي الكوف الذي يغطى مساحة قدرها ٩٨٠ كم٢ تنحصر في السطح الشمالي للجبل الأخضر الذي متوسط ارتفاعه ٥٨٩ م فوق سطح البحر (عبدالقادر،٢٠٠٨) . تهدف الدراسة إلى تقييم جودة بعض مياه الآبار في بعض مناطق الجبل الأخضر للاستخدامات الزراعية " الري " وتحديد مدى صلاحيتها للري.

مواد وطرائق البحث

أجريت الدراسة الحالية على مجموعة من الآبار الجوفية بمنطقة الجبل الأخضر _ شرق ليبيا وبالتحديد فى بعض المناطق المجاورة لمدينة البيضاء والتى تقع على مسافة ٢٠٠ كم شرق بنغازي والتى تتميز بارتفاعها عن سطح البحر وتتميز بمناخ جاف الى شبه جاف مع معدل سقوط امطار مرتفع نسبيا خلال السنة حيث تم

تقيم جودة مياه الري لبعض الآبار في بعض مناطق الجبل الأخضر البيضاء– ليبيا

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الملخص : أجريت الدراسة الحالية لتقييم جودة وصلاحية بعض مصادر المياه المستخدمة في الري في بعض المناطق بالجبل الأخضر شرق ليبيا. شملت الدراسة المناطق التالية: سيدي محمد الحمري – قندولة – عين مارة – شحات– الحنية. أخذت عينات مياه من هذه المناطق بمعدل مرتين في الشهر في بداية الشهر ونهايته لمدة شهرين متتاليين وذلك بهدف تقيم جودة المياه المستخدمة في الري ومقارنة ذلك بالمعايير القياسية العالمية. تم تقدير المتغيرات التالية: التوصيل الكهربائي (EC) والأس الهيدروجيني pH والايونات الذائبة التي شملت الكاتيونات مثل $Ca2+$, $Mg2+$, $Na+$ and $K+$ والأنيونات مثل $CO3=$, $Cl-$, $SO4=$ بالإضافة إلى تقدير بعض الادلة المحسوبة نظريا والمستخدمة في تقييم مياه الري مثل: SAR, AdjSAR, pHc, RSC, %Mg and SSP. من خلال النتائج المتحصل عليها ومقارنة ذلك بالمعايير القياسية فقد وجد أن هذه الآبار تتميز بمياه ذات درجة جودة مقبولة إلى جيدة ويمكن استخدامها في الري بدون أي تخوف على التربة و المحاصيل المزروعة.

الكلمات الدلالية: مياه الرى– مياه الابار– نسبة إدمصاص الصوديوم – جودة مياه الرى– كربونات الصوديوم المتبقية.

المقدمة

الماء عصب الحياة وأهم مكون من مكوناتها وتقدر كمية المياه على سطح الأرض بحوالي١٤٥٤ مليون كم^3 وتغطى البحار والمحيطات ما يعادل٩٧ % وتقريبا ٢% مياه محتجزة في الجبال الجليدية والباقي في أعماق الأرض(السلاوي، ١٩٨٦). ويستهلك الإنسان ما يقارب ٥% من حجم الماء الكلى لأنهار العالم في السنة والتي تمد الإنسان بمعدل ٣٨٠٠٠ كم^3 من المياه (الجنديل، ١٩٨٦).

الماء احد أهم الموارد الأساسية لنمو وإنتاج المحاصيل الزراعية وبدونه لا حياة للنبات حيث إنه المكون الأساسي لأنسجة النبات كما أنه الوسط الناقل للعناصر الغذائية في التربة وفيه تنتقل العناصر الغذائية في التربة والنبات(بن محمود، ١٩٩٣). تشكل الموارد المائية أهمية محورية للزراعة في العالم وخاصة عند شح هذه الموارد ومع الزيادة في معدل النمو السكاني مما يؤدى إلى زيادة الاستهلاك المائي وخاصة في المناطق التي لا توجد فيها أنهار مما يجعلها معتمدة كليا على الأمطار وبالتالي المياه الجوفية (الحيانى،٢٠٠٩).

تتميز المياه الجوفية (مياه الآبار) بخلوها من المواد العالقة والبكتريا نظرا لتعرضها لعملية الترشيح خلال مرور الماء في الأرض مع احتفاظها بدرجة حرارة ثابتة صيفا وشتاء بالإضافة إلى تميزها بانخفاض درجة التلوث فيها مقارنة بالمياه السطحية مما يجعلها مناسبة للاستعمالات المختلفة وهى المصدر الوحيد لمياه الري في المناطق التي لا توجد فيها أنهار.(هيل، ٢٠٠٨ والجنابنى، ١٩٨٦).

المحتويات

هيئة التحرير

مجلـة

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