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CONTENTS

Effect of Biofloc, Feeding Rate and Dietary Protein Levels on Growth Performance and Feed Utilization of Nile Tilapia, *(Oreochromis niloticus)*, Flathead Grey Mullet, (*Mugil cephalus*) and Thin Lipped Mullet, (*liza ramada)* Fingerlings in Polyculture

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ABSTRACT: The present study was carried out to investigate the effect of biofloc technology (BFT), feeding rate (FR) and dietary protein levels (PL) on growth performance, survival (%) ,feed utilization and economical evaluation parameters of Nile tilapia *(Oreochromis niloticus)* flathead grey mullet*, (Mugil cephalus)* and thin-lipped mullet, (*Liza ramada)* fingerlings. Two different daily feeding rate ($FR^{2\%BW}$ and $FR^{3\%BW}$) and three dietary protein levels ($PL^{20\%}$, $PL^{25\%}$ and $PL^{30\%\ CP}$) under the conditions of regular water exchange system or zero water exchange using BFT (Biofloc technology) were studied. The 12 experimental treatments were studied in duplicate and were allocated in twenty four 16 m^3 concrete ponds. Nile tilapia final body weight (FBW), total weight gain (TWG), average daily gain (ADG), specific growth rate (SGR) (%/ day) and survival (%) were significantly affected by rearing system and feeding rate. Significant difference was observed for the effect of dietary protein level on growth performance of Nile tilapia. It could be concluded that BFT system enhanced survival and growth rates of tilapia and mullet ssp. in polyculture under low feeding levels (2%) and high protein diets (30% CP) regimes.

Keywords: Biofloc, tilapia, mullet, feeding rate, dietary protein level, growth performance, feed utilization, chemical composition, water quality.

INTRODUCTION

Intensive aquaculture systems are used to efficiently produce dense biomasses of fish species. Since fish retain only 20-30% of feed nutrients (Avnimeleoh and Ritvo, 2003), the rest is excreted and typically accumulates in the water. As a result, intensive aquaculture industry faces two major problems. The first is the water quality deterioration caused by the high concentrations of metabolites and the second is the low feed utilization associated with lover water exchange rate. With almost seven billion people on earth, the demand for aquatic food carries on to increase and hence; expansion and intensification of aquaculture production are highly required. The prime goal of aquaculture expansion must be to produce more aquaculture products in sustainability (Avnimelech and Kochba , 2009; Naylor *et al*. 2000) . The second goal is to build up systems providing an equitable cost / benefit to support economic and social sustainability (Avnimelech and Kochba 2009). Biofloc technology is based upon the running of the pond using minimal water exchange; subsequent development of dense microbial population and managing the microbial population through the adjustment of the C/N ratio, so that it controls inorganic nitrogen concentration in the water. The recycling of feed and minimization of water exchange are important contribution to the economy of tilapia production. Monitoring and fast response to negative developments are essential to the success of the culture. The aim of the present work is to invetgate the effects of using biofloc technology (BFT) on growth performance; feed utilization ; chemical composition ; and water quality of Nile tilapia ,(*Oreochromis niloticus)* flathead grey mullet*, (Mugil cephalus)* and thin-lipped, (*Liza ramada)* fingerlings

under two feeding rate (2 and 3 %) and three dietary protein levels 20 , 25 and 30 % in ponds.

MATERIALS AND METHODS

Experimental fish and culture techniques:

Technique and duration:

The present study was carried-out at private fish hatchery belongs to El-kady fish farms group, Mutubis province, Kafr El-Sheik Governorate, Egypt. This experiment started on August, 08, 2014 and continued for 110 days using 2X2X3 in factorial design; two daily feeding rates (2% & 3% BW), three dietary protein levels (20%, 25%, and 30% CP) under zero water exchange biofloc system (BFT) or regular water exchange system (RS). The experimental treatments were subjected to be studied as follows (Table 1)

Table (1). Experimental treatments and design

Treatments	Water exchange	Feeding rate (%)	Protein level (%)
T 1	Regular	2	20
T2	Regular	2	25
T3	Regular	2	30
T4	Regular	3	20
T5	Regular	3	25
T6	Regular	3	30
T7	Biofloc	2	20
T8	Biofloc	2	25
T9	Biofloc	2	30
T10	Biofloc	3	20
T11	Biofloc	3	25
T12	Biofloc	3	30

Concrete ponds:

Twenty four concrete ponds each measuring Approximately 16 m^3 (3×7×0.76 m) width, length and depth of respectively under green-house condition were used, ponds were filled with surface water. Drainage water from draining canal was used as a source of inoculation of microbiota, in addition to 50 gm Urea as a source of nitrogen, while the control ponds were designed under open flow system. The experimental ponds represented the twelve experimental treatments in duplicate.

Rearing techniques:

Nile Tilapia, (*Oreochromis niloticus)*, flathead grey mullet,*(Mugil cephalus)* and thin lipped mullet, (*Liza ramada)* fingerlings 4.5, 10 and 3.5 g/fish, respectively were obtained from private fish farm located in Mutubis province, Kafr El-Sheik Governorate, Egypt. Prior to the start of the experiment, experimental fish were acclimatized to the new water conditions for two weeks and fed on a formulated diet. The fingerlings were stocked in at a density of 159 (145 tilapia+ 5 flathead mullet+ 9 thin-lipped mullet) fish / pond equivalent to 10 fish / m^3. Fish were reared under natural light (12:12 h, light: dark schedule). The water volume was

maintained at approximately 17 $m^{3,}$ and loss of water due to evaporation and leakage was replaced whenever necessary according to water size in BFT ponds. Water in regular system ponds was exchanged system at a rate of 16 m^3/ day equivalent to 100% daily exchange rate per pond, twice daily. Aeration was continuously provided using 5.5 Hp ring air blower (Saad Zakhary Co. for electric motors). Also, agitation was kept at biofloc ponds by continuously strong aeration.

Experimental diets formation and preparation:

The three experimental diets were formulated from fish meal, soybean meal, yellow corn, wheat bran, wheat flour, carboxy methyl cellulose (CMC), ascorbic acid, vegetable oil, vitamins and minerals mixture. Ingredients were obtained from the local market and the dry ingredients were mixed thoroughly at first and with oil thereafter. The experimental diets were pelleted, all diets were put into plastic bags after samples had been taken and stored in deep freezer until use. The composition (%) and Chemical analysis (% dry matter basis) of experimental diets are presented in Table 2.

Table (2). Formula and chemical analysis (%) of the experimental diets.

Ingredients	20% CP	25%CP	30%CP
Fish meal	20	40	50
Soy bean meal	185	225	350
Rice polishing	260.5	225.5	125.5
Wheat middling's	250	200	180
Corn gluten	50	100	110
Corn grain	200	175	150
Veg. oil	1.5	1.5	1.5
Salt	5	5	5
Di cal.	25	25	25
Vit. and Min[1]. premix	3	3	3
CMC[2]			
Total	**1000**	**1000**	**1000**
Proximate composition %			
Moisture	7.20	7.00	6.90
Dry matter	92.80	93.00	93.10
Crude protein	20.46	25.15	30.17
Ether extract	10.14	10.38	11.31
Crude fiber	7.25	6.81	6.06
Ash	7.40	8.54	8.93
NFE[3]	54.75	49.12	43.54
GE[4] Kcal/ 100 g diet)[4]	436.10	441.75	455.82

(1)Vitamins and minerals mixture : Each 1 kg contains Vit A (400000 i.u.), Vit D (100000 i.u.), Vit E (250 mg,) Vit K3 (200 mg,) Vit B1 (200 mg), Vit B2 70mg, Vit B6 (200mg), Vit B12 (1mg), Vit C 450mg, Niacin 1000mg, Methionine1000mg, Cholin chloride 10000mg, Folic acid 100mg, Biotin 2mg, Panthonic acid 220mg, Magnesium sulphate 1000mg, Copper sulphate 1000mg, Iron sulphate 3000mg, Zinc sulphate , 600mg, Cobalt sulphate 100mg, Carrier upto 1000mg.

(2) CMC: Carboxy methyl cellulose

(3) Total carbohydrate =100-(CP+EE+Ash+ CF)

(4) Gross energy (GE) was calculated as 5.64, 9.44 and 4.11 kcal/g for protein, lipid and NFE, respectively NRC, (2012).

Feeding regime:

All fish were fed the experimental diets (20, 25, and 30% CP) using daily ration of 2 or 3 % of the total stocked biomass two times daily.

Water quality and samples:

Water quality parameters were monitored during the study period to follow the changes under biofloc system compared to control treatments (regular water exchange). Temperature and pH values of the water samples were measured using graduating thermometer and portable digital pH meter Martini Instruments (Model 201/digital). Water salinity and total dissolved solid (TDS) were measured using Salinometer Y.S.I (Bekman, Model RS-10). Dissolved oxygen was measured using oxygen meter model Hanna oxy check. Organic phosphorus were measured by seal AA3 auto analyzer. Ammonia, Nitrite, and Nitrate were measured every week calorimetrically by kites according to the Animal Health Research Institute (AHRI) Biomedical Chemistry Unite.

Fish sampling:

Representative fish in each pond were weighted every 15 days to the nearest 0.00 g to adjust the feed quantity.

Carbon levels for biofloc system:

Starch was added according to the amount of feeding ration introduced to fish in order to maintain the optimal C/N ratio, (>10- 25: 1) to activate heterotrophic bacteria growth (Avnimelech, 1999). Starch had been completely dissolved in water at plastic barrel, and spread over the pond surfaces at 10 am. Adding starch as a carbohydrate source, shading ponds, and strong aeration condition are the main circumstances that cause floc growth and development (Azim and Little, 2008).

Growth performances, feed utilization parameters, and Survival rate:

Growth indices:

At the end of the experiment random fish samples were selected and weighted to determine mean final body weight (FBW), Total weight gain (TWG), average daily gain (ADG), specific growth rate (SGR %) and feed conversion ratio (FCR), which were calculated according to (El-Saidy and Gaber, 2004).

Feed Intake and Feed conversion ratio were also calculated according to (Azim and Little, 2008).

Survival %:

Survival % was calculated in all experimental units according to Ricker (1975) and Newman and Martin (1983) .

Survival (%) = (No. of fish at the end / No. of fish at the start) × 100

Proximate analysis:

Fish and diets analysis:

At the beginning and the end of the trial, random pooled samples of fish and diets were collected and sacrificed for determination of initial whole-body proximate or chemical composition were done according to AOAC (1995 and 2000).

Analytical methods

1) Physico-chemical parameters of water

Water dissolved oxygen, pH, , nitrite and nitrate were determined according to (APHA,1999 and Grasshoff *et al*., 1999)

2) Biofloc volume (FV)

Biofloc volume (FV) was determined on site using Imhoff cones daily registering the volume taken in by the flocs in 1000 ml of the tank water after 30 min sedimentation (Avnimelech and Kochba, 2009).

3) Statistical analysis:

Data of the experiment were analyzed using two ways ANOVA. Significant differences ($p \leq 0.05$) among means were tested by the method of Duncan (1955).The analyses of variance (ANOVA) were made according to Snedecor and Cochran (1981).

RESULTS AND DISCUSSION

Water quality

The overall mean, standard error, and range of water temperature, dissolved oxygen and pH are displayed in Table 3. All the environmental variables during the study period were within the range considered suitable for the culture of Nile tilapia.

A temperature in water of all treatments was in optimal condition for fish culture which ranged from 26.0-27.5℃ (Table 3). Tekelioglu (1998) recommended a preferred temperature values for tilapia between 20 to 35 ℃.

No significant differences in pH were found among treatments. pH was lower in the T9 (ranged from 7.91- 8.54) compared to T1 (ranged 7.81- 8.82). The pH were lower in the T9 treatments, suggesting a reducing condition in such treatments, probably due to the activity of heterotrophic bacteria, which release CO_2 to the water column causing a pH decrease. Contrarily, in the regular water exchange system (RS) treatments, where the photosynthesis was enhanced, the phytoplankton in agriculture drain water produced CO_2 during the night, but sequesters it during the day, causing pH increases. A similar trend was observed by many authors (Tacon *et al*., 2002 and Wasielesky *et al*., 2006). In addition others, (Chen *et al*., 2006; Ebeling *et al*., 2006 and Rijn *et al*., 2006) reported a decrease in pH during the chemoautotrophic nitrification process as a result of $CaCO_3$ consumption and the release of CO_2 and pH into

the culture medium. The significant increase in pH may have been as the result of enhanced photosynthesis.

Dissolved oxygen remained within the recommended range for growth of tilapia. By aerating the DO average was kept above 5 mg/L these values within the recommended levels of DO as reported by many researchers (El-Sayed, 2006; Kutty, 1996; Tsadik and Kutty, 1987 and Bergheim, 2007). The incidents of increased DO were higher in the regular water exchange treatments T1-T6 (ranged from 5.06 to 6.7 mg/L) compared to zero-exchange water system T7-T12 (ranged from 5.0 to 5.9 mg/L). This may explained by the high consumption of dissolved oxygen by heterotrophic organisms in biofloc treatments.

The concentrations of nitrogen species measured during this study are presented in Table 3. The incidents of increased TAN and nitrite–N were higher in the regular water exchange treatments T1-T6 compared to zero-exchange water system T7-T12. T1 showed relatively higher Total Ammonia Nitrogen (TAN) (0.61 mg/L) concentrations. The difference in TAN concentrations between regular exchange water and the other BFT treatments was expected as there is increase in the heterotrophic bacteria activities in BFT treatment which process to decrease TAN by nitrification.

Within the BFT treatments nitrate–N gradually decreased in all treatments, this may be explained by the low dose of nitrogen delivered for the system (Kirchman, 1994; Middelburg and Nieuwenhuize, 2000).

The significant low TAN and NO_2 values recorded for regular water exchange treatments. This decrease probably relates to nitrogen species uptake by phytoplankton in these treatments in particular when there is limited ammonia-N available in the water (Hargreaves, 1998).

Table (3). Mean±SE of water quality criteria in ponds as affected by rearing system, feeding levels and dietary protein levels

Treatment	Temp. Cº	pH	O_2 (mg/L)	TAN (mg/L)	NO_2 (mg/L)	NO_3 (mg/L)
T1	26.63±0.57a (26.0-27.5)	8.21±0.38a (7.81-8.82)	6.11±0.4ab (5.43-6.48)	0.58±0.4ab (0.15-0.95)	0.35±0.3a (0.20-0.95)	0.35±0.26a (0.17- 0.84)
T2	26±00c (26-26)	8.14±0.33a (7.76-8.55)	6.14±0.39ab (5.56-6.52)	0.59±0.26ab (0.17-0.83)	0.21±0.012a (0.19-0.23)	0.30±0.17a (0.18-0.54)
T3	26.2±0.31bc (26-26.6)	8.13±0.282a (7.82-8.49)	6.24±0.45a (5.56-6.7)	0.61±0.27a (0.17-0.95)	0.21±0.03a (0.16-0.25)	0.24±0.12a (0.15-0.40)
T4	26.38±0.3ab (26-26.6)	8.16±0.34a (7.73-8.52)	6.09±0.36ab (5.65-6.43)	0.49±0.31abc (0.10-0.85)	0.23±0.02a (0.20-0.27)	0.30±0.11a (0.19-0.44)
T5	26±00c (26-26)	8.11±0.34a (7.72-8.56)	6.1±0.49ab (5.43-6.43)	0.45±0.34abcd (0.1-0.89)	0.22±0.05a (0.18-0.32)	0.24±0.11a (0.15-0.45)
T6	26.25±0.274c (26-26.5)	8.12±0.32a (7.75-8.56)	6.36±0.4a (5.79-6.70)	0.31±0.23cbd (0.12-0.64)	0.22±0.02a (0.2-0.25)	0.24±0.09a (0.170-0.37)
T7	26±0c (26-26)	8.1±0.19a (7.87-8.4)	5.31±0.21bc (5.06-5.56)	0.19±0.03d (0.15-0.23)	0.35±0.39b (0.02-0.89)	0.1±0.09b (0.02-0.27)
T8	26±0.0c (26-26)	8.12±0.18a (7.94-8.41)	5.31±0.19bc (5.07-5.56)	0.22±0.05cd (0.18-0.31)	0.3±0.04b (0.02-0.85)	0.06±0.03b (0.02-0.09)
T9	26.25±0.27bc (26-26.5)	8.07±0.25a (7.91-8.54)	5.43±.32bc (5-5.93)	0.20±0.03d (0.15-0.24)	0.31±0.4b (0.02-0.85)	0.06±0.02b (0.03-0.08)
T10	26.08±0.20bc (26-26.5)	8.12±0.28a (7.9-8.66)	5.48±0.22bc (5.06-5.7)	0.2±0.02d (0.17-0.24)	0.31±0.4b (0.02-0.91)	0.06±0.03b (0.02-0.09)
T11	26.25±0.27bc (26-26.5)	8.01±0.1a (7.91-8.19)	5.46±0.3c (5.0-5.93)	0.22±0.02d (0.18-0.26)	0.28±0.36b (0.02-0.76)	0.03±0.02b (0.02-0.08)
T12	26.17±0.26bc (26-26.5)	8.09±0.24a (7.9-8.51)	5.52±0.07bc (5.43-5.61)	0.25±0.07cd (0.17-0.34)	0.31±0.39b (0.02-0.82)	0.07±0.02b (0.05-0.09)

Means in the same column having different letters are significantly (P≤0.05) different.

Growth performance

Nile tilapia

Table (4) are summarized the growth performance parameters of tilapia as affected by the experimental treatments rearing system had also effects on FBW. BFT group had significantly higher FBW (75.33 g/fish) compared to the RS group (70.54 g/fish). Feeding rate factor had effects on FBW $FR^{3\%}$ group had significantly higher FBW (75.108 g/fish) compared to the $FR^{2\%}$ group (70.77 g/fish). Dietary Protein level factor had no effects on FBW. The same trend was observed for FWG, ADG and SGR.

The interactions between rearing system, feeding level and dietary protein level had significant difference on FBW, TWG, ADG and SGR. The highest values were recorded by T12 group (77.50 g/fish, 72.90 g/fish, 0.66 g/day and 2.57 %/day, respectively), while the lowest values were recorded by T1 group (59.41 g/fish, 54.81 g/fish, 0.50 g/day and 2.33 %/day, respectively).

Flathead grey mullet

Table 5 is summarized the growth performance parameters of grey mullet as affected by the experimental treatments Rearing system factor levels had effects on FBW. BFT group had significantly higher FBW (118.83 g) compared to the RS group (103.54 g/fish). Feeding rate factor had effects on FBW. $FR^{3\%}$ group had significantly higher FBW (114.58 g) compared to the $FR^{2\%}$ group (107.79 g/fish). Dietary Protein level factor had significant effects on FBW. $PL^{30\%}$ group had significantly higher FBW (114.63 g) compared to the

$PL^{20\%}$ and $PL^{25\%}$ group (107.18 and111.57 g/fish, respectively). The same trend was observed for TWG, ADG and SGR.

The interactions between rearing system, feeding level and dietary protein level had significant difference on FBW, TWG, ADG and SGR. The highest values were recorded by T12 group (126.50 g/fish, 116.50 g/fish, 1.2 g/day and 2.31 %/day, respectively), while the lowest values were recorded by T1 group (95.73 g/fish, 85.73 g/fish, 0.85 g/day and 2.05 %/day, respectively).

Thin-lipped mullet

Table 6 is summarized the growth performance parameters of thin-lipped mullet as affected by the experimental treatments rearing system factor levels had effects on FBW. BFT group had significantly higher FBW (52.0 g/fish) compared to the RS group (44.0 g/fish). Feeding rate factor had effects on FBW. $FR^{2\%}$ group had significantly higher FBW (30.81 g/fish) compared to the $FR^{3\%}$ group (25.8 g/fish). Dietary Protein level factor had significant effects on FBW. $PL^{30\%}$ group had significantly higher FBW (51.75 g) compared to the $PL^{20\%}$ and $PL^{25\%}$ group (44.50 and 47.75 g/fish, respectively). The same trend was observed for TWG, ADG and SGR.

The interactions between rearing system, Feeding rateand dietary protein level had significant difference on FBW, TWG, ADG and SGR. The highest values were recorded by T12 group (59.0 g/fish, 55.50 g/fish, 0.5 g/day and 2.568 %/day, respectively), while the lowest values were recorded by T1 group (39.0 g/fish, 35.50 g/fish, 0.323 g/day and 2.19%/day, respectively).

Different studies have reported enhanced survival, health, and growth rates of fish and shrimps raised in ponds with high activity of algae, microbial flocs, and other natural biota (Avnimelech, 1999; Moss *et al*., 2000 and Burford *et al*., 2004). However it is not yet known exactly how microbial flocs enhance growth, but Izquierdo *et al.* (2006) suggested lipid contributions of microbial flocs are significant. Avnimelech (1999) reported that the microbial protein supplied by the stocked fish biomass was enough to supplement the protein provided by the fish feed.

In culture systems, together with microbial flocs acting as a feed also do play some important ecological roles. The deterioration of water quality due to unconsumed feed, fecal matter of cultured organisms or the presence of other organic matter in culture facilities is nullified because the floc microbes act as conditioner for water. This always control excess nitrogen. The subsequent uptake of nitrogen from the water facilitated synthesis of microbial protein. Hence biofloc based aquaculture system also offers potential to use as zero exchange recirculation aquaculture system (Avnimelech, 2007).

Many of previous studies have shown that growing shrimp (L. vannamei) in biofloc systems can improve shrimp survival and growth performance, compared to clear water (Cohen *et al*. 2005; Azim & Little 2008; Mishra *et al*. 2008). One reason for the improved performance is probably related to harvesting and consuming bioflocs by the shrimp. The second reason is therefore, it is assumed that the presumptively large quantity of bacteria

associated with bioflocs may contribute to enhance the immunity as well as growth performance of shrimp when the bioflocs are consumed by shrimp (Rao *et al*., 2010).

Table (4). Effects of different experimental treatments (rearing system, feeding rates and dietary protein levels on growth performance and survival rates of Nile tilapia fingerlings.

Treatment	Rearing system	Feeding rate	Protein level	IBW (g/fish)	FBW (g/fish)	TWG (g/fish)	ADG (g/fish)	SGR	Survival %
Regular system	Regular system	-	-	4.56a ±0.02	70.54b ±1.75	65.99b ±1.75	0.60 b ±0.02	2.49 b ±0.02	98.28a ±0.2
BFT System	BFT system	-	-	4.566a ±0.014	75.33a ±0.466	70.77a ±0.459	0.64a ±0.004	2.55a ±0.005	99.66a ±0.143
$FR^{2\%}$	-	2%	-	4.575a ±0.013	70.77b ±1.779	66.19b ±1.778	0.60b ±0.016	2.49b ±0.024	98.97a ±0.30
$FR^{3\%}$	-	3%	-	4.550a ±0.015	75.11a ±0.538	70.56a ±0.527	0.64a ±0.005	2.55a ±0.005	98.97a ±0.232
$PL^{20\%CP}$	-	-	20%	4.562a ±0.018	70.57a ±2.509	66.00a ±2.515	0.60a ±0.023	2.49a ±0.035	98.88a ±0.343
$PL^{25\%CP}$	-	-	25%	4.55a ±0.019	73.59a ±1.054	69.04a ±1.051	0.63a ±0.009	2.53a ±0.013	98.88a ±0.345
$PL^{30\%CP}$	-	-	30%	4.575a ±0.016	74.66a ±1.209	70.09a ±1.198	0.64a ±0.011	2.54a ±0.013	99.14a ±0.313
T1	Regular	2%	20%	4.600a ±0.00	59.41c ±0.308	54.81d ±0.308	0.498d ±0.003	2.33d ±0.005	97.59d ±0.345
T2	Regular	2%	25%	4.550a ±0.050	69.30b ±1.300	64.75c ±1.350	0.59c ±0.012	2.48c ±0.027	97.93d ±0.69
T3	Regular	2%	30%	4.550a ±0.050	71.40ab ±4.30	66.85bc ±4.25	0.61bc ±0.038	2.50bc ±0.045	99.31d ±0
T4	Regular	3%	20%	4.550a ±0.050	73.35ab ±2.75	68.80abc ±2.70	0.63abc ±0.024	2.53abc ±0.024	98.62cd ±0
T5	Regular	3%	25%	4.550a ±0.050	74.55ab ±0.45	70.00abc ±0.40	0.64abc ±0.004	2.54ab ±0.004	98.28cd ±0.345
T6	Regular	3%	30%	4.550a ±0.050	75.25ab ±0.95	70.70abc ±0.90	0.64abc ±0.008	2.55ab ±0.001	97.93d ±0
T7	BFT	2%	20%	4.600a ±0.00	75.00ab ±1.00	70.40abc ±1.00	0.64abc ±0.009	2.54abc ±0.012	99.66ab ±0.345
T8	BFT	2%	25%	4.550a ±0.050	75.00ab ±2.00	70.45abc ±1.95	0.64abc ±0.018	2.55ab ±0.014	100 a ±0
T9	BFT	2%	30%	4.600a ±0.00	75.00ab ±1.50	69.90abc ±1.50	0.64abc ±0.014	2.53abc ±0.018	99.31abc ±0.69
T10	BFT	3%	20%	4.500a ±0.00	74.50ab ±0.50	70.00abc ±0.50	0.64abc ±0.005	2.55ab ±0.006	99.66ab ±0.345
T11	BFT	3%	25%	4.550a ±0.050	75.50a ±0.50	70.95ab ±0.45	0.65ab ±0.004	2.55ab ±0.004	99.31abc ±0
T12	BFT	3%	30%	4.600a ±0.00	77.50a ±0.50	72.90a ±0.50	0.66a ±0.005	2.57a ±0.006	100a ±0

Means in the same column having different letters are significantly (P≤0.05) different.

Table (5). Effects of different experimental treatments (rearing system, feeding rates and dietary protein levels on growth performance and survival rates of flathead grey mullet fingerlings

Treatment	Rearing system	Feeding rate	Protein level	IBW (g/fish)	FBW (g/fish)	TWG (g/fish)	ADG (g/fish)	SGR	Survival rate %
Regular system	Regular system	-	-	10.12a ±0.06	103.54b ±1.99	93.42b ±1.97	0.98b ±0.02	2.11b ±0.02	100 ±0
BFT System	BFT system	-	-	10.18a ±0.08	118.83a ±1.34	108.65a ±1.34	1.13a ±0.01	2.23a ±0.01	100 ±0
FR2%	-	2%	-	10.17a ±0.07	107.79a ±3.09	97.62a ±3.06	1.01a ±0.03	2.14a ±0.02	100 ±0
FR3%	-	3%	-	10.13a ± 0.07	114.58a ±2.17	104.45a ±2.18	1.09a ±0.02	2.20a ±0.02	100 ±0
PL20%CP	-	-	20%	10.19a ±0.09	107.18a ±3.1	97c ±3.05	1.00c ±0.04	2.14a ±0.02	100 ±0
PL25%CP	-	-	25%	10.13a ±0.08	111.75a ±3.31	101.63b ±3.31	1.06b ±0.03	2.18a ±0.03	100 ±0
PL30%CP	-	-	30%	10.14a ±0.09	114.63a ±3.74	104.49a ±3.73	1.09a ±0.03	2.2a ±0.03	100 ±0
T1	Regular	2%	20%	10.00a ±0.00	95.73e ±1.93	85.73e ±1.93	0.85e ±0.02	2.05e ±0.05	100 ±0
T2	Regular	2%	25%	10.200a ±0.2	98.00ed ±1.00	87.8e ±0.8	0.94d ±0.01	2.05e ±0.01	100 ±0
T3	Regular	2%	30%	10.00a ±0.00	100.00ed ±2.00	90.00ed ±2.00	0.95d ±0.02	2.09ed ±0.02	100 ±0
T4	Regular	3%	20%	10.20a ±0.2	103.50d ±0.5	93.30d ±0.3	0.99d ±0.01	2.11d ±0.01	100 ±0
T5	Regular	3%	25%	10.00a ±0.00	111.00c ±1.00	101.0c ±1.00	1.05c ±0.01	2.19c ±0.01	100 ±0
T6	Regular	3%	30%	10.30a ±0.3	113.00c ±1.0	102.70c ±1.3	1.07bc ±0.03	2.18c ±0.01	100 ±0
T7	BFT	2%	20%	10.25a ±0.25	115.00bc ±0.00	104.75bc ±0.25	1.09bc ±0.02	2.2c ±0.0	100 ±0
T8	BFT	2%	25%	10.30a ±0.3	119.00b ±3.00	108.7b ±2.7	1.13ab ±0.004	2.22bc ±0.03	100 ±0
T9	BFT	2%	30%	10.25a ±0.25	119.00b ±3.00	108.75b ±2.75	1.13ab ±0.0007	2.23bc ±0.03	100 ±0
T10	BFT	3%	20%	10.30a ±0.3	114.50bc ±2.5	104.20bc ±2.2	1.09bc ±0.007	2.19c ±0.022	100 ±0
T11	BFT	3%	25%	10.00a ±0.00	119.00b ±1.00	109.00b ±1.00	1.13ab ±0.01	2.25b ±0.01	100 ±0
T12	BFT	30%	30%	10.00a ±0.00	126.50a ±0.50	116.50a ±0.50	1.20a ±0.004	2.31a ±0.005	100 ±0

Means in the same column having different letters are significantly (P≤0.05) different.

Table (6). Effects of different experimental treatments (rearing system, feeding rates and dietary protein levels on growth performance and survival rates) of Liza ramada fingerlings

Treatment	Rearing system	Feeding rate	Protein level	IBW (g/fish)	FBW g/fish)	TWG (g/fish)	ADG (g/fish)	SGR	Survival %
Regular system	Regular system	-	-	3.542a ±0.023	44.00b ±1.135	40.46b ±1.135	0.368b ±0.010	2.29b ±0.024	100 ±0
BFT System	BFT system	-	-	3.51a ±0.01	52.00a ±1.308	48.491a ±1.308	0.441a ±0.012	2.45a ±0.023	100 ±0
$FR^{2\%}$	-	2%	-	3.170a ±0.063	30.81a ±3.485	27.643a ±3.513	0.251a ±0.032	2.02a ±0.095	100 ±0
$FR^{3\%}$	-	3%	-	3.143a ±0.071	25.8b ±1.401	22.654b ±1.362	0.206b ±0.012	1.902b ±0.039	100 ±0
$PL^{20\%CP}$	-	-	20%	3.537a ±0.026	44.50c ±1.822	40.962c ±1.832	0.372c ±0.017	2.296c ±0.04	100 ±0
$PL^{25\%CP}$	-	-	25%	3.500b ±0.019	47.75b ±1.943	44.25b ±1.942	0.402b ±0.018	2.370b ±0.036	100 ±0
$PL^{30\%CP}$	-	-	30%	3.537a ±0.018	51.75a ±1.75	48.21a ±1.762	0.438a ±0.016	2.436a ±0.034	100 ±0
T1	Regular	2%	20%	3.500d ±0.00	39.00j ±1.00	35.50k ±1.00	0.323k ±0.009	2.191k ±0.023	100 ±0
T2	Regular	2%	25%	3.500dv ±0.00	41.50i ±0.500	38.00i ±0.500	0.345i ±0.004	2.248i ±0.011	100 ±0
T3	Regular	2%	30%	3.600b ±0.00	47.00f ±2.00	43.40f ±2.00	0.394f ±0.018	2.335h ±0.039	100 ±0
T4	Regular	3%	20%	3.650a ±0.050	41.50i ±0.500	37.85j ±0.550	0.344j ±0.005	2.21j ±0.023	100 ±0
T5	Regular	3%	25%	3.450e ±0.050	45.50h ±0.500	42.05h ±0.550	0.382h ±0.005	2.345f ±0.023	100 ±0
T6	Regular	3%	30%	3.550c ±0.050	49.50d ±0.500	45.95d ±0.550	0.418d ±0.005	2.395d ±0.022	100 ±0
T7	BFT	2%	20%	3.500d ±0.00	46.00g ±1.00	42.50g ±1.00	0.386g ±0.009	2.341g ±0.02	100 ±0
T8	BFT	2%	25%	3.550c ±0.050	48.50e ±0.500	44.95e ±0.550	0.409e ±0.005	2.377e ±0.022	100 ±0
T9	BFT	2%	30%	3.500d ±0.00	51.50c ±0.500	48.00c ±0.500	0.436c ±0.004	2.444c ±0.01	100 ±0
T10	BFT	3%	20%	3.500d ±0.00	51.50c ±0.500	48.00c ±0.500	0.436c ±0.004	2.444c ±0.01	100 ±0
T11	BFT	3%	25%	3.500d ±0.00	55.50b ±0.500	52.00b ±0.500	0.473b ±0.004	2.512b ±0.01	100 ±0
T12	BFT	3%	30%	3.500d ±0.00	59.00a ±1.00	55.50a ±1.00	0.504a ±0.01	2.57a ±0.015	100 ±0

Means in the same column having different letters are significantly (P≤0.05) different.

Feed intake and utilization

Feed intake and utilization are tabulated in (Table 7 and 8). The rearing system factor revealed higher significant amounts on feed intake. RS fish consumed significantly higher amount of feed (84.16 g/fish) compared with fish cultured under BFT condition (75.2 g/fish). Feeding levels had significant effects on feed intake. $FR^{3\%}$ Fish consumed significantly higher amount of feed (99.42 g/fish) compared with $FR^{2\%}$ group (59.94 g/fish). Also two-way ANOVA

showed a significant effect due to the interaction among rearing system, Feeding rate and dietary protein levels on feed intake.

The highest amount of feed intake was recorded by T4 group (108.40 g), which was statistically different ($P<0.05$) compared with other groups. T7 group consumed the lowest amount of feed intake (56.84 g).

Rearing system showed significant effects on mass weight gain of cultured fish and FCR ($P<0.05$). The best mass weight gain and FCR figures were obtained by fish reared in BFT system (70.7 g and 1.06), respectively compared to (65.4 g and 1.27) respectively which obtained by fish reared in regular system. The experimental feeding rate had significant effects on mass gain and FCR. $FR^{3\%}$ recorded the highest figures compared to the lowest feeding rate ($FR^{2\%}$).

The dietary protein level factor had no significant effects on mass weight gain and FCR. The interaction between rearing system feeding level and dietary protein levels showed significant difference on both mass weight gain and FCR. The range of FCR lied from 0.81 to1.6. Fish groups in T7 (raised under BFT, 2% feeding rate and at 20% crude protein diet) had achieved the best FCR (0.81) compared to other groups (Table 7).

These results might be due to the conditions of zero water exchange probably contributed to the decrease of the FCR in all the treatments because there was not any release of nutrients in effluents, which favored the formation of a nutrient cycling through the food chain. Nutrient cycling has been documented in systems without water exchange in which natural feed was promoted.

The result obtained for FCR in this study agrees with finding of Avnimelech, (2007) who reported that the feed contribution of microbial flocs in the tested ponds contributed close to 50% of fish protein requirement. The high number of protozoa and rotifers in the BFT communities' contributed to better shrimp performance in BFT treatments compared to the control as shown by Thompson *et al*. (2002). Avnimelech, (2006) showed that recovery of nitrogenous compounds from culture systems with tilapia could be increased from 25% to 50% under biofloc technology.

Table (7). Mass growth performance parameters and survival rates of Nile tilapia flathead and thin-lipped mullet as affected by experimental treatments. (rearing system, feeding rates and dietary protein levels (Mean± SE)

Treatment	Rearing system	Feeding rate %	Protein level %	IBW (g/fish)	FBW (g/fish)	TWG (g/fish)	ADG (g/fish/day)	SGR	Survival %
				Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE
Regular system	Regular system	-	-	4.68a ±0.01	70.07b ±1.68	65.4b ±1.68	0.59b ±0.02	2.46b ±0.02	98.43b ±0.16
BFT System	BFT system	-	-	4.68a ±0.01	75.38a ±0.49	70.7a ±0.49	0.64a ±0.00	2.53a ±0.01	99.69a ±0.09
$FR^{2\%}$	-	2%	-	4.68a ±0.01	70.50b ±1.75	65.81b ±1.75	0.6b ±0.02	2.46b ±0.02	99.06a ±0.25
$FR^{3\%}$	-	3%	-	4.67a ±0.01	74.95a ±0.62	70.28a ±0.61	0.64a ±0.01	2.52a ±0.01	99.06a ±0.21
$PL^{20\%CP}$	-	-	20%	4.68a ±0.02	70.24b ±2.44	65.56b ±2.45	0.6b ±0.2	2.458b ±0.3	98.98a ±0.31
$PL^{25\%CP}$	-	-	25%	4.67a ±0.02	73.32b ±1.14	68.65b ±1.13	0.62b ±0.01	2.5b ±0.01	98.98a ±0.29
$PL^{30\%CP}$	-	-	30%	4.69a ±0.01	74.62a ±1.13	69.93a ±1.22	0.64a ±0.01	2.51a ±0.01	99.21a ±0.26
T1	Regular	2%	20%	4.71a ±0.0	59.39d ±0.40	54.69d ±0.40	0.5d ±0	2.30e ±0.01	97.8e ±0.31
T2	Regular	2%	25%	4.67a ±0.05	68.62c ±1.18	63.95c ±1.23	0.58c ±0.01	2.44d ±0.03	98.11de ±0
T3	Regular	2%	30%	4.67a ±0.05	70.92bc ±3.74	66.25bc ±3.7	0.60bc ±0.03	2.47dc ± 0.04	99.37b ±0
T4	Regular	3%	20%	4.68a ±0.05	72.48bc ±2.55	67.81bc ±2.50	0.62bc ±0.02	2.49abc ±0.02	98.74c ±0
T5	Regular	3%	25%	4.66a ±0.05	74.04ab ±0.35	69.38ab ±0.3	0.63ab ±0.0	2.51abc ±0.01	98.43cd ±0.31
T6	Regular	3%	30%	4.67a ±0.03	74.97ab ±0.93	70.3ab ±0.89	0.64ab ±0.01	2.52abc ±0.0	98.11de± 0.0
T7	BFT	2%	20%	4.72a ±0.01	74.62ab ±0.97	69.9ab ±0.98	0.64ab ±0.01	2.51abc ±0.01	99.69ab ±0.31
T8	BFT	2%	25%	4.67a ±0.06	74.88ab ±1.9	70.21ab ±1.83	0.64ab ±0.02	2.52ab ±0.01	100a ±000
T9	BFT	2%	30%	4.72a ±0.01	74.6ab ±1.3	69.88ab ±1.31	0.64ab ±0.01	2.51abc ±0.02	99.37b ±00
T10	BFT	3%	20%	4.63a ±0.01	74.47ab ±0.35	69.83ab±0 .36	0.63ab ±0.003	2.53abc ±0.01	99.69ab ±0.31
T11	BFT	3%	25%	4.66a ±0.5	75.74ab ±0.4	71.08ab ±0.35	0.65ab ±0.003	2.53ab ±0.004	99.37b ±0
T12	BFT	3%	30%	4.71a ±0.0	77.99a ±0.53	73.29a ±0.53	0.67a ±0.004	2.55a ±0.01	100a ±00

Means in the same column having different letters are significantly (P≤0.05) different.

Table (8). Feed utilization parameters of Nile tilapia flathead and thin-lipped mullet as affected by experimental treatments (rearing system, feeding rates and dietary protein levels (Mean± SE)

Treatment	Rearing system	Feeding rate %	Protein level %	FI (g)	FCR(g)	PI	PER
				Mean± SE	Mean±SE	Mean±SE	Mean±SE
Regular system	Regular system	-	-	84.16a ±6.86	1.27a ±0.08	21.31a ±2.05	3.33b ±0.25
BFT System	BFT system	-	-	75.2b ±5.41	1.06b ±0.07	18.99b ±1.63	4.03a ±0.34
FR2%	-	2%	-	59.939b ±1.62	0.92b ±0.03	15.21b ±0.94	4.48a ±0.26
FR3%	-	3%	-	99.42a ±2.55	1.42a ±0.04	25.10a ±1.33	2.88b ±0.15
PL20%CP	-	-	20%	78.33a ±8.37	1.19a ±0.11	16.03c ±1.71	4.37a ±0.42
PL25%CP	-	-	25%	80.61a ±7.77	1.17a ±0.1	20.27b ±1.96	3.61b ±0.34
PL30%CP	-	-	30%	80.10a ±7.59	1.14a ±0.10	24.16a ±2.29	3.07c ±0.27
T1	Regular	2%	20%	57.57c ±142	1.05d ±0.03	11.78h ±0.29	4.65b ±0.15
T2	Regular	2%	25%	64.22c ±7.68	1.00d ±0.10	16.15fg ±1.93	4.01c ±0.40
T3	Regular	2%	30%	65.24c ±5.61	0.98ed±0.03	19.68ed ±1.69	3.37de ±0.10
T4	Regular	3%	20%	108.40a ±2.61	1.6a ±0.02	22.18cd ±0.53	3.06fe ±0.04
T5	Regular	3%	25%	101.82ab±8.86	1.47ab±0.12	25.61bc ±2.23	2.73f ±0.23
T6	Regular	3%	30%	107.71a ±2.82	1.53ab±0.02	32.49a ±0.85	2.16g ±0.03
T7	BFT	2%	20%	56.84c ±2.49	0.81f ±0.02	11.63h ±0.51	6.02a ±0.18
T8	BFT	2%	25%	57.92c ±0.72	0.83ef ±0.01	14.57hg ±0.18	4.82b ±0.07
T9	BFT	2%	30%	57.84c ±2.05	0.83ef ±0.04	17.45ef ±0.62	4.01c ±0.22
T10	BFT	3%	20%	90.52b ±0.32	1.3c ±0.002	18.52ef ±0.07	3.77cd ±0.01
T11	BFT	3%	25%	98.46ab ±1.63	1.39bc±0.02	24.76bc ±0.41	2.87fe ±0.03
T12	BFT	30%	30%	89.61b ±1.11	1.22c ±0.02	27.03b ±0.33	2.71f ±0.05

Means in the same column having different letters are significantly (P≤0.05) different.

Biofloc composition .

Mean values on dry matter basis of the proximate analysis from pooled samples collected during floc harvesting for the different treatments are presented in (Table 9). Proximate analysis of BFT from the current study indicates the presence of 30.63 % crude protein in the T11 BFT system, 3% feeding rate at 25% protein diet which was higher than for the other treatments (Table 9). Protein content generally was higher in T10, T11 and T12 treatments which fed at a rate of 3% (ranged from 26.250 to 30.63%) than in T10, T11 and T12 treatments which fed 2% feeding rate (ranged from 25.10 to 25.72%). The higher protein concentration in bioflocs of the high feeding level treatments may be related to the chemical composition of heterotrophic bacteria and other organisms associated to bioflocs and biofilms (Fernandes *et al*., 2008). Also, the high Zooplankton organisms (high in protein) which maybe increased with the increasing feeding level, consume both bacteria and algae and may be considered as another reason.

There were significant differences in crude lipid among the ponds (ranged from 2.22%to 4.16%).

Lipid content generally was higher in T10, T11 and T12 treatments which fed 3% Feeding rate(ranged from 3.65 to 4.27%) than in T10, T11 and T12 treatments which fed 2% feeding rate(ranged from 2.12 to 2.51%). The higher lipid concentration in bioflocs of the high feeding level treatments may be

related to the chemical composition of heterotrophic bacteria and other organisms associated to bioflocs and biofilms (Fernandes *et al*., 2008). Also, the high Zooplankton organisms (high in lipid) which maybe increased with the increasing feeding level, consume both bacteria and algae and may be considered as another reason.

Table (9). Mean ± standard error of two replicates of biofloc composition as affected by daily feeding rates and varying dietary protein levels.

Treatments	Rearing System	Feeding rate	Dietary rotein level	Dry matter %	Cp %	Lipid %	Ash %
T7	BFT	2%	20%	11.855ab±0.555	25.10a ±1.0	2.510a±1.00	32.32±ab2.09
T8	BFT	2%	25%	10.20 a ±0.10	25.715a±3.815	2.120b±0.380	32.320a±2.090
T9	BFT	2%	30%	10.020ab±0.0100	25.715a±3.815	2.120ab±0.380	37.75ab±5.350
T10	BFT	3%	20%	11.165ab ±0.465	26.795a±0.545	4.200ab±1.200	30.395ab±3.1750
T11	BFT	3%	25%	10.600 ab ±0.900	30.630 a± 0	3.655ab±0.455	30.400ab± 5.100
T12	BFT	3%	30%	12.200b ±0.200	26.250a± 0	4.270ab±0.630	24.260b±0.690

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الملخص العربي

تأثير مساهمة البيوفلوك ومعدل التغذية ومستوي البروتين علي الاداء الانتاجي للاستزراع المتعدد لأسماك البلطي النيلي والبوري والطوبار

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صممت هذه التجربة لدراسة تأثير مساهمة البيوفلوك و معدل التغذية ومستوي البروتين علي الاداء الانتاجي للاستزراع المتعدد لأسماك البلطي النيلي والبوري والطوبار واستمرت التجربة لمدة (١١٠) وقد صممت تجربة عامليه ٢*٢*٣ لدراسة تأثير عوامل كما يلي :-

١. نظام الاستزراع (استزراع تقليدي بتغيير المياه مقابل استزراع بنظام البيوفلوك)

٢. مستوي التغذية (٢ ، ٣ % من وزن الجسم)

٣. مستوي البروتين الخام بالعليقة (٢٠ ، ٢٥ ، ٣٠ %)

لينتج ١٢ اثني عشر معاملة تجريبية تم توزيعها علي ٢٤ اربعة وعشرون حوض اسمنتي سعة الواحد ١٦م٣ بمعدل مكررتين (حوضين) لكل معاملة

ـ بعد انتهاء مدة التجربة اظهرت النتائج ما يلي :-

ان الاداء الانتاجي للبلطي النيلي و البوري والطوبار قد تأثرت معنويا بعوامل الدراسة وخاصة نظام الاستزراع ومعدل التغذية وبدرجة اقل بمستوي البروتين الخام في العليقة

ـ وتوصي الدراسة بأهمية تطبيق تكنولوجيا البيوفلوك (عدم تغيير المياه) مع مستويات التغذية المنخفضة ٢ % من وزن الجسم ومستوي البروتين الغذائي (٣٠ % بروتين خام).

Impact of Yeast Foliar Application on The Growth of Maize Intercropped with Peanut Irrigated with Saline Water

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ABSTRACT: The present study was carried out to evaluate the effects of foliar application of *Saccharomyces cerevisiae* (yeast) on vegetative growth of the sole and intercropped maize and peanut plants grown under irrigation with saline water. This trial was initiated in Soil Salinity & Alkalinity Research Department at Alexandria, Egypt in 2014. A 3-way factorial experiment based on a completely randomized block design, with three replicates was used. The treatments are comprised of three water salinity levels (0, 4, and 8 dS/m), three different cropping system (maize, peanut and maize-peanut intercropped) and 2 foliar yeast applications. Agronomic traits, including plant height, shoot dry weight, cob weight, grain yield, and weight of 100 seeds were recorded. Increasing salinity levels up to 8 dS/m decreased the seeds weight of corn to 56.03% and decreased the grain weight of peanut to 45.06% as compared with control treatment. With respect to the cropping system, intercropping was primitive to induce higher yields than sole plants confirming the positive effect of intercropped corn with peanut. Spraying plants with yeast increased the yield of peanut plants than maize ones.
Keywords: Salinity – Intercropped – Yeast – Peanut – Maize

INTRODUCTION

In arid and semiarid regions, different problems are commonly prevail due to the deficit of the irrigation water supply and salinity hazard under such condition. Plants are generally suffering from severe nutritional imbalance, retardation of plant growth, associated with reduction in yield potentials. Self-sustaining, low-input, and energy-efficient agricultural systems in this context are being in the center of attention of many farmers, researchers and policy makers worldwide (Altieri, 1999). Intercropping and the agricultural practice of cultivating two or more crops in the same space at the same time are well known as cropping practice which aims to match efficiently crop demands to the available growth resources and labor (Lithourgidis *et al.,* 2011**)**. The most common goal of intercropping is to produce greater yields on a given agricultural area (Ouma and Jeruto 2010). Intercropping system has benefits in maximize the use of agricultural factors such as water, area, light and nutrients (Li *et al*., 2003), as well as to amendment crop quality and quantity (Mpairwe *et al*., 2002). Moreira (1989) stated that mixed cropping especially with legumes can betterment both forage quality and quantity because legumes are well source of protein.

Bio-fertilizers are formulations of beneficial microorganisms, which upon application can increase the availability of nutrients by their biological activity and help to improve the soil health (Agamy *et al*., 2013). In addition, bio-fertilizers are generally characterized by low cost prices and very effective for providing surplus nutritional supply, as compared with chemical fertilizers (Boraste *et al*., 2009). In addition to their role in enhancing the growth of the plants, biofertilizers can act as biocontrol agents in the rhizosphere at the same

time. This synergistic effect, when present, increases the role of application of bio-fertilizers in the sustainable agriculture (Agamy *et al.*, 2013). The use of yeast as a bio-fertilizer in agriculture is now receiving considerable attention, because they synthesize antimicrobial and other useful substances required for plant growth from amino acids and sugars secreted by bacteria, organic matter and plant roots (Boraste *et al.*, 2009). *Saccharomyces cerevisiae* is, recently, introduced as a new promising plant growth promoting yeast for different crops. Its application is being practiced as an alternative mean for the chemical fertilizers, safely used for human, animal and environment (Omran, 2000). Most of the studies indicate that plant root growth may be directly or indirectly enhanced by yeasts in the rhizosphere (Nassar *et al.*, 2005, El-Tarabily and Sivasithamparam, 2006 and Cloete *et al.*, 2009). Representatives of *Saccharomyces* is able to nitrify ammonium to nitrate via nitrite in vitro (Al-Falih, 2006) and oxidize elemental sulfur in vitro to produce tetrathionate, and sulfate (Al- Falih and Wainwright, 1995).

The objective of this study is being proposed to investigate the effect of foliar application of yeast *(Saccharomyces cerevisiae*) on the tolerance of maize (*Zea mays*) and peanut (*Arachis hypogaea)* either sole or intercropped together grown under irrigation with saline water.

MATERIALS AND METHODS

This study was carried out at Soil Salinity and Alkalinity Research Department in Alexandria, Egypt from June to September 2014. The experiment was carried out in sandy soil plots ($1m^2$). The Physical and chemical properties of soil were determined (Table 1) according to the methods described by Richards (1954) and Watanabe & Olsen (1965) and Page (1982) and BlacK (1965) and Bouyoucos (1951). A 3-way factorial experiment was planned on randomized complete block design with three replicates was employed. Basically the seeds of peanut (Grilly) and maize (single cross Giza 176) were provided from the Crop Research Institute, Agricultural Research Center (ARC) - Giza, Egypt. Treatments were consisted of 3 levels (0, 4 and 8 dSm^{-1}) of saline water (NaCl solution), 3 cropping system (sole maize, sole peanut and maize/peanut intercropped) and 2 foliar yeast extract; half of the plants were subjected to yeast foliar spray monthly during the growing season (3 times) and the rest was untreated to be used for the relative comparison.

Maize and peanut seeds were sown, keeping the plant density of sole maize and sole peanut at 7 and 40 kg/fed, respectively. In maize/peanut intercropping system, one-half of the population density was used.

The yeast inoculum was prepared as follow: 200 g of yeast (produced by Alexandria Starch and Yeast Company) mixed with 100 g black honey and the mixture was adjusted to 1 litter with tap water and left for 48 hr. The yeast extract was diluted with tap water 10 times and used for foliar application treatments.

At harvest, the above–ground shoots were recorded. The agronomic benefit of the intercrops was evaluated by the land equivalent ratio (LER) index (Mead and Willey, 1980), using the following formula:

$$LER = (Yab/Yaa) + (Yba/Ybb)$$

Where; Yab= the yield per unit area of crop (a) in the intercrop, Yba= the yield per unit area of crop (b) in the intercrop, Yaa = the yield per unit area of crop (a) in the solo crop, and Ybb = the yield per unit area of crop (b) in the solo crop (Ghanbari-Bonjar and Lee, 2002). A LER value greater than 1.0 indicates the positive effect of the intercropping system.

The term "harvest index percentage";(HI %) is being introduced to relate the grain yield (GY) to total plant biomass. Accordingly, HI was calculated using the following relation; where SY is the straw yield:

$$HI (\%) = GY/ (GY+SY) X 100$$

Data were subjected to analysis of variance test (ANOVA) and the LSD was calculated to assess the significant differences between treatments, using COSTAT program (Costat CoHort Software, 1985).

Table (1).Chemical and physical properties of the used soils

Properties		Sandy soil
Soil pH (1:2 soil - water)		7.35
Total Soluble Salts (1:2 soil -water):		
EC	dS m^{-1}	1.58
Ca^{++}	meq L^{-1}	4.1
Mg^{++}	"	2.3
Na^{+}	"	7.9
K^{+}	"	1.5
CO_3^{--}	"	-
HCO_3^{-}	"	2.1
Cl^{-}	"	3.9
SO_4^{-}	"	9.8
Organic matter	%	0.14
Total Nitrogen	%	0.06
Available K	Cmol Kg^{-1}	0.97
Available P	mg Kg^{-1}	5.15
Calcuim Carbonate	%	0.85
Sand (2- 0.05 mm)	%	93
Silt (0.05 - 0.002 mm)	%	5
Clay (< 0.002 mm)	%	2
Texture		Sandy

RESULTS

1. The Performance of Maize Yield Attributes:

The effect of foliar application of yeast, and cropping system under different water salinity levels on maize yield attributes; expressed as plant height, cob weight, grain (GY) and straw (SY) yields, 1000-grain weight and harvest index percentage (HI %) are presented in (Table 2) Irrespective to the foliar application of yeast and cropping system, (Table 2) showed that maize plants exposed to salinity stress exhibited marked significant decrease on all measured parameters across the water salinity level from 0 to 4 & 8 dS/m. However, spraying plants with yeast significantly increased only the height of maize plants, associated with negative effects on the other measured parameters (Table 2). In addition, the results revealed that the monoculture crop yielded higher straw and grain records than the corresponding intercropped maize. The estimated advantages in SY and GY for the sole crop were 48.6 and 11.2%, respectively. To the contrary, the results proved that intercropped maize was more superior for mediating the cob weight, 1000-grain weight and HI% than the sole crop. On average, the advantages of the concerned traits were, however, limited by 27.3, 9 and 20.7%, respectively. (Table 2).

Irrespective to foliar yeast application, the data presented in (Table 3) revealed that all water salinity levels exhibited marked negative effects on the studied parameters. Such effects were, however, more abundant in sole maize crop than the intercropped plant at the same level of salinity or control treatments. Quantitatively, the reduction in maize grain yield accounted for 56.6% and 55.7% in sole and intercropped plants at EC 8 dS/m, respectively. Similarly, yeast foliar application significantly increased plant height, SY and GY in control treatments (Table 3), associated with significant increase on the weight of 1000 grain at EC 4 dS/m. Besides, the foliar yeast treatments acted to exert significantly decrements in cob weight in control plants and SY & GY across all the water salinity levels.

2. The Performance of Peanut Yield Attributes:

The data presented in (Figure 1) showed that different salinity levels imposed significant decrement in peanut yield (GY). Relative to the control treatments, the estimated relative decrease in GY was 22% and 45% at EC 4 & 8 dS/m, respectively. Regardless to salinity levels and foliar yeast treatments, the results outlined in (Figure 2) revealed that the intercropped peanut yielded higher grain yield (153.6 g/plant) than the corresponding monoculture one (128.1 gm/plant). Moreover, foliar application of yeast exhibited marked significant increases in GY as compared with non-fertilized ones (163.9 &117.8 g/plant), respectively (Figure 3). The similar results were noted in the weight of 100 peanut seed (Table 4).

Table (2). Means of the measured agronomic traits recorded on maize plants as affected by water salinity levels, cropping system and spraying with yeast extract as main effects

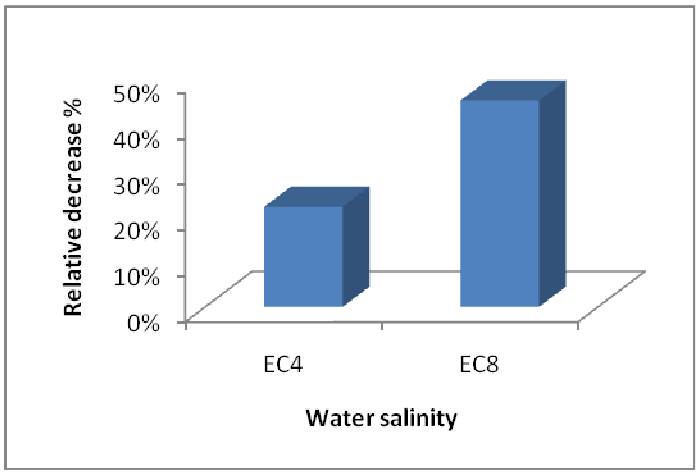
Treatment variables	Plant Length (cm)	SY (kg/m^2)	Cob Weight (g)	GY (kg/m^2)	Wt. 1000 grain (g)	HI (%)
Water Salinity						
Tap water	276.5	1.55	232.4	0.928	355.8	37.7
4 (dS/m)	247.0	1.30	184.9	0.597	315.1	31.2
8 (dS/m)	215.0	1.06	144.1	0.407	254.5	28.5
LSD, 5%	5.56	0.10	6.89	0.04	3.64	0.89
Foliar yeast						
Without	236.0	1.48	202.9	0.732	329.5	32.5
With	256.3	1.13	171.4	0.557	287.3	32.5
LSD, 5%	4.54	0.08	5.62	0.03	2.97	0.72
Cropping system						
Sole	234.5	1.56	164.7	0.700	295.2	29.0
Intercropped(Ic)	257.7	1.05	209.6	0.588	321.7	35.9
LSD, 5%	4.54	0.08	5.62	0.03	2.97	0.72

SY= Straw yield, GY= Grain yield, HI= Harvest index

Table (3). Yield components of maize in relation to the interaction effects of water salinity with cropping system and yeast application.

Treatments	Water salinity	Cropping system		LSD	Yeast application		LSD
	dS/m	Sole	IC	5%	without	with	5%
Plant Height, cm	0	273.0	280.0	7.85	260.5	292.5	7.85
	4	236.0	258.0		252.5	241.5	
	8	195.0	235.0		195.5	235.0	
SY , kg/m^2	0	1.85	1.25	0.14	1.48	1.63	0.14
	4	1.48	1.13		1.66	0.95	
	8	1.35	0.78		1.30	0.83	
Cob weight,g	0	212.9	251.8	9.73	246.9	217.9	9.73
	4	159.3	210.4		188.5	181.3	
	8	121.8	166.5		173.3	115.0	
GY , kg/m^2	0	0.99	0.86	0.05	0.90	0.96	0.05
	4	0.67	0.52		0.79	0.40	
	8	0.43	0.38		0.51	0.31	
1000 grain wt.,g	0	342	370	5.13	411	301	5.13
	4	280	351		301	329	
	8	264	245		277	232	
HI , %	0	35.0	40.5	1.24	37.8	37.6	1.24
	4	29.0	33.0		31.8	30.6	
	8	22.7	34.3		27.8	29.1	

SY = Straw yield, GY = Grain yield, HI % = GY/(GY+SY) *100



Fig(1). Relative decrease (%) of Peanut seed yield/plant

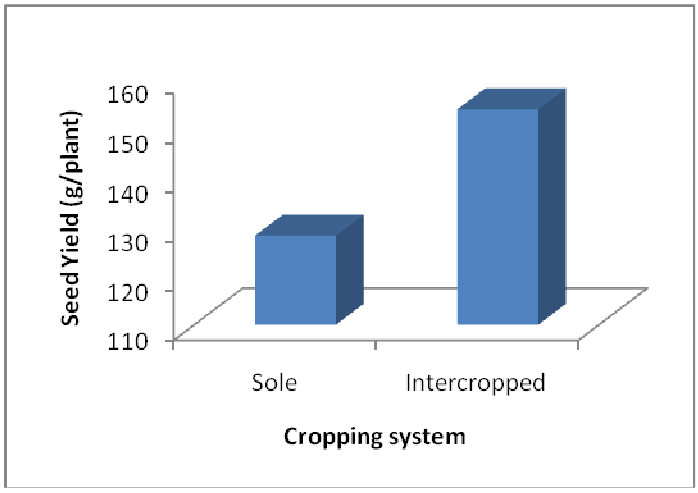


Fig (2). Peanut seed yield (g/plant)

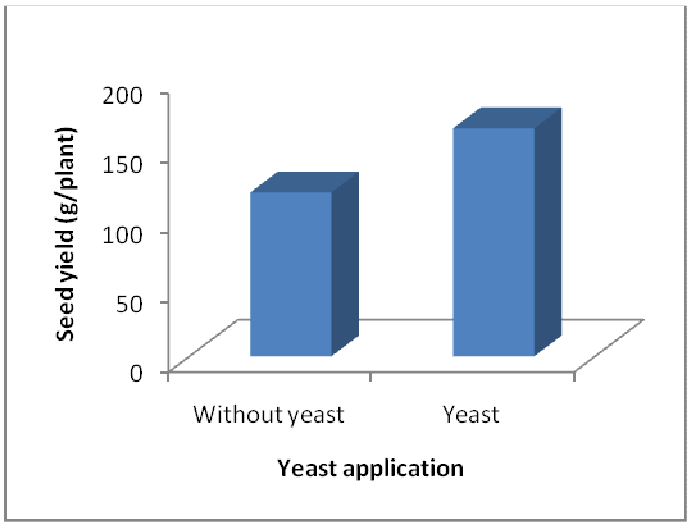


Fig (3). Peanut seed yield (g/plant)

Table (4).The main effect of water salinity levels, cropping system and yeast application on the peanut yield.

Treatment		Seeds weight (g/plant)	Wt.100 seed (g)
Water salinity	Tap water	181.3	139.2
	S1	141.7	100.5
	S2	99.6	55.8
	L.S.D.(5%)	0.016	4.82
Cropping system	Sole	128.1	81.5
	Intercropped	153.6	115.5
	L.S.D.(5%)	0.013	3.94
Yeast application	Without yeast	117.8	84.9
	Yeast	163.9	112.1
	L.S.D.(5%)	0.013	3.93

S1= ECw 4 dS/m S2= ECw 8 dS/m

The data given in (Table 5) showed that intercropped peanut leads to considerable improvement in peanut yield along the different salinity levels, as compared with the corresponding sole crop, whereas the relative increases accounted for 17.5, 18 and 27.6% at 0, 4 and 8 dS/m, respectively. Moreover, this tendency was also manifested in weight of 100 seed as affected by intercropping system and water salinity levels. Yeast treatment was creative and exhibited marked significant increases in peanut seed yield and 100-seed weight along the concerned salinity levels (Table 5).

The highest relative increase in seed yield was, however, recorded in plants sprayed with yeast, particularly, at the highest water salinity level.

Table(5). Yield components of peanut in relation to the interaction effects of water salinity with cropping system and yeast application

Treatments	Water salinity	Cropping system		LSD	Yeast Application		LSD
	dS/m	Sole	IC	5%	without	with	5%
Seed yield(g/plant)	0	166.7	195.9	0.025	154.2	208.4	0.025
	4	130.0	153.4		115.9	167.5	
	8	87.5	111.7		83.3	115.8	
Wt 100 seed (g)	0	103.3	175.1	6.81	130.4	148.0	6.81
	4	98.0	103.1		89.6	111.4	
	8	43.2	68.5		39.7	72.0	

3.Land equivalent ratio (LER)

To assess the contribution, land equivalent ratio (LER) is being an important tool for studying and evaluation the intercropping systems. This concept reveals that all other things being equal to measure of the yield advantage obtained by intercropping two or more crops or varieties as compared to the sole of the same crops or varieties. It is worthy to point out that when the LER accounted for 1.0, this means that there aren't differences in yield between the intercrop and the collection of monocultures.

Any value greater than 1.0 revealed the presence of positive interferences among the crops components of the mixture. On the other hand, when any negative interspecific interference is developed, it reveals that the mixture was not as intensive as the interspecific interference that existed in the monocultures. The results presented in (Table 6), proved that LER>1, indicating that the yield advantage of intercropping. The highest significant values of LER were obtained when treated the maize plants with yeast as a main effect. At the higher salinity level (EC 8 dS/m), the highest LER accounted (1.53) as compared with other treatments, irrespective to the addition of yeast (Table 6). Our experimental results support the findings by Okpara (2000) in maize-cowpea intercrops, which showed yield advantages in the systems. The LER obtained in his study indicated a greater productivity per unit area of land for the mixtures than when either of the two crops was grown separately.

Table (6). Main effects of foliar application of yeast and water salinity levels on the performance of land equivalent ratio (LER) components for grain yield(GY) data of maize/peanut cropping system

Treatment variables	GY		LER
	Lm	Lp	
Water Salinity levels			
Tap water	0.87	0.59	1.46
4 (dS/m)	0.77	0.59	1.36
8 (dS/m)	0.89	0.64	1.53
biofertilizer			
without	0.61	0.68	1.34
with	1.28	0.55	1.83

Lm & Lp= partial LER for maize & peanut, respectively

DISCUSSION & CONCLUSION

Salinity induced serious causes effects on peanut and maize plants. According to FAO (1988), Table (7) presented the yield potential of pervious plants as influenced by irrigation water salinity (EC_w) or soil salinity (EC_e)

Table (7).Crop tolerance and yield potential of Maize & Peanut as influenced by irrigation water salinity (EC_w) or soil salinity (EC_e)

Field Crops	100%		90%		75%		50%		0%	
	ECe	ECw	ECe	ECw	ECe	ECw	ECe	ECw	ECe	ECw
Maize	1.7	1.1	2.5	1.7	3.8	2.5	5.9	3.9	10	6.7
Peanut	3.2	2.1	3.5	2.4	4.1	2.7	4.9	3.3	6.6	4.4

Our experimental data proved that both maize and peanut were moderately sensitive plants whereas the accounted EC_w that can't produce any yield were about 7 and 4.5 dS/m, respectively. Under our experimental condition, it's evident that cropping system and foliar application with yeast decreased the salinity hazard and improved the salinity tolerance, even at high water salinity level. Obviously, the aforementioned confirmed results that peanut - maize intercropping system was more superior to the sole- cultivated plants. It was creative to improve the carbohydrate and the protein levels for the small farms (Liben *et al*., 2001). Evidently, the maize-peanut intercropping system is a good alternative mean for the sustainable farming. This finding also agreed quite closely with finding of Lemlem (2013) who indicated that the intercropping of maize-cowpea and maize-lablab was advantageous than monocrop maize. Similar results were reported by Ghosh (2004), indicated that significant yield and monetary advantage were assessed in the case of intercrops of groundnut with maize.

Moreover, the use of yeast as a biofertilizer showed significant positive results to the most of the measured parameters of both maize and peanut plants. Positive effects of yeast were reported in previous works (Mahdi *et al*., 2010). In agreement with our results, Wali (2010) indicated that yeast has good efficiency on growth characters of wheat plants. The positive effect of yeast is supported by the findings of Mekki and Ahmed (2005), Mirabal *et al.* (2008) and Hesham and Mohamed (2011).

They explained that the increase in yield components, due to yeast application could be inferred to its effect ,on providing surplus available nutrients for the growing plants and promoted the regulation of regulators such as auxins, gibberellins, cytokinins, and vitamins that are essentially required for growth yield production. Agamy *et al.* (2013) reported that the application of saccharomyces sp.enhanced the formation of photosynthetic pigments (chlorophyll a and b).

So, we assume that maize-peanut intercropping system is a good alternative of cropping system in the sustainable farming in salt-affected soils in presense of yeast.

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الملخص العربى

تأثير الرش بالخميرة على نمو الذرة المحملة مع الفول السودانى المروية بمياه ملحية

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أجريت هذه الدراسة لتقيم تأثير الرش بالخميرة على النمو الخضرى لمحصول الذرة والفول السودانى المنزرعين منفردين وكذا المنزرعين محملين معا تحت ظروف الرى بمياه ملحية .

هذه الدراسة أجريت فى قسم بحوث الأراضى الملحية والقلوية – الأسكندرية – مصر فى ٢٠١٤. وكان التصميم الأحصائى للتجربة هو القطاعات العشوائية الكاملة ويشمل ٣ عوامل بمستوياتها وكررت جميع المعاملات ٣ مكررات ؛ كانت العوامل هى ملوحة مياه الرى فى ثلاث مستويات (٠، ٤، ٨ ديسى سيمنز/م) و نظام الزراعة (ذرة ، فول سودانى ، ذرة وفول محملين معا) وإضافة الخميرة رشا فى مستويان (بدون أضافة للمقارنة – اضافة) و فى نهاية التجربة تم الحصول على القياسات النباتية مثل : طول النبات – الوزن الجاف للمجموع الخضرى – وزن كيزان الذرة – محصول حبوب الفول – وزن ١٠٠ حبة . وقد أظهرت النتائج أن أرتفاع مستوى الملوحة حتى ٨ ديسى سيمنز/م أدى الى خفض وزن حبوب الذرة الى ٥٦.٠٣ % وحبوب الفول السودانى الى ٤٥.٠٦% مقارنة بمعاملة الكنترول . أما بخصوص نظام الزراعة فقد اظهرت النتائج أن نظام التحميل أعطى أعلى محصول عن زراعة النباتات منفردة والرش بالخميرة أعطى تأثير أيجابى على المحصول وقد ظهر ذلك فى الفول السودانى أكثر من الذرة مقارنة بمعاملات الكنترول .

Preliminary Nematicidal Activity of Some Plant Extracts on A Field Root-knot Nematode (*Meloidogyne incognita*) Species

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ABSTRACT: Lethal effects of bitter wood, thyme and myrrh aqueous extracts were evaluated against Meloidogyne incognita at concentrations of 20, 40, 60, 80 and 100% after 24h. and 48h. The results revealed that the mortality percent of *M. incognita* tended to with increasing the concentration. The effect of the three tested aqueous extracts slightly changed from 24 to 48 hours exposure. The probit analysis revealed that the heterogeneity of nematode response to myrrh was slightly higher than thyme and bitterwood. According to LC_{95}, LC_{50} and LC_{05} thyme achieved 147.7, 44.75 and 13.57%, respectively after 24 and 48 hours, no significant differences was observed between LC_{95} of thyme (107.4%) and bitterwood (122.7%) but both differed significantly from myrrh (182.3%).

Keywords: Aqueous extracts, nematicidal activity, *Quassia amara, Commiphora molmol*, *Thymus vulgaris*.

INTRODUCTION

Using of synthetic pesticides in crop production resulted in disturbance in the environment, pest resurgence, pest resistance and lethal and sub-lethal effects on non-target biota, including humans (Prakash and Rao, 1997). At the same time, increases in plant parasitic nematode populations lead to use greater quantities of pesticides, which increases the environmental problems (Abd-Elgawad and Mohamed, 2006). Although the chemical nematicides hold major promise in nematode control, their high costs, hazards as environmental pollutants discourage most potential users. These disadvantages have stimulated research on alternative nematode management practices for plant parasitic nematodes.

The use of environmentally friendly bio-nematicides, organic soil amendments, cropping systems and biological control agents have been reported efficiently against nematodes (Abd-Elgawad and Aboul-Eid, 2005; Delfosse, 2005; Gohar, 2003; Maareg, 1984; Youssef *et al.,* 2008). Several plants are good sources for naturally occurring nematicides (Chitwood, 2002; Gommers, 1981) including neem (*Azadirachta indica*), garlic (*Allium sativium* L.), castor bean (*Ricinus communis*) and marigolds (*Tagetes* spp.). Studies on the identification and use of local plant materials for control of nematodes or integrated pest management are current areas of research in plant nematology. This study aimed to evaluate the lethal effects of some plant aqueous extracts against the second stage juveniles (J2s) of *M. incognita.*

These extracts are bitterwood (*Quassia amara*), Myrrh (*Commiphora myrrh*) and Thyme (*Thymus vulgaris*) as it has an deadly impact against some other pests.

MATERIALS AND METHODS

Plant materials:

The medicinal plant species were (bitterwood tree, *Quassia amara*; myrrh, *Commiphora myrrh* and thyme, *Thymus vulgaris*) this plant species were purchased from a perfumery shop in the market.

Tested root-knot nematode:

Females and egg masses of *Meloidogyne incognita* were isolated from infected eggplant (*Solanum melongena*) roots collected from the West Nubaryia region (Mohamed Abdel Wahab Village). The culture of this nematode was obtained from a single egg mass of adult females previously identified by the morphological characteristics of the female patterns (Taylor and Sasser, 1978). The culture was reared on eggplant cv. Black Beauty growing in earthen pots filled with steam sterilized soil consisted of clay and sand (1 : 2) in volume in a greenhouse.

Meloidogyne incognita isolates were maintained on eggplant roots in pot cultures. Inocula of freshly hatched second stage juveniles (J2s) were obtained from egg masses in distilled water. Only, the J2s that hatched within 24 hr period were used.

Preparation of the tested aqueous plant extracts:

Different parts of the tested plants were taken to prepare their extracts. The chosen parts were stem of bitterwood, crude of myrrh (gum, resins) and flowers and leaves of thyme. These plant origins were washed with distilled water to remove any dust and air dried in shade. The dried plant materials were powdered and passed through a 50 mesh sieve. Samples of plant powders were homogenized with a laboratory blender used at 50 g from each powders in one liter of distilled water for 10 min., and then left in dark glass bottles for 72 hr for tissue maceration. The extracts were filtered through muslin cloth, followed by whatman filter paper No. 1 to get the clear extract. The final extracts were collected separately in dark glass bottles and stored in refrigerator at 5°C until use. Each extract was arbitrarily termed as a standard solution.

Contact toxicity bioassay measurements:

A direct-contact bioassay test was used to evaluate the biological performance of the tested aqueous extracts against the second stage juveniles (J2s) of root-knot nematode, *M. Incognita.* Aqueous nematode suspension (aprox. 50 freshly hatched J2s ml^{-1}) was prepared from a standard nematode suspension. Five concentrations of each tested aqueous plant extract (20, 40, 60, 80 and 100%) were prepared from the standard extract. The assessment was carried out in 5 cm Petri plates containing 5 ml of each plant material concentratios. Nematode suspension carrying one ml (50 J2s) was added. One

petri plate containing juveniles in water was kept as control. Five replicates were considered as one treatment. Dead larvae were counted and the dishes were covered with lids and held at the same conditions (incubated at 28°C). Mortality percents were determined after 24 and 48h. exposure under binocular microscope and corrected (Abbott, 1925).

Statistical analysis:

Statistical analysis was performed using Costat program (1988) with LSD at 5% probability. The mortality percents treated of the nematode were corrected (Abbott, 1925). LC_{50}, LC_{95} values and the regression line-slope were calculated using probit analysis (Finney, 1971).

RESULTS AND DISCUSSION

Lethality effects of the tsted plant extracts:

The used tested plant extracts as shown in Tables (1 and 2) killed the treated nematode, *M. incognita* in a concentration and exposure time dependant effect. The untreated nematode population was naturally killed with 4.02% after 24 hours. The tested, Thyme (*Thymus vulgaris*) extract caused 17.29, 37.90, 63.87, 79.92 and 88.94% mortality at concentrations of 20, 40, 60, 80 and 100% of the original aqueous extract solution achieving 147.7, 44.75 and 13.57% for LC_{95}, LC_{50} and LC_{05} values, respectively. The bitterwood aqueous extract revealed its lethal effect against the treated animal population systematically with increasing the tested concentration giving 151, 48.85 and 15.74% LC_{95}, LC_{50} and LC_{05} values, respectively with no significant differences between their aqueous extract at the tested concentration range. Both Thyme and bitterwood aqueous extracts exceeded Myrrh in their mortal effect significantly at the used concentration range as it caused LC_{95}, LC_{50} and LC_{05} values of 13.99, 60.39 and 260.7% respectively. Worth mentioning, Myrrh achieved good effect at the lowest concentration nearly similar to bitterwood at 20% of the original aqueous extract after 24 hours exposure (Table 2).

Table (1). The tested plant species.

Common names	Scientific name	Major components	Extracted origin
Bitterwood tree	*Quassia amara*	Quassinoids (quassin and neoquassin)	Stem (wood)
Myrrh	*Commiphora molmol*	Oles - gum - resins - terpenoids	Gum - resins
Thyme	*Thymus vulgaris*	Thymol - phenols - carvacrol	Flowers - leaves

Table (2). Mortality effects of the tested aqueousTable (2). Mortality effects of the tested aqueous extracts on *Melodogine incognita* after 24 hours.

Tested Extracts	Mortality (%) at different concentrations of the standard aqueous extract (%)						LC_{95}	LC_{50}	LC_{05}	χ^2	p
	0	20	40	60	80	100					
Thyme	4.022 ± .29	17.29 ±0.24	37.90 ±0.56	63.87 ±0.30	79.92 ± 0.17	88.94 ±0.36	147.7 [b] (137.7-158.1)*	44.75 [c] (43.3 - 46.5)	13.57 [a] (12.4 - 14.9)	3.99	0.399
Bitter wood	4.022 ± 0.29	11.02 ±0.63	36.20 ±1.62	61.83 ±0.93	77.01 ±0.93	85.35 ±1.05	151 [b] (141.6-162.2)	48.85 [b] (47.4 - 50.4)	15.74 [a] (14.5 - 17.1)	4.24	0.526
Myrrh	4.022 ±0.29	11.59 ±0.46	31.63 ±0.68	47.30 ±0.51	63.84 ±1.42	72.03 ±0.86	260.7 [a] (231.7-293.5)	60.39 [a] (58.2 - 62.7)	13.99 [a] (12.5 - 15.7)	3.96	0.389

* Confidence limits; **P,** Probability; χ^2**,** Chi Square; **DF,** Dgree of freedom = 4

All the tested plant extracts increased their mortal effect against the treated animal population after 48 hours exposure at all the tested concentrations (Table 3). Both Thyme and bitterwood aqueous extracts overcomedd the myrrh aqueous extract in their nematicidal effects significantly after 48 hours exposure also as the achieved 107.4, 122.7 and 182.3 LC_{95} values comparing with 38.54, 42.01 and 49.99 LC_{50} values and 13.84, 14.38 and 13.71 LC_{05} values for thyme, bitterwood and myrrh aqueous extracts, respectively. The obtained results agreed with Salazar-Antón and Guzmán-Hernández (**2014)** as they found that *in vitro* treatment of *M. incognita* with 10% *Quassia amara* extract caused 78% mortality of its juveniles after 48 hours exposure. Korayem *et al.* (1993) added *Thymus vulgaris* shoot powder killed all the treated juveniles after 72 hours exposure. On the other hand, Soler-Serratosa *et al.* (1995) proved that LC_{90} value of thymol against *M. arenarea* in soil was 161 ppm and its activity was enhanced when combined with benzaldehyde as an essential oil of almond. From the results in Tables (2 and 3), it was obvious that the estimated probability values of the aqueous extracts were considered to be reliable and acceptable, whereas, it ranged between (0.683 - 0.917). Hence, Chapman (1985) mentioned that one line with a probability of less than 0.01 was a result of poor replication at lower doses.

Table (3): Mortality effect of the tested aqueous extracts on *Melodogine incognita* after 48 hours.

Tested Extracts	Mortality (%) at different concentrations of the standard aqueous extract (%)						LC95	LC50	LC05	χ^2	p
	0	20	40	60	80	100					
Thyme	9.02 ±0.47	17.48 ±1.20	48.71 ±1.54	73.84 ±1.26	91.16 ± 0.72	93.59 ±0.66	107.4 b (101.8- 113.3)*	38.54 c (37.2- 39.9)	13.84 a (12.7-15.1)	22.68	0.433
Bitter wood	9.02 ±0.47	15.69 ±0.80	40.74 ±0.63	74.15 ±1.66	83.95 ±1.31	90.88 ±1.96	122.7 b (115.6- 130.3)	42.01b (40.6- 51.8)	14.38 a (13.1- 15.7)	26.77	0.415
Myrrh	9.02 ±0.47	15.33 ±1.08	39.78 ±0.95	50.34 ±1.29	72.04 ± 1.08	86.42 ±1.02	182.3 a (166.5- 199.6)	49.99 a (48.2- 51.8)	13.71 a (12.3- 15.3)	55.57	0.372

* Confidence limits; **P,** Probability; χ^2**,** Chi Square; **DF,** Dgree of freedom = 4

Comparing between the tested intervals, the slopes of the tested plant extracts were slightly higher after 48h than 24h. The highest variation in the regression line slope of thyme (0.53) resulted from subtraction between 24 hours (3.17) and 48 hours (3.7) was observed followed by myrrh (0.34) that subtracted from 24 hours (2.59) and 48 hours (2.93). While, this difference was nearly neglected for bitterwood which was (0.18) in variance between 24 hours (3.35) and 48 hours (3.53). This observation revealed that the behaviour of myrrh did not differ than 48h. On the other hand, the behaviour of thyme altered after 24 hours than 48 hours. While, Bitterwood behaviour slightly changed after 24 hours. than 48 hours.

The slope of the tested aqueous extracts after 48 hours exposure of bitterwood (3.53) and thyme (3.70) were almost the same and higher than myrrh (2.93). Therefore, the heterogeneity of response of the treated nematode to thyme and bitterwood were slightly higher than myrrh after both bioassay intervals. Differences in heterogeneity maybe, due to the differences of their active ingredients and/or their mode of action. The regression and slope of statistical analysis were shown in Table (4).

Table (4): Regression of N.E.D response (Y) on log dose

Plant species	(Y=a + bX) after 24 hrs	(Y=a + bX) after 24 hrs
Thyme	Y =-5.24 + 3.17 X	Y =-5.86 + 3.70 X
Bitterwood	Y =-5.65 + 3.35 X	Y =-5.74 + 3.53 X
Myrrh	Y =-4.61 + 2.59 X	Y =-4.97 + 2.93 X

* Regression of normal equivalent deviation (N.E.D); **y**, log dose; **x**

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الملخص العربى

النشاط الإبادى المبدئ لبعض المستخلصات النباتية على نيماتودا تعقد الجذور (ميلودوجينى إنكوجنيتا) سلالة حقلية

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تم إجراء المستخلص المائى لثلاثة مصادر نباتية (خشب المر، الزعتر، صمغ المر) لتقييم تاثيرها على نيماتودا تعقد الجذور (ميلودوجينى إنكوجنيتا) معمليا. تم عمل خمسة تركيزات من التركيز الاصلى (٥٠ جرام مسحوق نباتى لكل لتر ماء) هى (٢٠، ٤٠، ٦٠، ٨٠، ١٠٠%) من المستخلصات النباتية لتقييم تأثيرها بعد ٢٤ ساعة و ٤٨ ساعة. ظهر تغير طفيف فى تأثير المستخلصات المائية الثلاثة خلال ٢٤ ساعة و ٤٨ ساعة من المعاملة. التركيز الأقل والأعلى (٢٠ و ١٠٠%) للزعتر حقق أعلى نسبة موت هى ١٧.٢٩ و ٨٨.٩٤% بعد ٢٤ ساعة وحقق ١٧.٤٨ و ٩٣.٥٩% بعد ٤٨ ساعة من المعاملة. اظهرت الأنحدارات البيانية أن عدم التجانس فى إستجابة النيماتودا لصمغ المر كان أكثر قليلا من إستجابتها للزعتر وخشب المر. حقق الزعتر أعلى نتيجة حيث أعطى أقل قيم للتركيزات المميتة (LC_{95}, LC_{50} and LC_{05}) وهى ١٤٧.٧ و ٤٤.٧٥ و ١٣.٥٧% على التوالى بعد ٢٤ ساعة من المعاملة. بعد ٤٨ ساعة من المعاملة لوحظ أن ليس هناك فروق معنوية للتركيز المميت LC_{95} للزعتر وخشب المر ولكنهما يختلفان معنويا بين صمغ المر. التركيز المميت LC_{50} للزعتر ٣٨.٥٤% له أعلى تأثير يلية خشب المر ٤٢.٠١% بينما صمغ المر لة أقل تأثير ٤٩.٩٩%. ليس هناك فروق معنوية بين المستخلصات الثلاثة فى التركيز المميت LC_{05} حيث تتراوح النتيجة بين ١٣.٧١% لصمغ المر و ١٤.٣٨% لخشب المر.

Causal Relationship between Gross Domestic Product and Agricultural Production in Libya (1970-2012)

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ABSTRACT: This paper is empirically investigated the causal relationships between gross domestic product and agricultural production in Libya by using annual time series data during the period (1970 to 2012). Granger causality, cointegration, and error correction techniques were used in order to determine the long run equilibrium relationship and the direction of the causality in both short run and long run.

The cointegration test indicated the existence of long run equilibrium relationship between agricultural production and the Gross Domestic Product. The causality test based on error correction techniques indicated that there is an unidirectional causality relationship between agricultural production and the Gross Domestic Product in the short run. This result means that the agricultural sector in Libya is expected to play a major role in the future to determine the growth rate of the economy with further expected development of the agricultural sector.

Keywords: Causality, Cointegration, GDP, Agricultural production, Libya

INTRODUCTION

Libya is a Northern African country located between Tunisia and Algeria on the west and Egypt on the east. The population was estimated at about 6 million in 2010, which about 85% lives in urban areas. The population density is about a 3 persons/m^2 which is one of the lowest in the world. Although the population growth rate has been declining, it has averaged about 2.5% annually over the past 20 years. About 135,700 people work in agriculture, out of a total of 1.8 million workers. (FAO, 2011).

The currency of Libya is the Libyan Dinar (hereafter referred to as LYD), which equals 0.8 US $ in 2012. The Libyan economy began to develop when oil was discovered in 1958; Libyan economy is based basically upon revenues from the oil sector, which contributes to practically all export earnings and about one quarter of Gross Domestic Product at constant price hereafter (GDP). As shown in Table 1, the GDP in 2012 was about LYD 117 billion. With high oil revenues and small population, Libya ranks as one of the countries with the highest per capita GDP in the African continent.

Table (1). Agricultural production and its contribution to the Libyan gross domestic product in million Libyan dinars during the period (1970-2012).

Item	1970	1980	1990	2000	2005	2010	2012
Total GDP(LYD)	1,288	10,553	8,246	184,560	66,618	102,538	117675
Agriculture (LYD)	33.1	236.4	482.9	1437.7	1447.5	2543.6	928.7
% of GDP	2.6	2.23	5.9	7.8	2.2	2.5	0.78

Source: Central Bank of Libya, Economic Bulletin, Research and Statistics Department, various issues.

Libyan agriculture has experienced slow growth since the 1990s and has been facing considerable challenges in recent years. The annual agricultural production has increased over the years, but the share of agriculture in the gross domestic product declined from about 2.6% in 1970, to about 2.2% in 1980, and it was about 0.78% in 2012 (Table 1).

The total area of Libya is about 176 million hectares; only about 1.2% is arable land, while the rest is desert. Agricultural land area was about 13 million hectares in 1970 increased to about 15 million hectares in 2010 represents about 18.6% from basic year. Permanent crop areas increased from about 327,000 hectares in 1980 to about 335,000 hectares in 2010 (18% of total arable land). Irrigated agricultural land also increased from about 225,000 hectares in 1980 to about 470,000 hectares in 2010 (FAO, 2015). The main crop products were potatoes, tomatoes, olive, watermelons, onions and dates, oranges and barley are produced. (FAO, 2011).

According to the study of Aljdi and Elbeydi (2010) which investigate the development of the Libyan agricultural sector and its main components and the determination of both relative share of the agricultural subsectors which constitute the Libyan agricultural income, and the most important economic factors affecting the Libyan agricultural income during the period (1980-2005).The results of their study indicated that there is a significant increase in the annual rate of the agricultural production. The results of the study indicated that the most important variables affecting the Libyan agricultural income were the agricultural machine and the irrigated area. Consequently, it is recommended to carry out several empirical and economic studies to determine adequate basic needs of modern mechanical and irrigation methods to perform various agricultural operations for all agricultural activities.

The agricultural sector comprises of four major subsectors includes crops, livestock, fisheries and forestry. The largest portion of the agricultural sectoral is on account of crops and livestock with share of 71% and 28% respectively in 2005. However, in the late 1990s and earlier, the crop sector was dominating and accounting for more than 50% of the total agricultural output.

Libya has invested more than LYD 5 billion in the agricultural sector during the period of 1970-1990. These investments, in addition to the private sector investment, enabled the country to establish the infrastructure needed to develop the sector to a satisfactory level. During the periods of 1970 – 1986, Libya had implemented three successive development plans; a three - year development plan (1973 – 1975), and two five – year development plans (1976-1980) and (1981 – 1985). The objectives of these plans were to ensure self-sufficiency level in food, especially wheat, which was considered the most strategic food crop.

Therefore, it is too important to explore the possible relation between agriculture and economic growth. Increasing of GDP is the main target of almost every economy, promoting agriculture of the country is one of the ways of achieving economic growth.

A strong and an efficient agricultural sector would enable a country to feed its growing population, generate employment, earn foreign exchange and provide raw materials for industries. The agricultural sector has a multiplier effect on any nation's socio-economic and industrial fabric because of the multifunctional nature of agriculture.

There are a number of real and monetary links from the agricultural sector affecting the economic performance of the general economy. These relationships often are referred to as backward linkages. Agriculture, as one sector of the economy, competes for scarce labor and capital inputs from other sectors, it provides raw materials for other sectors, it directly provides consumer needs for food and fiber, and it generates a component of national income.

Stringer and Pingali (2004) argued that investments in agriculture contribute to more than increases in production. With the proper policies and incentives, agricultural sector investments improve food security, lower rural and urban poverty, reduce inequality and enhance environmental outcomes. Economic development in general and agricultural economists in particular have long focused on how agriculture can best contribute to overall economic growth and modernization. Many early analysts highlighted agriculture because of its large quantity of resources and its ability to transfer surpluses to the more important industrial.

The conventional approach to the role of agriculture in development concentrated on agriculture’s important market-mediated linkages: first, providing labor for an urbanized industrial work force, second, producing food for expanding populations with higher incomes, third, supplying savings for investment in industry, fourth, enlarging markets for industrial output, fifth, providing export earnings to pay for imported capital goods, and lastly, producing primary materials for agro-processing industries.

Economic growth originating in agriculture can have a particularly strong impact in reducing poverty and hunger. Increasing employment and incomes in agriculture stimulates demand for non-agricultural goods and services, providing a boost to non-farm rural incomes as well. (Pingali.,2006) .

Therefore, the main focus of this study is to analyze empirically the existence and direction of Granger causality and co-integration between agricultural production and the total economy activity to help the policy makers for having a better insight into economic growth and to formulate effective economic policies.

MATHERIALS AND METHODS

The recent developments in non-stationarity and cointegration theory have contributed to a better understanding of long-run and short-run dynamics in international economics and finance. Many applications in agricultural economics research have focused on the problem of testing Granger non-causality. (Zapata and Gil, 1999).

This study is based on three hypotheses for testing the causality and co-integration: (i) whether there is bi-directional causality between agricultural and GDP, (ii) whether there is unidirectional causality between the two previous variables, (iii) whether there is no causality between the two previous variables.

In the first stage the order of integration was tested using the Augmented Dickey-Fuller (ADF) unit root test. We assume all the series to be integrated of order 1. If this assumption is satisfied, we try to identify the long run equilibrium relations between the integrated time series and estimate short run equations. Granger (1988) shows that in the presence of cointegration there must be at least one direction (unidirectional) or bidirectional. The error-correction term (ect) opens up an additional channel of Granger causality so far ignored by (the standard Granger (1969) and Sims (1972) tests. The granger causality test augmented with a lagged error-correction term (ECM) was also conducted in the final stage. If long run relationship exists among the variables specified, there must be granger causality in at least one direction (Engle and Granger, 1987).derived from the residuals of the appropriate co integration relationship to test for causality:

$$\Delta \ln(AGP_t) = a_1 + \sum_{i=1}^{n} b_{1i} \Delta \ln(AGP_{t-i}) + \sum_{i=1}^{n} c_{1i} \Delta \ln(GDP_{t-i}) + e_1 ect_{t-1} + u_{1t} \rightarrow (1)$$

$$\Delta \ln(GDP_t) = a_2 + \sum_{i=1}^{n} b_{2i} \Delta \ln(GDP_{t-i}) + \sum_{i=1}^{n} c_{2i} \Delta \ln(AGP_{t-i}) + e_2 ect_{t-1} + u_{2t} \rightarrow (2)$$

where the AGPt denotes agricultural gross production at time t, GDPt denotes gross domestic product at time t and Coefficients e1 and e2 are the adjustment coefficients while ectt-1 and ectt-2 express the error correction term, Δ indicates first difference operator. In the second equation, the null hypothesis that

AGDP does not Granger-cause economic output is rejected if the set of estimated coefficients on the lagged values of AGP is jointly significant. The Long run Granger causality can also be revealed through the model specified in the equations (1) and (2) , with the significance of the lagged error correction term (ect) by t-test, while the short run causality with the help of F-statistics, will be taken from the significance of joint test with an application of lags of explanatory variables in the model. (Masih and Masih,1996)

Data source

The empirical analysis is conducted using annual data of GDP and agriculture production covering the period (1970 - 2012). The data used in the study are transformed to natural logarithms to minimize the variance in time series data set. The series data are denoted as ln AGP (logarithm of agricultural output) and ln GDP (logarithm of GDP). All data were collected from Central Bank of Libya, Research and Statistics Department Planning and Programming Department, Public Planning Council 1962-2000.

RESUTS AND DISCCUSION

The cointegration modeling procedure starts with determining the appropriate lag order (p). For this purpose, we use the Schwarz information criterion (SC), it indicated that p = one is the most appropriate lag length for study model. Then, the study investigate the stationarity properties of the time series to determine whether a series is stationary or nonstationary using the modified Dickey-Fuller test know as (DF-GLS TEST) proposed by Elliott *et al*. (1996). The results for unit root tests on levels and first differences of the time series are summarizes in Table 2.

Table (2). Univariate Statinarity Properties of the Time Series

Variable	DF-GLS TEST (Levels)		DF-GLS TEST (First difference)	
	intercept	Intercept & trend	intercept	Intercept & trend
AGDP	-0.415	-0.783	-5.830	-6.608
GDP	-0.016	-2.127	-2.359	-2.593

The critical values are -1.949 with intercept and -3.19 with intercept and trend, respectively.
Source: Author's estimation.

The results of Table 2 suggested that the null hypothesis of a unit root in the time series cannot be rejected at a 5% level of significant. Therefore, no time series appear to be stationary in variable levels when the test is applied on the logarithms of the data. However, when the variables are transformed into first differences they become stationary and consequently the related variables can be characterized as integrated of order I (1).

The study now proceed by defining the number of cointegration vectors between the variables, using the maximum-likelihood test procedure established by

Johansen and Juselius (1990), Johansen (1988) and Johansen (1996). This approach tests for the number of cointegrating vectors between the two variables based on the Trace test and Max eigenvalue test we accepted hypothesis on existence of 1 cointegration equation (both tests at 1 percent significance level).

Table (3). Johansen Cointegration Test Statistics

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistics	5% Critical Value	Prob. **
None *	0.332	16.59	15.89	0.03
At most 1	0.097	4.199	9.164	0.38

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	5%Critical Value	Prob.*
None *	0.332	20.79	20.26	0.04
At most 1	0.097	4.199	9.16	0.38

Trace test and Max-eigenvalue indicates 1 cointegration equation at the 0.05 level
*denotes rejection of the hypothesis at the 0.05 level
Source: Author's estimation.

Table 4 gives causality test results for the variables of the study. The Granger- causality conducted by the t-test suggests a unidirectional impact from GDP to agricultural production in Libya. This result, summarized in table 4, it showed weak evidence of unidirectional causation from GDP to agricultural production, where t- value for ECM term is statistically significant

Table (4). Causality Results Based on Vector Error Correction Model (VECM)

Error Correction:	(ln(AGDP))	(ln(GDP))
ect_{t-1}	-0.036	-0.089
	(-2.889)	(-1.366)
$(ln(AGDP_{t-1}))$	0.052	0.060
	[0.295]	[1.695]
$(ln(GDP_{t-1}))$	-0.077	-0.077
	[-0.434]	[-0.434]
R-squared	0.477	0.577
Adj.R-squared	0.373	0.492
F-statistic	4.570	6.830

Source: Author's estimation.

CONCLUSION

Using annual data on Libyan agriculture production and GDP during the period (1970 to 2012), the study analyzed the time series properties of these variables in order to determine the appropriate functional form for testing the relationship between agricultural production and GDP. The study finds that GDP and agriculture production are cointegrated. Based on the VECM results, the evidence suggests strong support for long-run unidirectional causality between agriculture production and GDP. Second, the study conclude that both agriculture

and GDP are related to past deviations (error-correction terms) from the empirical long run relationship. This implied that all variables in the system have a tendency to quickly revert back to their equilibrium relationship. The rise in GDP would have a positive influence on agricultural production in the long run. The results of this study also suggested that promoting agriculture via promotion policies will contribute to high economic growth levels in Libya.

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الملخص العربي

العلاقة السببية بين الناتج المحلى الإجمالي والناتج الزراعي في ليبيا للفترة (١٩٧٠-٢٠١٢)

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تهدف هذه الدراسة إلى تحليل العلاقة السببية بين الناتج المحلى الإجمالي و الناتج الزراعي للاقتصاد الليبي وذلك باستخدام بيانات سنوية للفترة (1970-2012). أسلوب التكامل المشترك و نموذج تصحيح الخطأ ومنهجية السببية (Granger's Causality) تم استخدامهم لتحديد العلاقة في الزمن الطويل وايجاد اتجاه السببية. و اشارت النتائج على وجود تكامل مشترك بين الناتج المحلي الإجمالي و الناتج الزراعي ، أي وجود علاقة توازنيه طويلة الأجل بينهما، أما اختبار السببية فقد دلت النتائج على وجود علاقة سببية في اتجاه واحد من الناتج الإجمالي الى الناتج الزراعي. هذه النتيجة توضح الدور المهم الذى من الممكن ان يلعبه الناتج الزراعي في تحقيق معدلات نمو مناسبة للاقتصاد الليبي.

كلمات مفتاحيه: السببية، التكامل المشترك، الناتج المحلى الإجمالي، الناتج الزراعي، ليبيا.

Availability of Heavy Metals in Borg Elarab Soil and Their Uptake by Potato Plants (*Solanum tuberosum* L.) Irrigated with Wastewater

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ABSTRACT: To demonstrate availability of heavy metals in soil uptake by potato plants irrigated with wastewater. The wastewater near Sayed Darwish village, Borg Elarab City, Alexandria, Egypt was collected. The measured heavy metals in the wastewater were compared with the permissible levels stated in environmental regulations, Law No. 48 of 1982 concerning the protection of the Nile River and waterways from pollution**.** Heavy metals accumulation in potato irrigated with wastewater as following: Fe (140 mg/kg), Mn (33.2 mg/kg), Zn (31.1 mg/ kg), Cu (6.3 mg/kg), Co (1.1 mg/ kg), Ni (3.2 mg/kg), Pb (2.4 mg/kg), all item are more than allowable limits, concentrations of these available heavy metals in the surface layer (0-5 cm) of irrigated soil of waste water Fe (22.9 mg/kg), Mn (18.6 mg/kg), Zn (18.2 mg/ kg), Cu (4.3 mg/kg), Co (1.7 mg/ kg), Ni (4.1 mg/kg), Pb (4.1 mg/kg), compared with irrigated soil from artesian water Fe (11.2 mg/kg), Mn(9.5 mg/kg), Zn (19.1 mg/ kg), Cu (6.2 mg/kg), Co (1.2 mg/ kg),Ni (0.2 mg/kg), Pb (1.5 mg/kg) respectively. Potato plants irrigated with such wastewater specially wastewater not safe for human and animal consumption accordingly, the study suggests and recommends remediation of wastewater using physical, chemical and/or biological methods.

Keywords: Heavy metals, Borg El arab, waste water, potato plant

INTRODUCTION

Day *et al.* (1979) found that the extractable phosphorous was higher in soils irrigated with the pump water – wastewater mixture than in soils irrigated with pump water. Also, Hinasly *et al.* (1979) indicated that there exists a tremendous increase in the concentrations of Zn, Cu, Fe, and Mn in sandy soils irrigated with sewage water and similar results were obtained by (El – Nennah *et al.*,1982).

Elsokkary (1980) found that contents of Zn, Pb, Cd, and Co in some plants (wheat grain, radish, pepper, cabbage, barley and Jews mallow) depend on its concentration in industrially polluted soil. El- Nennah *et al.* (1982) found that continuous usage of sewage effluents in irrigation, increased markedly available p, soluble B and DTPA- extractable Cd, Co, Cr, Cu and Pb in soil.

Abdel-Tawab (1985) reported that using polluted water in irrigation increased the concentration of Mn, Zn, and Pb in soils located beside the factories at Helwan. Khalil (1990) reported that the prolonged period of irrigation with sewage water has markedly increased the amount of Fe, Zn, Mn, Cu, Pb and Ni in plants grown on Abu Rawash area, but the trace element levels in the leaves and juice fruits citrus and field crops (faba been, lupine) are below the standard level values

Water pollution remains a serious global problem, with impacts on the health of fresh water ecosystems and the human communities. The traditional pollution sources like sewage, industrial wastes and pollutants like pesticides and inorganic fertilizers have combined to degrade water quality, particularly near urban industrial centers and intensive agriculture areas (UNEP/ GEMS, 1995).

Abdel- Sabour *et al.* (2000) showed that the prolonged irrigation with heavy metals contaminated wastewater increased significantly heavy metals contents of the tested soil Moreover, data showed that heavy metals contents in either rice or sorghum plants grown in polluted soils are higher in most cases compared with the control. Abdelrazek (2014) found that the accumulation of heavy metals was pronounced in soil. Moreover, data showed that heavy metals contents in either rice or sorghum plants grown in polluted soils are higher most cases compared with the control.

Elgala *et al.* (2003) mentioned that the total Fe, Zn, Cu, Co, Ni and Pb concentrations in the upper 10 cm layer increased by about 1.4, 4.5, 1.1, 2.7, 2.8 and 5.5 times in Musturud soil, which irrigated with industrial wastewater; while in Elgabal-Elasfar soil, which irrigated with sewage water, it reached to 9.0, 3.3, 10.6, 9.6, 6.9 and 3.2 times that of soil irrigated with Nile water. In many countries of the world, treated wastewater is considered as an important element in water resources planning (Abd-El-Naim *et al.*,1989). Chang *et al*. (1984) reported that heavy metals tend to accumulate in the surface soil layers and that strong binding force with clay minerals and organic matter limit their movement. These results were in good agreement with those reported by Al-Lahham *et al*. (2003), Abbas *et al*. (2007) and Madrid *et al*. (2007).

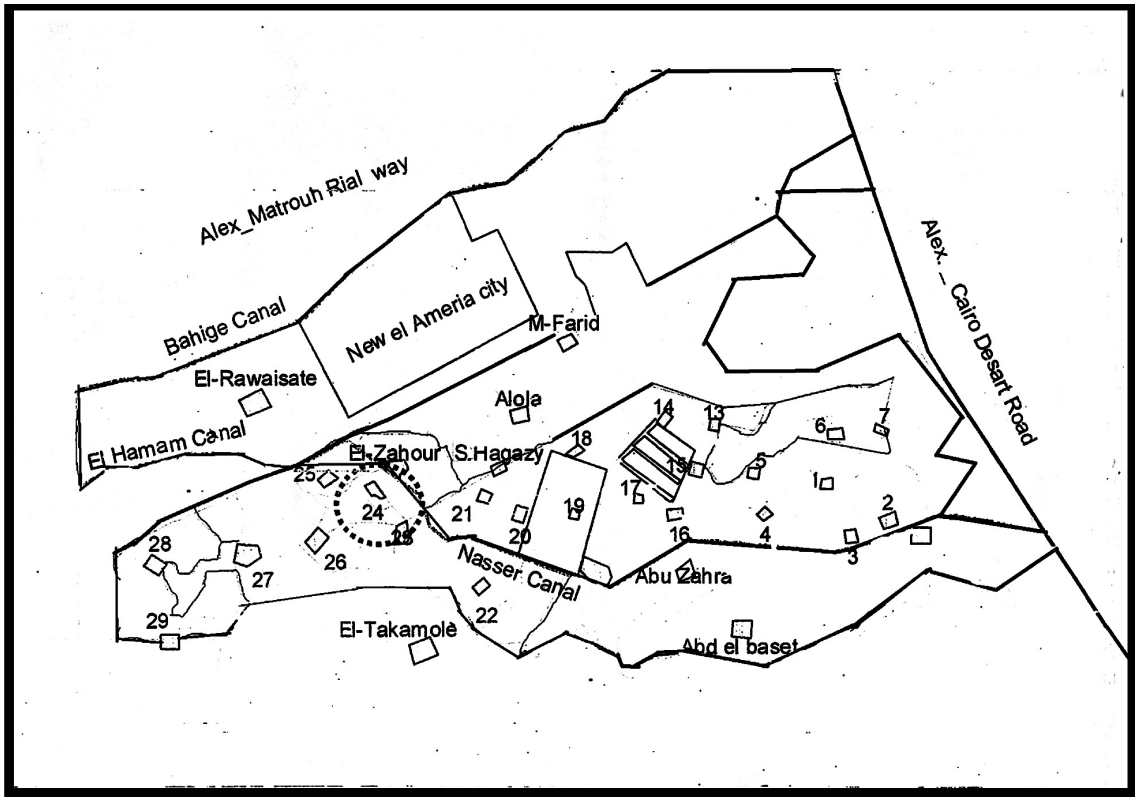
As soil health emphasizes the holistic approach to soil management, it must include water indicators, as the use of wastewater where it was sometimes the only source of irrigating crops, preferable by farmers (Abdelrazek, 2007 and Idowu *et al*. 2007). Industrial liquid wastes are more varied and more concentrated and contain certain various acids, alkalis chemical contaminants, oil, coarse solids, and other constituents. Dissolved materials include inorganic nutrients (Phosphate, ammonium, nitrate, sodium, etc). Toxic wastes (heavy metals mostly from industry Cu, Zn, Hg, Pb, Cd, Cr, Co, As etc.) and non-biodegradable organic chemicals (Mohamed and Abdelrazek, 2014**)**.

Shouman (2015) found that in El-amia drain the accumulated amounts of heavy metals in soil were in the following order: Pb (ranged from 6.3-7.9 mg kg^{-1}) ≥ Ni (6.2-7.9 mg kg^{-1}) > Co (4.7-7.1 mg kg^{-1}) > Cd (3.8-5.3 mg kg^{-1}).

The objectives of this study were to evaluate a wastewater for irrigation and its effect on the distribution of total and chemically available heavy metals in Silt Clay Loam soil to the depth of 150 cm as well as to evaluate the accumulation of such elements in certain grown crop in Borg El arab area.

MATERIALS AND METHODS

Study area: Borg El arab, 48 Kilometer west of Alexandria – Marsa Matruh road. It lays approximately between latitudes 30° 45˙ and 30° 55˙ N, and longitudes 29° 30˙ and 29° 50˙ E The study area covered about 504 Hectare planted potatoes and located near alex- cairo desert road and alex- Matrouh road way as shown in Fig 1.



Fig(1). Location map of the study area
Wastewater(1,7,6,5,13,14,17,15,22,23,25,28,9,10)
Artesian water(2,3,4,16,18,20,21,24,26,29,27,8,11,21)

Samples: Soil samples from two sites were collected from Borg Elarab area. The first site is irrigated with artesian water and the second site is irrigated with wastewater in the same area (Cast directly on the irrigation canals). In each site, five soil profiles were dug to the depth of 150 cm and soil samples were collected from successive depths (0-5, 5-10, 10-30, 30-60, 60-90, 90-150 cm). These samples represent variations in cropping patterns, and different irrigation water sources. The present cropping patterns include potatoes (*Solanum tuberosum* L.).Twelve water samples from irrigation water, six samples from the Artesian and six samples from the wastewater were collected for chemical analysis.Twelve plant samples were collected from each side, six samples from the plants which irrigated from Artesian water and six samples from the plants which irrigated from wastewater were collected for chemical analysis.

Analysis: The collected plant samples were washed with tap water, 10^{-4} M HCl solution, and ionized water, then oven dried at 65°C for 48 hours. Plant materials were ground and mixed well and kept for Fe, Zn, Cu, Co, Ni and Pb analysis (Rawa, 1973).

Total heavy metals contents of Fe, Zn, Cu, Co, Ni and Pb in soil were determined after digestion with hydrofluoric/ perchloric acids mixture (Jackson, 1958) .

Available heavy metals were evaluated by extracting the soil with DTPA according to Lindsay and Norvell (1978) and the metals in the extract were determined using an atomic absorption spectrophotometer.

The physical and chemical properties of the soil samples were determend according to the method of (Richards, 1954), Table 1

Also, some chemical composition of the two water sources were measured and presented in Table 2.

Table(1). Some physical and chemical characteristics of the selected soils irrigated with artesian and wastewater.

Parameter	Soil irrigated with artesian water	Soil irrigated with wastewater
pH	8.23	7.62
EC dSm^{-1}	5.71	2.51
$CaCO_3$ %	39	28
OM%	0.55	1.24
CEC $cmolc.kg^{-1}$	10	19
Sand%	76	32
Silt%	1	44
Clay%	23	24
Textural class	**Silt Clay Loam**	**Loam**

Table (2). Some chemical composition of the two water sources in Borg Elarab area

Parameter	units	FAO * guidelines	Law No. 48 of1982	Artesian water	Wastewater*
pH		6.5-8.4	7-8.5	8.8	7.3
EC	$dS.m^{-1}$	< 3		2.53	3.80
TDS	ppm	< 450	500	1619.2	2432
COD	$mg\ L^{-1}$	=====	>10	n.d	250
BOD5	$mg\ L^{-1}$	=====	>5	6.5	563.7
Ca^{2+}	$mg\ L^{-1}$	=====	------	5.12	7.81
Mg^{2+}	$mg\ L^{-1}$	=====	------	1.9	7.3
Na+	$mg\ L^{-1}$	< 70	-----	7.1	13.10
Total N	$mg\ L^{-1}$	< 30.0	>1	5.11	75.2
$NO3^-$	$mg\ L^{-1}$	10	>45	1.13	16.82
$PO^{=}4$	$mg\ L^{-1}$	8.6	1	0.07	4.34
B	$mg\ L^{-1}$	< 1.0	-----	0.12	0.28
Cl^-	$mg\ L^{-1}$	<140	-----	5.91	14.9
HCO^-_3	$mg\ L^{-1}$	< 90	-----	5.94	4.32
Fe	$mg\ L^{-1}$	5.0	>1	2.81	3.69
Mn	$mg\ L^{-1}$	0.2	>0.5	0.95	1.32
Zn	$mg\ L^{-1}$	2.0	>1	0.90	1.15
Cu	$mg\ L^{-1}$	0.2	>1	0.31	0.64
Ni	$mg\ L^{-1}$	0.2	-----	0.21	0.82
Co	$mg\ L^{-1}$	0.05	-----	0.11	0.3
Cd	$mg\ L^{-1}$	0.01	>0.01	0.13	0.46
Pb	$mg\ L^{-1}$	5.0	>0.05	0.41	0.62
SAR		< 9.0	-----	3.80	4.76

n.d = not detected * Fair *et al*. 1971), FAO (1976), WHO (1993)
*****Source of wastewater (artificial water from Industrial City Borg Elarab and sewage water from Mary Mina a church)

RESULTS AND DISCUSSIONS

I-Total Heavy metals content in soils:

Data in Table 3 show the total amounts of Fe, Mn, Zn, Cu, Co, Ni and Pb in different layers of the investigated soils profiles. Data reveal that the total content of these elements differed according to water source used for irrigation. These results are in agreement with the findings of Pescod (1992) who found that after 6 years of continually applying sludge at a cropland disposal site over 90 % of the applied heavy metals were found in the 0 to 15 cm soil depth. This depth is practically within the plow layer. If the soil still irrigated with this water for the long time, the root zone could be polluted with Zn, Cu, Ni and Pb.

Table (3). Total and DTPA-extractable heavy metals, mgkg^{-1} in the studied soils as affected by source of irrigation and soil depth

Depth (cm).	Fe		Mn		Zn		Cu		Co		Ni		Pb	
	Total	DTPA	Total	DTPA	Total	DTPA	Total	DTPA	Total	DTPA	Total	DTPA	Total	DTPA
Soil irrigated with wastewater														
0-5	62 5	22.9	37.27	18.6	31.54	18.2	8.95	4.3	1.93	1.7	5.89	4.1	6.88	4.1
5-10	70.4	23.2	32.80	14.2	31.74	17.2	7.36	3.1	1.84	1.5	5.67	4.3	6.47	2.7
10-30	62.2	20.1	34.98	10.4	19.68	11.3	7.75	3.8	1.15	0.6	3.36	2.9	6.26	2.8
30-60	48.5	9.2	23.12	7.5	19.64	9.3	6.95	2.4	0.68	0.2	4.96	3.6	3.69	2.1
60-90	39.8	10.2	36.38	6.2	6.51	5.96	5.65	2.6	0.97	0.5	3.51	2.1	2.88	1.6
90-150	46.4	5.5	23.10	4.2	15.20	7.2	4.86	1.2	0.88	0.7	2.63	1.6	4.49	1.1
Soil irrigated with artesian water														
0-5	40.9	11.2	15.58	9.5	23.23	19.1	13.59	6.2	1.65	1.2	0.98	0.2	2.39	1.5
5-10	50.8	9.3	10.37	9 .6	14.13	8.3	2.84	1.9	1.98	1.4	0.87	0.5	2.42	1.6
10-30	40.7	9.2	15.66	7.2	15.14	5.6	1.69	1.4	1.64	0.8	0.98	0.5	2.57	1.1
30-60	33.7	7.2	15.36	7.6	15.13	5.3	1.48	0.6	1.38	0.6	0.94	0.1	2.62	1.0
60-90	49.7	4.6	14.24	5.3	6.12	4.4	1.75	0.9	1.37	0.2	0.70	0.1	1.75	0.8
90-150	49.7	2.3	13.25	3.4	5.13	1.2	1.75	0.3	0.65	0.1	0.63	0.2	1.33	0.7

II- DTPA-extractable heavy metals in soils:

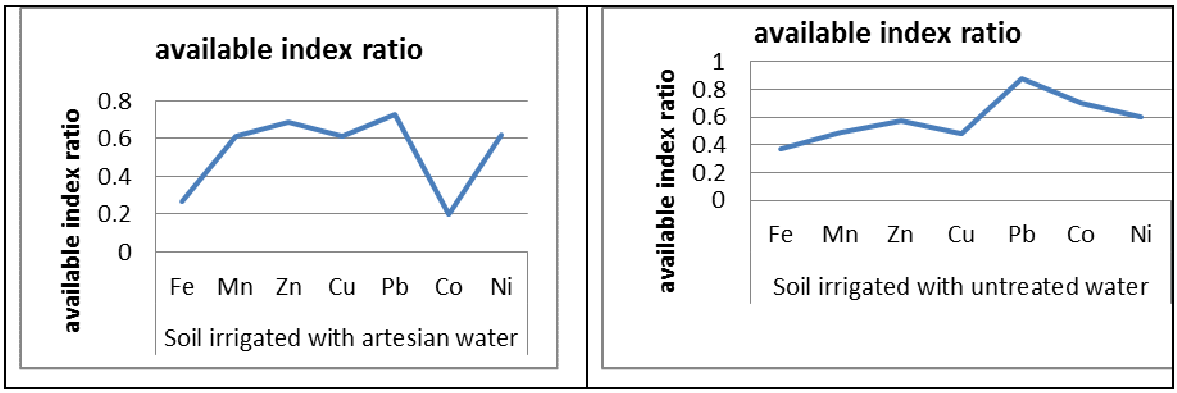
Results given in Table 4 show the DTPA-extractable Fe, Mn, Zn, Cu, Co, Ni and Pb in the successive layers of Borg ELarab soil as affected by irrigation with artesian water and wastewater. Chemically available values for different heavy metals vary according to water source and decreased with increasing soil depth. The increasing extractability of the concerned heavy metals in the soil irrigated with wastewater could be attributed to increasing the total contents. Beside the relatively low pH values (increase of acidity in wastewater in this soil also in Table (4) the chemically available Mn, Zn and Cu showed the highest values in the upper layer for soil irrigated with wastewater compared to other elements Fig 2.

Table (4). available index ratio* for different heavy metals in the studied soils as affected by source of irrigation and soil depth

	Soil irrigated with wastewater water							Soil irrigated with artesian water						
Depth (cm).	Fe	Mn	Zn	Cu	Co	Ni	Pb	Fe	Mn	Zn	Cu	Co	Ni	Pb
0-5	0.37	0.49	0.57	0.48	0.88	0.70	0.60	0.27	0.61	0.82	0.45	0.73	0.20	0.62
5-10	0.33	0.43	0.54	0.42	0.82	0.76	0.42	0.18	0.93	0.59	0.67	0.71	0.57	0.66
10-30	0.32	0.30	0.57	0.50	0.52	0.85	0.43	0.23	0.46	0.37	0.83	0.94	0.51	0.43
30-60	0.19	0.32	0.47	0.35	0.29	0.73	0.57	0.21	0.49	0.35	0.41	0.43	0.11	0.38
60-90	0.26	0.18	0.92	0.46	0.52	0.59	0.57	0.09	0.37	0.72	0.51	0.15	0.14	0.46
90-150	0.12	0.13	0.47	0.25	0.80	0.60	0.24	0.04	0.24	0.23	0.17	0.15	0.32	0.53

*Available index ratio AIR= Available heavy metals/Total heavy metals)

These results coincide with those of (Dumontet *et al*. 1990 and El-Gendi *et al*. 1997) who found that irrigating sandy soil in the Abou- Rawash area with drainage water increased total Cu, Zn and Fe, which reached 125, 170 and 5 times that of the virgin soil in the same area. It seems that the high permeability of the calcareous soil in Borg Elarab area, besides the colloids state of the suspended matter, facilitates the downward movement of heavy metals (ionic, complexed with organic molecules and /or finely dispersed colloidal).



Fig(2). Available index ratio in soils irrigated with artesian and wastewater

III- Effect of wastewater on heavy metals concentrations in potato growing in the Borg ELarab area

Contents of Fe, Zn, Cu, Co, Ni and Pb in leaves potato plants grown on the studied areas are found in Fig. 3. Results show that, the highest values of heavy metals content were found in plants grown on soil irrigated with waste water. This coincides with the previous findings that soil contained the highest values of chemically available heavy metals (Table 3). Variation in accumulation percent of different heavy metals in potato plant arranged in the following order: Cu > Ni > Pb > Co , Fe > Mn ≥ Zn (Table 4).Heavy metals are non-biodegradable and persistent environmental contaminants, which may be uptake and then absorbed by tissues of vegetables plants (Khairiah *et al*. 2004; Al Jassir *et al*., 2005; Singh and Kumar, 2006; Sharma *et al*., 2008).

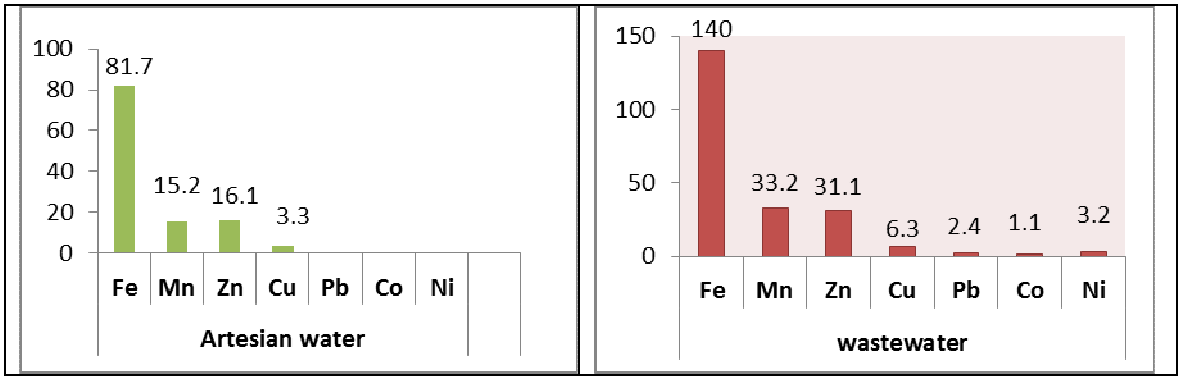


Fig (3). Heavy metals concentrations mgkg^{-1}in leaves of potato affected by source of water irrigation.

Radwan and Salama (2006) studied the mean concentrations and range of heavy metals found in fresh fruits and vegetables samples from several local markets in Alexandria city, Egypt during 2005. Among vegetables, the leafy vegetables lettuce and spinach have content of Pb, Cd, Cu and Zn ranged between 0.28 -0.65, 0.05-0.09, 1.82-2.22, 7.80 – 12.0; 0.23-0.43, 0.09-0.15, 3.50-5.90 and 18.0 -22.8 mg/kg dry weight, respectively. The means of Pb, Cd, Cu and Zn for lettuce and spinach were 0.58, 0.07, 1.97, 9.76; 0.34, 0.11, 4.48 and 20.9 mg/ kg dry weight, respectively. In addition, Arora *et al*. (2008) reported that wastewater irrigated spinach has shown significantly higher concentrations of Fe (309 mg/kg), Mn (69.4mg/kg), Cu (16.5 mg /kg) and Zn (33.1 mg/ kg), compared to the freshwater – irrigated spinach, indicating the highest metal absorption for this vegetable.

Correlation matrix between available heavy metals in soil and concentrated heavy metals in potato plant irrigated with wastewater as the same result with Correlation matrix between available index ratio in soil and concentrated heavy metals in potato plant irrigated with wastewater:

There is a significant strong correlation between the concentration of heavy metals in the soil and its concentration on the potato plants Fig 4,5.
Available index ratio in soils irrigated with wastewater relatively higher than soil irrigated with artesian these rever that the important available index ratio in these study Fig 2. Available index ratio in soils has high correlation with heavy metals concentrations in potato plants

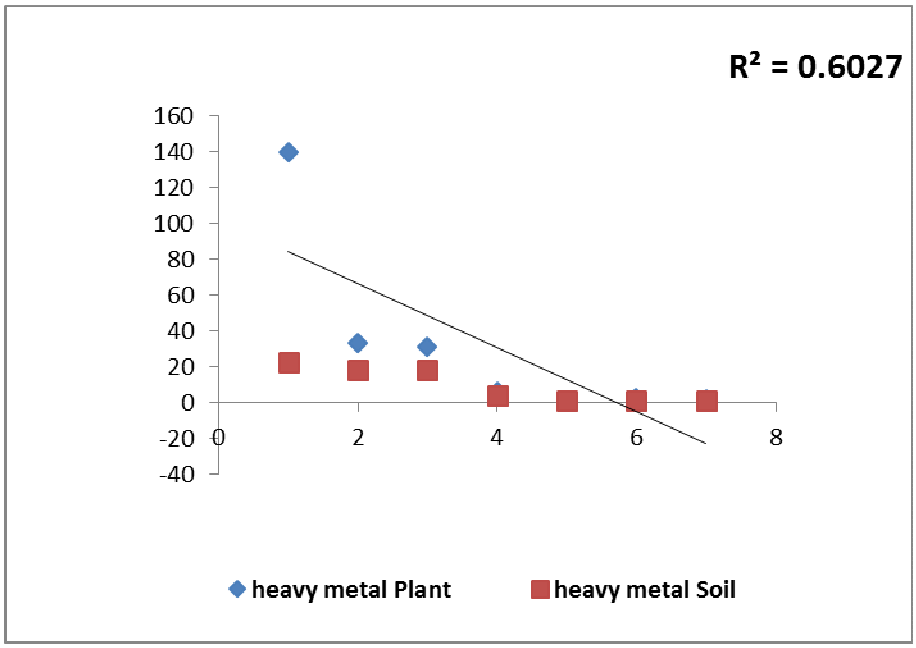


Fig (4). Available heavy metals in soil irrigated with wastewater and concentrated heavy metals potato plan

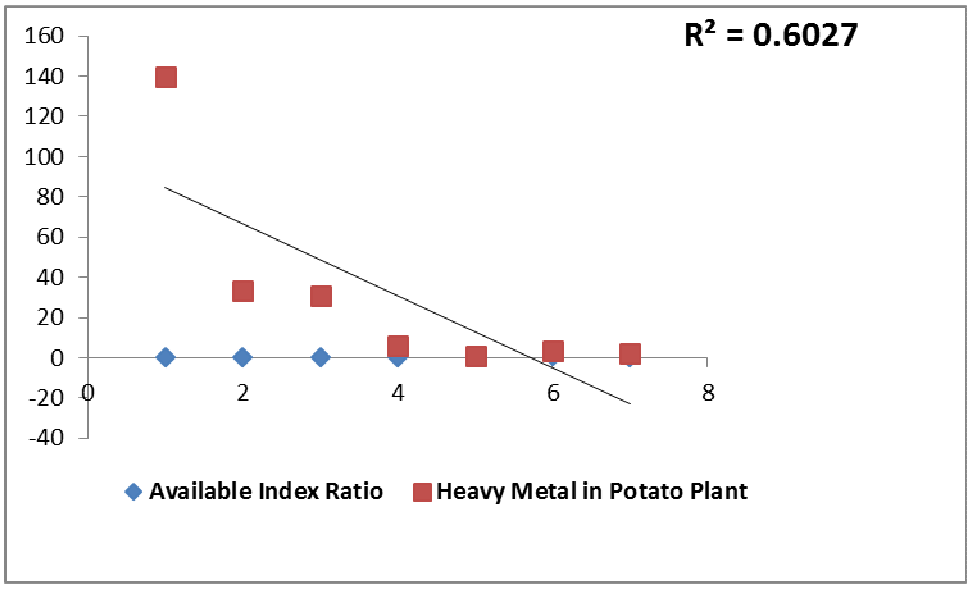


Fig (5). Available Index Ratio and concentrated heavy metals in potato plant (Available Index Ratio (AIR= Available heavy metals/Total heavy metals)

Table 4. Effect of different sources water irrigation on yield components of potato grown in Borg Elarab area

Irrigation Water sources	Tuber yield (Ton ha^{-1})	Straw yield (kg ha^{-1})
Artesian water	9.425	8.905
Wastewater	7.820	6.642

The shoots in potato plants grown in soils irrigated with artesian water were higher than soil irrigated with Wastewater respectively. Indicating that the tuber yield was more than the straw yield in soil irrigated with Wastewater Table 4

Conclusions

This depth is practically within the blow layer. If the soil still irrigated with this water for the long time, the root zone could be polluted with Zn, Cu, Ni and Pb. The increasing extractability of the concerned heavy metals in the soil irrigated with wastewater could be attributed to increasing the total contents of profiles. The highest values of heavy metals content were found in potato plants grown on soil irrigated with wastewater.

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الملخص العربي

صلاحية المعادن الثقيلة في اراضى برج العرب وامتصاصها بنباتات البطاطس المروية بمياه الصرف

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زادت مخلفات الصرف الناتجة عن الأنشطة البشرية، بشكل ملحوظ مما أدى إلى زيادة مشكلة التخلص منها ، وتسبب ذلك فى تأثير غير مرغوب فيه على الموارد الطبيعة والإنسان. ومع كثرة استخدام المياه العادمة في ري المحاصيل لابد من مراقبة دقيقة بسبب احتمال وجود مكونات غير مرغوب فيها من المعادن الثقيلة والملوثات العضوية. ولمعرفة تأثير الري بمياه الصرف على التربة ، تم دراسة خصائص التربة الزراعية في مدينة برج العرب (٥٠٤ هكتار منزرعة بنبات البطاطس) وتم جمع عينات من التربة والنبات من الاراضى المروية بمياه الصرف (مصدرها المجمع الصناعى ودير مارى مينا ببرج العرب) ومن المروية بمياه الآبار ككنترول. تم اخذ عينات من خمس قطاعات من التربة على ابعاد متعاقبة إلى عمق ١٥٠ سم (٠- ٥ ، ٥-١٠، ١٠-٣٠، ٣٠-٦٠، ٦٠-٩٠،٩٠-١٥٠ سم). تم دراسة تأثير مياه الصرف على تركيز العناصر الثقيلة في التربة وامتصاص النبات لها. وأظهرت النتائج أن المحتوى الكلي لهذه المعادن الثقيلة كانت أعلى في الطبقة السطحية من تلك الطبقات تحت السطحية .وكانت تركيزات هذه المعادن الثقيلة في الطبقة السطحية (٠-٥ سم) من التربة المروية من مياه الصرف كالاتى. (الحديد٢٢.٩ ملجم/كجم)، (المنجنيز١٨.٦ملجم/كجم)، (الزنك ١٨.٢ ملجم/كجم)، (النحاس ٤.٣ ملجم/كجم)، (الكوبلت ١.٧ ملجم/كجم)، (النيكل٤.١ ملجم/كجم)، (الرصاص ٤.١ ملجم/كجم. بالمقارنة مع

التربة المروية بمياه الآبارعلى التوالي وهى (الحديد١.٥ ملجم/كجم)، (المنجنيز٠.٢ ملجم/كجم)، (الزنك ٩.١ ملجم/كجم)، (النحاس١.٥ ملجم/كجم)، (الكوبلت ٩.٥ ملجم/كجم)، (النيكل١١.٢ ملجم/كجم)، (الرصاص ١١.٢ ملجم/كجم. تجاوز مجموع المعادن الثقيلة في الطبقة السطحية الحدود المسموح بها فى التربة المروية بمياه الصرف. وأظهرت الدراسة أن. نباتات البطاطس المزروعة في التربة وفقا لقدرتها على تراكم المعادن الثقيلة كما في الترتيب التالي البطاطس المروية بمياه صرف اكثر فى تراكم العناصر الثقيلة من البطاطس المروية بمياه البئر وإختلاف تركيز المعادن الثقيلة فى البطاطس المرواه بمياه الصرف وفقا للترتيب التالي:النحاس > النيكل > الرصاص > الكوبلت والحديد > المنجنيز ≤ الزنك . بجانب التراكم المفرط للكوبلت، النيكل والرصاص فى نبات البطاطس المروى بمياه الصرف.

الكلمات الدلالية : معادن ثقيلة ، برج العرب ، مياه الصرف غير المعالجة ، نبات البطاطس

Influence of Some Pregerminaton Treatments on Seed Germination and Seedling Quality of Two Ornamental Palm Species Common in Egypt

I- Golden Cane Palm (*Chrysalidocarpus lutescens* H. Wendl)

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ABSTRACT: A pot experiment was conducted under shade at the nursery of Antoniades Botanical Garden, Hort. Res. Inst., Alexandria, Egypt during 2014 and 2015 seasons in order to overcome the hardseededness of golden cane palm (*Chrysalidocarpus lutescens* H. Wendl.) seeds by subjecting them after removing the fleshy exocarp to the following treatments: untreated depulped seeds (control), soaking in either tap or hot (60-70 °C) water for 48 h. under room temperature, scarifying the hard endosperm by either clefting it with a hacksaw or rasping it at the distal rounded end that facing the placental pointed-end with a file and soaking in concentrated H_2SO_4 (98.5 %) for either 1 or 2 h in a completely randomized design, replicated thrice, each replicate contained 10 seeds. The results have shown that soaking treatments either in tap or hot water for 48 h. gave the highest germination % (87.33 and 85.00 % in the first season and 90.00 and 87.50 % in the second one, respectively) compared to the control and other treatments in the two seasons. The least percent of germination was recorded by soaking in concentrated sulphuric acid for either 1 or 2 h., while the seeds treated with clefting or rasping treatments have failed to germinate in both seasons. The least no. days to either the highest percent of germination (G.V.) or 50 % germination (MGR) was also achieved by soaking either in tap or in hot water treatments. The means of germination rate index (GRI), vigour index (V.I.), seed viability (S.V.) and plumule length, as a real indicator for germination vigour, the lengths of seedling, sheath, leaf, petiole and root and No. leaves/seedling, as well as leaf content of chlorophyll a, b, carotenoids and total soluble sugars were also improved by the various treatments used in this study except the treatments of H_2SO_4 , but the excellence in most previous parameters was for soaking the depulped seeds in tap water treatment, which gave the utmost highest values at all in both seasons and followed by soaking in hot water one. Hence, it can be recommended to soak the depulped seeds of golden cane palm (*Chrysalidocarpus lutescens* H. Wendl.) in either tap or hot water for 48 h. in order to get the best germination characters and seedling quality.

Keywords: *Chrysalidocarpus lutescens* H. Wendl, germination, soaking, thermal scarification, mechanical scarification, chemical scarification.

INTRODUCTION

Golden cane palm (*Chrysalidocarpus lutescens* H. Wendl., syn. *Dypsis lutescens* (H. Wendl) Beentje and J. Dransf.), known also as bamboo palm, yellow palm, Areca palm or butterfly palm (Fam. Palmaceae). It is a beautiful palm tree that can grow up to 6-9 m tall with a golden ringed stem (like bamboo stem). Its leaves are light green with long petioles arise from the main trunk and gracefully arch outward and downward distributing in all directions. It can be used in gardens as sole specimen, in front of buildings, on sides of enterances and in borders. Also used for indoor landscaping in places with enough light to add a tropical touch. It is considered a good tolerant for drought (**Huxley, 1992**).

Golden cane palm is propagated mainly by seeds, which need to 2-6 months to germinate due to their hard, horny endsperm. So, such seeds must be soaked in lukewarm water for two days to enhance germination (**Meerow, 1991**). On other palms, **Al-Fredan and Ali (2008)** found that the highest

germination % in doum seeds was recorded by mechanically scarified seeds for 30 min and then soaked in water for 24 h. **Zarchini *et al*. (2011)** mentioned that seeds of *Cycas revoluta* pretreated with hot water (70-80 °C) for 12h. germinated faster than untreated ones, while the most germination rate (GR) and value (G.V.) were obtained from seeds pretreated with hot water (100 °C) for 1 h along with 25 % H_2SO_4 for 2 h. **Viana *et al*. (2013)** reported that the highest germination rate was found when green fruits of *Livistona rotundifolia* had their pulp removed and soaked in tap water. On triangle palm, **Shahin *et al*. (2014)** observed that soaking the depulped seeds in concentrated H_2SO_4 for 3 h gave the best germination percentage and velocity, higher means of vigour index, seed viability and plumule length, best growth of the resulted seedlings, as well as higher content of pigments, soluble sugars and indoles in the seedling leaves.

Several reports were also obtained for ornamental trees. In this concern, **Alamgir and Hossain (2005)** noticed that immersing seeds of *Albizia saman* in tap water for 24 h may be recommended for maximal germination and initial vigorous seedlings growth in the nursery. On *Acacia mangium,* **Bahar (2011)** stated that hot water soaking for 24 h or H_2SO_4 for 15 min. soaking enhanced germination of seeds to more than 92 %. Likewise, were those results elicited by **Azad *et al*. (2010)** on *albizia richardiana*, **Azad *et al*. (2012)** on *Albizia procera*, **Khan (2013)** on *Cassia auriculata and C. tora* and **Shahin *et al*. (2015)** whom claimed that soaking seeds of Elephant apple (*Dillenia indica*) either in concentrated H_2SO_4 for 3 min or in tap water for 72 h gave the highest germination % and best quality of the seedlings.

The purpose of this study, however is determining the response of Golden cane palm seeds to some pre-sowing treatments for higher germination percentage and velocity along with better seedling quality.

MATERIALS AND METHODS

The current work was performed under shade at the nursery of Antoniades Botanical Garden, Hort. Res. Inst., Alexandria, Egypt throughout the two consecutive seasons of 2014 and 2015 to overcome the hardseededness of yellow areca palm by some pre-sowing treatments, and to explore the effect of these treatments on growth and quality of the produced seedlings.

Thus, the yellow-ripened fruits of Golden cane palm (*Chrysalidocarpus lutescens* H. Wendl.) were collected at maturity stage (on mid September) for each season and the fleshy exocarp was removed, then were stored at room temperature inside paper bag. The mean weight of 10 seeds after exocarp removal ranged between 3.80-4.27 g. On March, 15th, the depulped seeds were surface sterilized with 10 % solution of sodium hydrochloride for 10 minutes, then rinsed several times in a sterile distilled water and directly undergone to the following treatments:

1. Untreated depulped seeds, referred to as control.
2. Soaking in tap water for 48 hours under ambient conditions.
3. Soaking in hot water (60-70 °C) for 48 hours as thermal scarification treatment.

4. Mechanical scarification by either clefting one side of the mesocarp with a hacksaw or rasping the distal rounded end that facing the placental pointed-end with a file.
5. Soaking in concentrated sulphuric acid (98.5 %) for either 1 or 2 h. as chemical scarification treatments.

The treated and control seeds were then directly sown in 16-cm-diameter plastic pots (10 seeds/pot) filled with about 1.5 kg of sand and clay mixture (1 : 1, by volume) and kept under shade till the end of the experiment. The physical and chemical analyses of the sand and clay used in the two seasons were determined and listed in Table (1).

Table (1). The physical and chemical analyses of the used sand and clay in both seasons.

Soil type	Particle size distribution (%)				S.P.	E.C. (dS/m)	pH	Cations (meq/L)				Anions (Meq/L)		
	Coarse sand	Fine sand	Silt	Clay				Ca^{++}	Mg^{++}	Na^{+}	K^{+}	HCO_3^{-}	Cl^{-}	SO_4^{--}
Sand	81.03	10.15	2.30	6.52	23.11	3.51	7.90	7.50	1.63	33.60	0.50	3.20	22.50	17.53
Clay	7.86	21.29	31.67	39.18	55.18	2.21	8.10	7.82	2.12	15.40	0.75	6.60	8.20	11.29

The layout of the experiments in the two seasons was a completely randomized design (**Silva and Azevedo, 2009**) with 3 replicates, as each pot contained 10 seeds represents one replicate. Irrigation and the other agricultural practices were done whenever needed as usually farmer did. The data were recorded as follows:

A. Germination characteristics:-

1- Germination percentage (G %) from the following equation:
G. % = (No. germinated seeds/ Total No. sown seeds) x 100
2- Germination velocity (G.V.) in days, which equal average number of days from sowing till emergence of the final plumule.
3- Mean germination rate (MGR) in days = mean number of days till 50 % germination (**Odetola, 1987**).
4- Germination rate index (GRI), which calculated from Bartled equation indicated by **Hartmann and Kester (1983).** GRI = A + (A + B) + (A + B + C) + … /N (A + B + C ….).
- Where: A, B, C, …. etc. are number of germinated seeds counted at different times, and N is number of times at which the germinated seeds were counted.
5- Vigour index (VI) = G % x mean length of plumule (**Selvaraju and Selvaraj, 1994**)
6- Seed viability (SV) = number of survived seedlings in each treatment after excluding the deteriorated and dead ones (**Odetola, 1987**).
7- Plumule length of the germinated seeds (cm).

B. Seedling growth characters:-

At the end of each season (on July, 15th), seedlings from the different treatments were gently lifted to measure the following parameters: seedling,

sheath, leaf and petiole lengths (cm), number of leaves/seedling, number of leaflets/leaf, root length (cm) and leaves and roots fresh and dry weights (g).

C. Chemical determinations:-

In fresh leaf samples taken only from the seedlings produced in the second season, photosynthetic pigments (chlorophyll a, b and carotenoids, mg/g. f.w.) and total soluble sugars (mg/100 g f.w.) were measured according to the methods described by **Yadava (1986)** and **Dubois *et al.* (1966)**, respectively.

Data were then tabulated and subjected to analysis of variance according to **SAS Institute (2009)** program and the means of various treatments were differentiated using Duncan's New Multiple Range Test at 5 % level (**Steel and Torrie, 1980)**.

RESULTS AND DISCUSSION

Effect of pre-germination treatments on:

1- Germination characteristics:

Data in **Table (2)** show that soaking treatments in either tap or hot water for 48 h gave the highest germination percentage compared to control in the two seasons. However, the superiority in both seasons was for soaking in tap water treatment which slightly improved this trait over soaking treatment in hot water with non-significant differences among them. This may be attributed to that hot water may injure embryos of some seed species. In this connection, **Souza *et al.* (2012)** stated that after treating the seeds of *Schizolobium parahyba* with hot water, the lens detached from the coat. Blocking water from contacting the lens inhibited water absorption in hot-water-treated seeds. Moreover, **Kavita and Kumar (2014)** reported that seeds of *Stylosanthes guianensis* cv. Cook which were treated with hot water showed maximum death compared to other treatments. On the other hand, the least percent of germination was recorded by soaking in concentrated H_2SO_4 for either 1 or 2 h, whereas the seeds either clefted with a hacksaw or rasped with a file failed to germinate giving 0.0 % germination in the two seasons. This may indicate the negative effect of H_2SO_4 on seed germination of this palm due to prolonging time exposure. In this regard, **Chikumba *et al.* (2006)** found that exposing seeds of *Macrotyloma daltonii* to concentrated H_2SO_4 for 10 min increased germination % from 21 to 80 %, but 20-min. exposure reduced germination and increased the number of dead seeds. Combining pre-chilling with 10-min of acid treatment damaged seeds and impaired germination.

Furthermore, the least number of days to the highest germination percent (G.V.) or 50 % germination (MGR) was also achieved by soaking either in tap or in hot water for 48 h. treatments which recorded means closely near together with non significant differences in between in both seasons. However, soaking in hot water treatment shortened G.V. means to less number of days than soaking in tap water one, while prolonged MGR means to more number of days than tap water soaking treatment in the two seasons, like result was also obtained by **Shahin *et al.* (2014)** who noted that seeds of triangle palm soaked in previously boiling water failed to germinate because of rotting their pith.

Data also indicated that means of G.R.I., V.I. and plumule length (cm), as real indicators for germination vigour were greatly increased in response to the most used treatments, but the prevalence was also for soaking in tap water treatment for 48 h., which scored the highest values in the two seasons and directly followed by hot water treatment that occupied the second rank. This may indicate the hyper-ability of tap or hot water in softening the hard, horny endosperm of such seeds, which consequently permits the ease permeable of water across this soften endosperm which finally leads to activating enzymatic systems that decay the complex nutritional substances of this endosperm to produce energy required for activating the embryo.

The previous results are in accordance with those revealed by **Meerow (1991)** on golden cane palm, **Zarchini *et al*. (2011)** on *Cycas revoluta*, **Alamgir and Hossain (2005)** on *Albizia saman*, **Khan (2013)** on *Cassia auriculata and C. tora* and **Shahin *et al*. (2015)** on *Dillenia indica*.

Table (2). Effect of pre-germination treatments on germination traits of *Chrysalidocarpus lutescens* H. Wendl palm seeds during 2014 and 2015 seasons.

Pre-germination treatments	Germination percentage (G. %)	Germination velocity (G.V., day)	Mean germination rate (MGR, day)	Germination rate index (GRI)	Vigour index (VI)	Seed viability (S.V.)	Plumule length (cm)
First season: 2014							
Control	60.00b	95.28a	89.33a	0.87c	196.80c	3.00c	3.28c
Soaking in tap water for 48 h.	87.33a	49.88c	36.50b	2.58a	392.99a	8.33a	4.50a
Soaking in hot water for 48 h.	85.00a	46.33c	41.00b	1.36b	338.30b	6.76b	3.98ab
Clefting with a hacksaw	00.00e	-	-	-	-	-	-
Rasping with a file	00.00e	-	-	-	-	-	-
Soaking in concn. H_2SO_4 for 1 h	20.50d	87.50b	-	0.95c	71.75e	1.76d	3.50a
Soaking in concn. H_2SO_4 for 2 h	33.67c	81.29b	-	1.00bc	117.85d	2.35d	3.50b
Second season: 2015							
Control	55.49b	97.48a	93.50a	0.84d	163.70c	3.00b	2.95c
Soaking in tap water for 48 h.	90.00a	50.33c	37.26b	2.21a	378.00a	9.00a	4.20a
Soaking in hot water for 48 h.	87.50a	48.56c	44.00b	1.31b	308.00b	8.71a	3.52ab
Clefting with a hacksaw	00.00e	-	-	-	-	-	-
Rasping with a file	00.00e	-	-	-	-	-	-
Soaking in concn. H_2SO_4 for 1 h	20.00d	88.00b	-	0.99c	62.80e	1.90c	3.14b
Soaking in concn. H_2SO_4 for 2 h	35.10c	83.78b	-	1.03bc	112.32d	3.00b	3.20b

- Means within a column having the same letters are not significantly different according to Duncan's New Multiple Range Test at 5 % level.

2- Seedling growth parameters:

It is obvious from data averaged in **Tables (3 and 4)** that all pre-sowing treatments employed in such work improved the means of the various seedling growth traits, with significant differences relative to control means in most cases of both seasons.

Number of leaflets/leaf is the only trait which was not affected by the applied treatments. So, the differences among them were non-significant in the two seasons. In general, the mastery in all parameters of seedling growth was for soaking in tap water treatment (48 h.) that registered the tallest lengths of seedling, sheath, leaf, petiole and root, the highest No. of leaves and the

heaviest fresh and dry weights of leaves and roots with few exceptions in the two seasons. Also, soaking in hot water for 48 h. treatment came to the second position giving records near, to some extent to those of the dominant treatment in most instances of the 1st and 2nd seasons (Photo,1).

Photo (1). A comparison between control seedling and the best treatment one (Tap water, 48 h.).

Improving growth of the resulted seedlings by tap and hot water treatments may be attributed to that these two treatments accelerate seed germination before the other treatments and consequently saving enough time for the new formed seedlings to grown better than those formed lately. Besides, soaking in water for proper time helps the water to penetrate the hard endosperm and hence increases ability of the seeds to absorb more water necessary for hydrolysis of the complex food reserves to absorbable forms. Analogous observations were also obtained by **Meerow (1991)** on golden cane palm, **Al-Fredan and Ali (2008)** on doum palm and **Viana *et al*. (2013)** on *Livistona rotundifolia*. In this connection, **Azad *et al*. (2010)** mentioned that hot water treatment (80 °C for 10 min) was the best for higher germination percentage of *Albizia richardiana* seeds and better growth of the seedlings. Likewise, **Khan (2013)** noted that hot water treatment (80 °C for 10 minutes) was very effective to enhance germination of *Cassia uriculata* and *C. tora* seeds and improving growth of the resulted seedlings.

Table (3). Effect of pre-germination treatments on growth traits of *Chrysalidocarpus lutescens* H. Wendl palm seedlings during 2014 and 2015 seasons.

Pre-germination treatments	Seedling length (cm)	Sheath length (cm)	Leaf length (cm)	Petiole length (cm)	No. leaves per seedling	No. leaflets per leaf	Root length (cm.)
First season: 2014							
Control	15.50d	2.79c	12.71d	5.83bc	1.00b	2a	6.33d
Soaking in tap water for 48 h.	27.24a	4.53a	22.71a	9.80a	3.00a	2a	11.20b
Soaking in hot water for 48 h.	23.80b	4.46a	19.34b	6.28b	3.00a	2a	14.80a
Clefting with a hacksaw	-	-	-	-	-	-	-
Rasping with a file	-	-	-	-	-	-	-
Soaking in concn. H_2SO_4 for 1 h	15.78d	2.58bc	13.20cd	5.50c	1.00b	2a	7.40cd
Soaking in concn. H_2SO_4 for 2 h	18.43c	2.97b	15.46c	6.10b	1.00b	2a	8.01c
Second season: 2015							
Control	15.41d	2.54c	12.87c	5.40b	1.00b	2a	7.25c
Soaking in tap water for 48 h.	27.03a	4.50a	22.53a	9.13a	3.00a	2a	13.72a
Soaking in hot water for 48 h.	23.50b	4.50a	19.00b	5.85b	2.76a	2a	12.10ab
Clefting with a hacksaw	-	-	-	-	-	-	-
Rasping with a file	-	-	-	-	-	-	-
Soaking in concn. H_2SO_4 for 1 h	18.33c	3.00bc	15.33c	5.51b	1.00b	2a	8.47b
Soaking in concn. H_2SO_4 for 2 h	18.50c	3.17b	15.33c	5.73b	1.00b	2a	8.30b

- Means within a column having the same letters are not significantly different according to Duncan's New Multiple Range Test at 5 % level.

Table (4). Effect of pre-germination treatments on leaves and roots fresh and dry weights of *Chrysalidocarpus lutescens* H. Wendl seedlings during 2014 and 2015 seasons.

Pre-germination treatments	Leaves				Roots			
	Fresh weight (g)		Dry weight (g)		Fresh weight (g)		Dry weight (g)	
	2014	2015	2014	2015	2014	2015	2014	2015
Control	0.43c	0.40c	0.13b	0.12b	0.35c	0.41c	0.14c	0.17c
Soaking in tap water for 48 h.	0.78a	0.74a	0.25a	0.24a	0.75a	0.92a	0.31a	0.39a
Soaking in hot water for 48 h.	0.72a	0.70a	0.23a	0.23a	0.66ab	0.56b	0.24ab	0.21bc
Clefting with a hacksaw	-	-	-	-	-	-	-	-
Rasping with a file	-	-	-	-	-	-	-	-
Soaking in concn. H_2SO_4 for 1 h	0.52b	0.61b	0.14b	0.17ab	0.45b	0.52b	0.18bc	0.21bc
Soaking in concn. H_2SO_4 for 2 h	0.63ab	0.63ab	0.16b	0.17ab	0.49b	0.52b	0.21b	0.23b

- Means within a column having the same letters are not significantly different according to Duncan's New Multiple Range Test at 5 % level.

3- Leaf content of pigments and sugars:

A similar trend to that obtained in case of germination and seedling growth traits, was also attained regarding pigments and sugars content in the leaves of seedlings originated from the treated seeds (**Table, 5**), where a marked increment was noticed in the leaf content of chlorophyll a, b and carotenoids (mg/g f.w.), as well as total soluble sugars (mg/100 g f.w.) relative to control content in the two seasons, except of the soaking in concentrated H_2SO_4 for 1 h treatment which slightly reduced total soluble sugars content in the first season only to 1.543 against 1.557 (mg/100 g f.w.) for control. The highest content in all previous constituents, however, was also found due to

soaking the depulped seeds in tap water treatment for 48 h. that gave contents surpassed those recorded by all other treatments. The second rank was also taken up by soaking in hot water treatment for 48 h.

These findings could be discussed and interpretted as indicated before in case of germination and seedling growth characters. On the same line, were those results observed by **Meerow (1991)** on golden cane palm, **Shahin *et al.* (2014)** on triangle palm and **Azad *et al.* (2012)** who postulated that immersion the seeds of *Albizia procera* in hot water (100 °C for 1 min) greatly improved germination % and leaf content of pigments, sugars, N, P and K of the seedlings originated from treated seeds. In this concern, **Shahin *et al.* (2015)** established that soaking *Dillenia indica* seeds either in concentrated sulphuric acid for 3 min. or in tap water for 72 h. pronouncedly improved the leaf content of chlorophyll a, b, carotenoids, total soluble sugars and indoles, but decreased total phenols content.

Table(5). Effect of pre-germination treatments on some active constituents in the leaves of *Chrysalidocarpus lutescens* H. Wendl seedlings during 2014 and 2015 seasons.

Pre-germination treatments	Pigments content (mg/g. f.w.)						Total soluble sugars (mg/100 g. f.w.)	
	Chlorophyll (a)		Chlorophyll (b)		Carotenoids			
	2014	2015	2014	2015	2014	2015	2014	2015
Control	0.937	0.756	0.404	0.361	0.369	0.328	1.557	1.306
Soaking in tap water for 48 h.	2.522	2.143	1.068	0.969	0.913	0.965	2.967	2.497
Soaking in hot water for 48 h.	1.668	1.253	0.616	0.562	0.699	0.641	2.609	2.201
Clefting with a hacksaw	-	-	-	-	-	-	-	-
Rasping with a file	-	-	-	-	-	-	-	-
Soaking in concn. H_2SO_4 for 1 h	1.595	1.238	0.509	0.453	0.471	0.500	1.543	1.422
Soaking in concn. H_2SO_4 for 2 h	1.586	1.267	0.587	0.530	0.437	0.496	1.861	1.568

Accordingly, it is advised to soak the dopulped seeds of yellow areca palm (*Chrysalidocarpus lutescens* H. Wendl.) in either tap or hot water for 48 h. to improve germination characteristics and quality of the resulted seedlings.

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الملخص العربى

تأثير بعض معاملات ما قبل الإنبات على إنبات بذور وجودة شتلات نوعين من نخيل الزينة المتداول فى مصر

١- نخيل الأريكا الصفراء (*Chrysalidocarpus lutescens* H. Wendl.)

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أجريت تجربة أصص تحت الظل بمشتل حديقة أنطونيادس النباتية، معهد بحوث البساتين، الإسكندرية، مصر خلال موسمي ٢٠١٤، ٢٠١٥ بقصد التغلب على صلابة بذور نخيل الأريكا الصفراء وذلك بتعريضها، بعد إزالة الجزء اللحمي الخارجي للمعاملات الآتية: بذور منزوعة اللحم بدون معاملة (كمقارنة)، النقع إما في ماء الصنبور أو الماء الدافئ (٦٠-٧٠ °م) لمدة ٤٨ ساعة على درجة حرارة الغرفة، خدش الإندوسبرم الصلب ميكانيكياً إما بشقه بالمنشار عند أحد الأجناب أو كشطه بالمبرد عند الطرف البعيد المستدير المقابل للطرف المشيمى المدبب وكذلك النقع في حمض الكبريتيك المركز (٩٨,٥ %) إما لمدة ساعة أو ساعتين في تصميم عشوائي كامل، به ثلاث مكررات/معاملة وبكل مكررة عشرة بذور.

أوضحت النتائج المتحصل عليها أن معاملتي النقع إما في ماء الصنبور أو الماء الدافئ لمدة ٤٨ ساعة أعطيتا أعلى نسبة مئوية للإنبات (٨٧,٣٣، ٨٥,٠٠ % في الموسم الأول، ٩٠,٠٠، ٨٧,٥٠ % في الموسم الثاني، على الترتيب) مقارنة بالكنترول والمعاملات الأخرى فى كلا الموسمين. أما أقل نسبة مئوية للإنبات فقد سجلتها معاملتي النقع في حمض الكبريتيك المركز لمدة ساعة أو ساعتين، بينما فشلت البذور المخدوشة ميكانيكياً إما بالشق أو الكشط في الإنبات بكلا الموسمين. أيضاً، فإن أقل عدد للأيام لتحقيق أعلى نسبة للإنبات (سرعة الإنبات) أو تحقيق ٥٠ % إنبات (معدل متوسط الإنبات) فقد أحرزته معاملتي النقع إما في ماء الصنبور أو في الماء الدافئ. أوضحت النتائج كذلك أن متوسطات دليل معدل الإنبات، دليل قوة الإنبات، حيوية البذور وطول الريشة كأدلة حقيقية على قوة الإنبات، أطوال الشتلة، الغمد، الورقة، عنق الورقة والجذر وعدد الأوراق/شتلة، وأيضاً محتوى أوراق الشتلات الناتجة من كلوروفيل أ، ب، الكاروتينويدات والسكريات الكلية الذائبة قد تحسنت بمختلف المعاملات المطبقة بهذه الدراسة عدا معاملات حمض الكبرتيك، لكن السيادة في معظم القياسات السابقة كانت

لمعاملة النقع في ماء الصنبور (٤٨ ساعة) والتي أعطت أعلى القيم على الإطلاق في معظم الحالات بكلا الموسمين وتلتها معاملة النقع في الماء الدافئ (٤٨ ساعة).

وعليه، يمكن التوصية بنقع البذور منزوعة اللحم لنخيل الأريكا الصفراء إما في ماء الصنبور أو في الماء الدافئ لمدة ٤٨ ساعة للحصول على أفضل صفات للإنبات وعلى جودة للشتلات الناتجة.

Influence of Some Pregerminaton Treatments on Seed Germination and Seedling Quality of Two Ornamental Palm Species Common in Egypt
II- Pygmy Date Palm (*Phoenix roebelenii* O`Brien)

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ABSTRACT: This investigation was undertaken under the shade at the Nursery of Antoniades Botanical Garden, Hort. Res. Inst., Alexandria, Egypt during 2014 and 2015 seasons to study the effect of the following pregermination treatments: untreated intact fruits (as control), depulped seeds (Pyrenes) without any treatment, soaking the depulped seeds in tap water for either 24 or 48 hours, soaking the depulped seeds in hot water (60-70 °C) for 24 hours or soaking them in diluted sulphuric acid (50 %) for either 6 or 12 hours on germination characters of Pygmy date palm (*Phoenix roebelenii* O`Brien) seeds and growth and quality of the resulted seedlings.The obtained results indicated that soaking the depulped seeds in tap water for 24 h. treatment gave the highest percentage of germination in the two seasons and followed in the first season by soaking in hot water for 24 h treatment, but in the second one by the untreated depulped seeds. The depulped seeds soaked in diluted H_2SO_4 (50 %) for 6 h. failed to germinate in both seasons, while those soaked in such acid for 12 h. gave 10 % germination only in the first season. The least number of days passed to either the highest percent of germination (G.V.) or 50 % germination (MGR) in the two seasons was also recorded by soaking in tap water for 24 h. treatment. The germination rate index (GRI) was significantly increased over control by depulping and soaking in tap water for 48 h. treatments, but slightly decreased by soaking in tap water for 24 h. and significantly by soaking in hot water for 24 h. treatments compared to control in the two seasons. Most of the used treatments improved the means of vigour index (V.I.), seed viability (S.V.), plumule length, vegetative and root growth parameters of the produced seedling, as well as their leaf content of pigments and total soluble sugars with various significant differences relative to control means in most cases of both seasons. However, the mastership was recorded for treatment of soaking in tap water for 24 h., which gave the utmost highest values in most of the previous measurements in the two seasons.So, it can be recommended to soak the depulped seeds (Pyrenes) of Pygmy date palm (*Phoenix roebelenii* O`Brien) in tap water for 24 h. to achive the highest and fastest germination along with the best quality of the seedlings.

Keywords: *Phoenix roebelenii* O`Brien, germination, soaking, thermal scarification, mechanical scarification, chemical scarification.

INTRODUCTION

Pygmy date palm (*Phoenix roebelenii* O`Brien) belongs to Fam. Arecaceae is a small to medium sized, slow-growing slender tree growing to 2-3 m tall. The leaves are 60-120 cm long, pinnate, with around 100 leaflets arranged in a single plane. Each leaflet is 15-25 cm long and 1 cm broad, slightly drooping and grey-green in colour. The fruit is an edible 1 cm drupe resembling a small, thin fleshed date, violet-black in colour when mature and the seed shows a longitudinal furrow. They are very much appreciated by birds and one kilogram contains 3663 seeds (**Lorenzi *et al*. 2004**).

Pygmy date palm is a popular ornamental plant in gardens in tropical and subtropical areas. In cooler area, it is grown under glass or as a house plant. It is resistant to pests, tolerant to soil variation and moderately drought tolerant. It grows in partial shade to full sun and needs little pruning to develop a strong structure. It excels in containers of all kinds, also looks great by patios and entry ways. Use clumps of this palm as specimens and to serve as focal point in a mass planting of annuals. Also, nice combined with evergreen shrubs in a

mixed hedges. This palm is said to remove formaldehyde and xylene from air (**Barrow, 1994**).

The seeds of *P. roebelenii* (Pyrenes) are elliptical or cylindrical and slightly flattened. They are albuminous, with a very hard endosperm almost completely filling its inner part. So, they must be soaked in water for at least 24 hours (**Lossi *et al*. 2006**). *P. roebelenii* seed germination is of the remote-tubular type, in which the cotyledon petiole is considerably elongated and no ligula is visible (**Uhl and Dransfield, 1997**). **Matthes and Castro (2007)** reported that seeds from three different locations and harvest times started to germinate 47, 60, 120 days after sowing. This difference may be ascribed to the genetic factor, the climatic conditions under which the plant develops or stage of fruit maturation.

Little studies were carried out on seed germination of species belongs Phoenix genus, especially under environment of Egypt such as that of **Shahin *et al*. (2014)** who found that soaking the depulped seeds of *Phoenix rupicola* in either concentrated H_2SO_4 for 4 min or tap water for 3 h. increased germination percentage to 100 and 80 %, respectively. These two treatments have also improved germination velocity, mean germination rate, germination rate index, vigour index, seed viability, plumule length, vegetative and root growth of the resulted seedlings and their leaf content of pigments, total carbohydrates and total indoles. On the other side, great efforts were done in relation to the germination of seeds of other palms, such as those revealed by **Shahin and Arafa (2014 a and b)** on *Butia capitata* and *Hyphaene thebaica*, **Al-Fredan and Ali (2008)** on Doum, **Junior *et al*. (2013)** on *Acrocomia aculeata* and **Shahin *et al*. (2014)** on *Syagrus schizophylla*.

However, this investigation aims to find out the best pregermination treatment reliable for germination enhancing and accelerating of Pygmy date palm seeds with high quality of the resulted seedlings.

MATERIALS AND METHODS

This study was carried out under the shade at the nursery of Antoniades Botanical Garden, Hort. Res. Inst., Alexandria, Egypt throughout the two consecutive seasons of 2014 and 2015 to examine the effect of some pre-sowing treatments on germination traits and quality of the seedlings that will be formed from Pygmy date palm treated seeds.

Therefore, the mature fruits of Pygmy date palm (*Phoenix roebelenii* O`Brien) were collected from trees located on Antoniades Botanical Garden, Alexandria, from mid to end of March for each season. The pulp of the fruit was removed. Next, the pyrenes (which consisted of the endocarp and seed) were washed in running water and dried in the shade for one day. On April, 1st for each season, the depulped seeds (pyrenes, the mean weight of 10 pyrenes was about 1.42 g) received the following treatments:

1. Untreated depulped seeds.
2. Depulped seeds soaked in tap water for either 24 or 48 hours under ambient conditions.
3. Depulped seeds soaked in hot water (60-70 °C) for 48 hours as thermal scarification treatment.

4. Depulped seeds soaked in diluted sulphuric acid (50 %) for either 6 or 12 hours under ambient conditions.

Besides, the intact fruits (undepulped seeds) which raised without any treatment as control (the mean weight of 10 intact fruits was about 1.83 g). Before, sowing the treated pyrenes and intact fruits of control treatment were surface sterilized with 10 % Na-hydrochloride for 10 min., they rinsed several times with sterile distilled water and sown in 16-cm-diameter plastic pots (10 seeds or fruits/pot) filled with about 1.5 kg of sand and clay mixture (at equal ratios by volume). The physical and chemical analyses of the sand and clay used in both seasons are shown in Table (1).

Table (1). The physical and chemical analyses of the used sand and clay in both seasons.

Soil type	Particle size distribution (%)				S.P.	E.C. (dS/m)	pH	Cations (meq/L)				Anions (Meq/L)		
	Coarse sand	Fine sand	Silt	Clay				Ca^{++}	Mg^{++}	Na^{+}	K^{+}	HCO_3^{-}	Cl^{-}	SO_4^{--}
Sand	81.03	10.15	2.30	6.52	23.11	3.51	7.90	7.50	1.63	33.60	0.50	3.20	22.50	17.53
Clay	7.86	21.29	31.67	39.18	55.18	2.21	8.10	7.82	2.12	15.40	0.75	6.60	8.20	11.29

The pots were arranged in a completely randomized design (**Silva and Azevedo, 2009**), replicated thrice as each pot containing 10 seeds exemplifies a replicate. Clearly visible plumule protrusion was used as criterion for germination. All agricultural practices needed for such plantation was carried out on time. Data were recorded as follows:

A. Germination characteristics:-

1- Germination percentage (G %) from the following equation:
G. % = (No. germinated seeds/ Total No. sown seeds) x 100

2- Germination velocity (G.V.) in days, which equal average number of days from sowing till emergence of the final plumule.

3- Mean germination rate (MGR) in days = mean number of days till 50 % germination (**Odetola, 1987**).

4- Germination rate index (GRI), which calculated from Bartled equation indicated by **Hartmann and Kester (1983).** GRI = A + (A + B) + (A + B + C) + … /N (A + B + C ….).

- Where: A, B, C, …. etc. are number of germinated seeds counted at different times, and N is number of times at which the germinated seeds were counted.

5- Vigour index (VI) = G % x mean length of plumule (**Selvaraju and Selvaraj, 1994**)

6- Seed viability (SV) = number of survived seedlings in each treatment after excluding the deteriorated and dead ones (**Odetola, 1987**).

7- Plumule length of the germinated seeds (cm).

B. Seedling growth characters:-

At the end of each season (on August, 20th), seedlings from the different treatments were gently lifted to measure the following data: the lengths of seedling, sheath, leaf and petiole (cm), number of leaves / seedling, root length (cm), number of root branches per main root and leaves and roots fresh and dry weights (g).

C. Chemical determinations:-

In fresh leaf samples, photosynthetic pigments (chlorophyll a, b and carotenoids, mg/g. f.w.) and total soluble sugars (mg/100 g f.w.) were determined using the methods described by **Yadava (1986)** and **Dubois *et al*. (1966)**, respectively.

The collected data were then tabulated and statistically analysed using **SAS Institute (2009)** program, which was followed by Duncan's New Multiple Range Test (**Steel and Torrie, 1980)** for elucidating the significancy between the means of various treatments at 5 % level.

RESULTS AND DISCUSSION

Effect of pre-germination treatments on:

1- Germination characteristics:

According to data averaged in **Table (2)**, it was noticed that soaking the depulped seeds in tap water for 24 h treatment significantly increased the percent of germination to the highest values compared to other treatments in the two seasons, and followed in the first season by soaking in hot water for 24 h. treatment (67.33 %), but in the second one by untreated deepulped seeds (70.33 %). The least improvement in this parameter was gained in the 1st season by untreated depulped seeds and those soaked in tap water for 48 h., as these two treatments raised germination % to 60 % against 50 % for the control, while in the 2nd one, that was attained by soaking the depulped seeds in either tap water for 48 h. or hot water for 24 h. treatments, which elevated the mean of such trait also to 60 % versus 47.5 % for control. On the other hand, the depulped seeds soaked in diluted H_2SO_4 for any time failed to germinate in the two seasons except of soaking for 12h treatment that scored 10 % germination in the 1st season only. This may be due to exposure the embryo to injury by the acid. In this regard, **Chikumba *et al*. (2006)** mentioned that the 10-min acid treatment increased germination of *Macrotyloma deltonii* seeds from 21 to 38 %, but 20-min treatment reduced germination and increased the number of dead seeds.

The least number of days lapsed to reach either the highest germination % (G.V.) or 50 % germination (MGR) was also recorded by soaking treatment in tap water for 24 h with significant differences when compared to control and other treatments in the two seasons. The germination rate index (GRI), as a real indicator for germination accelerating was significantly increased over control by depulped seeds and soaking in tap water for 48 h in both seasons, as well as by soaking in diluted acid in the first season, but slightly decreased by soaking in tap water for 24 h treatment and significantly by soaking in hot water for 24 h.

relative to control in both seasons. As for vigour index (V.S.), seed viability (S.V.) and plumule length (cm) parameters, they were significantly improved by the most treatments used in such trial, with the superiority of soaking in tap water for 24 h. treatment which gave the highest records in this traits in the two seasons.This may be attributed to ability of tap water to penetrate the hard endosperm of Pygmy date palm seeds in amount sufficient to activate enzymes which decay the complex nutritional substances stored in this hard endosperm to produce the energy necessary for embryo growth. In this concern, **Al-Fredan and Ali (2008)** mentioned that soaking doum seeds in water for 24 h. is needed after mechanical scarification treatment to activate growth of the embryo. **Junior *et al*. (2013)** noticed that immersing macaw palm seeds in tap water after removing the orpecular tegument progressively increased the germination speed index with elongating the immersing time.The previous results were supported by those declared by **Lossi *et al*. (2006)** on *Phoenix roebelenii*, **Shahin *et al*. (2014)** on *Phoenix rupicola* and **Shahin *et al*. (2014)** on *Syagrus schizophylla*.

Table (2). Effect of pre-germination treatments on germination traits of *Phoenix roebelenii* O`Brien palm seeds during 2014 and 2015 seasons.

Pre-germination treatments	Germination percentage (G. %)	Germination velocity (G.V., day)	Mean germination rate (MGR, day)	Germination rate index (GRI)	Vigour index (VI)	Seed viability (S.V.)	Plumule length (cm)
First season: 2014							
Control	50.00d	117.67a	117.67a	0.67c	70.00c	5.00c	1.40cd
Depulped seeds (DS)	60.00c	101.00c	93.58c	0.78b	108.60b	6.10bc	1.81b
DS soaked in tap water for 24 h.	80.76a	89.72d	80.50d	0.61c	170.40a	8.76a	2.11a
DS soaked in tap water for 48 h.	60.00c	108.25b	103.69bc	0.71b	97.80bc	6.00bc	1.63b
DS soaked in hot water for 24 h.	67.33b	110.78b	107.33b	0.53d	101.00b	6.73b	1.50c
DS Soaked in diluted H_2SO_4 for 6 h.	0.00f	-	-	-	-	-	-
DS Soaked in diluted H_2SO_4 for 12 h.	10.00e	99.00c	-	1.00a	12.3d	0.00d	1.23d
Second season: 2015							
Control	47.50d	125.91a	-	0.71b	69.35d	4.33d	1.46c
Depulped seeds (DS)	70.33b	107.63c	99.00b	0.82a	133.63b	7.00b	1.90ab
DS soaked in tap water for 24 h.	90.00a	90.96d	83.46c	0.63bc	189.00a	9.00a	2.10a
DS soaked in tap water for 48 h.	60.00c	115.50b	109.50a	0.76ab	102.60c	6.00c	1.71b
DS soaked in hot water for 24 h.	60.00c	117.31b	110.76a	0.61c	97.80c	6.00c	1.63b
DS Soaked in diluted H_2SO_4 for 6 h.	0.00e	-	-	-	-	-	-
DS Soaked in diluted H_2SO_4 for 12 h.	0.00e	-	-	-	-	-	-

- Means within a column having the same letters are not significantly different according to Duncan's New Multiple Range Test at 5 % level.

2- Seedling growth parameters:

Parallel results to those of germination characteristics were also attained regarding vegetative and root growth parameters of the seedlings generated from the respondent treated seeds (**Tables, 3 and 4),** where the means of the lengths of seedlings, sheath, leaf, petiole and root (cm), No. leaves/seedling, No. root branches/main root, as well as leaves and roots fresh and dry weights (g) were pronouncedly improved by most employed treatments with the dominance of soaking in tap water one for 24 h., which registered the utmost high means over the control and other treatments in most cases of both seasons. In general, the untreated depulped seeds and those were soaked in either tap eater for 48 h. or hot water for 24 h gave values closely near together with non-significant differences in between in most instances of the two seasons.

Table (3). Effect of pre-germination treatments on growth traits of *Phoenix roebelenii* O`Brien palm seedlings during 2014 and 2015 seasons.

Pre-germination treatments	Seedling length (cm)	Sheath length (cm)	Leaf length (cm)	Petiole length (cm)	No. leaves per seedling	Root length (cm.)	No. root branches per main root
				First season: 2014			
Control	11.88d	1.50b	9.80c	1.50c	1.00c	12.00c	1.00c
Depulped seeds (DS)	16.50b	1.81ab	11.38b	2.45b	2.00b	15.33ab	2.00b
DS soaked in tap water for 24 h.	20.10a	2.00a	14.46a	3.96a	2.78a	14.51b	3.00a
DS soaked in tap water for 48 h.	14.07c	1.67b	10.20c	2.20b	2.00b	12.63c	1.76b
DS soaked in hot water for 24 h.	14.83c	1.80ab	10.29c	2.14b	2.00b	16.00a	2.00b
DS Soaked in diluted H_2SO_4 for 6 h.	-	-	-	-	-	-	-
DS Soaked in diluted H_2SO_4 for 12 h.	-	-	-	-	-	-	-
				Second season: 2015			
Control	12.47c	1.59b	10.00c	1.53c	1.00c	10.68c	1.00c
Depulped seeds (DS)	15.98b	1.90ab	12.07b	2.31b	2.00b	13.67b	1.33bc
DS soaked in tap water for 24 h.	18.79a	2.10a	13.64a	3.68a	3.00a	15.23a	2.16a
DS soaked in tap water for 48 h.	15.01b	1.76b	10.50c	2.30b	1.90b	13.65b	1.50b
DS soaked in hot water for 24 h.	15.27b	1.83ab	10.47c	2.33b	1.78b	14.25ab	1.50b
DS Soaked in diluted H_2SO_4 for 6 h.	-	-	-	-	-	-	-
DS Soaked in diluted H_2SO_4 for 12 h.	-	-	-	-	-	-	-

- Means within a column having the same letters are not significantly different according to Duncan's New Multiple Range Test at 5 % level.

Table (4) Effect of pre-germination treatments on leaves and roots fresh and dry weights of *Phoenix roebelenii* O`Brien seedlings during 2014 and 2015 seasons.

Pre-germination treatments	Leaves				Roots			
	Fresh weight (g)		Dry weight (g)		Fresh weight (g)		Dry weight (g)	
	2014	2015	2014	2015	2014	2015	2014	2015
Control	0.11c	0.12c	0.03b	0.03c	0.10b	0.09c	0.05b	0.04b
Depulped seeds (DS)	0.20b	0.19b	0.07ab	0.08b	0.019a	0.17ab	0.09a	0.08ab
DS soaked in tap water for 24 h.	0.32a	0.30a	0.10a	0.13a	0.018a	0.19a	0.10a	0.12a
DS soaked in tap water for 48 h.	0.17b	0.19b	0.05b	0.07b	0.12b	0.14b	0.06ab	0.07b
DS soaked in hot water for 24 h.	0.19b	0.20b	0.06ab	0.07b	0.21a	0.19a	0.10b	0.09ab
DS Soaked in diluted H_2SO_4 for 6 h.	-	-	-	-	-	-	-	-
DS Soaked in diluted H_2SO_4 for 12 h.	-	-	-	-	-	-	-	-

- Means within a column having the same letters are not significantly different according to Duncan's New Multiple Range Test at 5 % level.

The previous findings could be interpretted and discussed as indicated before in case of germination characters. However, they are in harmony with those detected by **Shahin *et al*. (2014)** on *Phoenix rupicola* and **Alamgir and Hossain (2005)** whom found that immersing *Albizia saman* in tap water for 25 h. increased germination percentage, germination velocity, vigour index, initial morophological growth and biomass production of the seedlings. Likewise, **Dhanda *et al*. (2011)** pointed out that tap water treatment improved seed germination of *Albizia lebbek, Acacia catechu and Melia azadirach* and pronouncedly increased seedling growth, number of nodules and biomass production.

3- Leaf content of pigments and sugars:

Data illustrated in **Table (5**) clear that leaf content of chlorophyll a, b and carotenoids (mg/g f.w.), as well as total soluble sugars (mg/100 g f.w.) were markedly increased over control in the two seasons by depulping treatment and soaking in either tap water or hot water ones with the mastery of soaking in tap water for 24 h. treatment that recorded, generally the highest content of the aforenamed constituents compared to control and the other treatments in both seasons, except of carotenoids content in the first season, as the depulping treatment raised such component to the utmost high mean. In general, depuling treatment occupied the second position as it gave the second highest content in all previous constituents immediately after the tap water treatment for 24 h.

Table (5). Effect of pre-germination treatments on some active constituents in the leaves of *Phoenix roebelenii* O`Brien seedlings during 2014 and 2015 seasons.

Pre-germination treatments	Pigments Content (mg/g. f.w.)						Total soluble sugars (mg/100 g. f.w.)	
	Chlorophyll (a)		Chlorophyll (b)		Carotenoids			
	2014	2015	2014	2015	2014	2015	2014	2015
Control	0.737	1.025	0.282	0.323	0.309	0.352	2.223	2.498
Depulped seeds (DS)	1.422	1.307	0.436	0.479	0.613	0.458	4.395	4.884
DS soaked in tap water for 24 h.	1.501	2.088	0.466	0.534	0.534	0.570	4.435	4.989
DS soaked in tap water for 48 h.	0.896	1.152	0.322	0.361	0.512	0.561	3.097	3.465
DS soaked in hot water for 24 h.	0.879	1.223	0.369	0.397	0.431	0.473	3.664	3.510
DS Soaked in diluted H_2SO_4 for 6 h.	-	-	-	-	-	-	-	-
DS Soaked in diluted H_2SO_4 for 12 h.	-	-	-	-	-	-	-	-

This may be attributed to the ease permeation of water into the Pyrenes after removal the fleshy exocarp, which finally leads to increasing the amount of water by the depulped seeds and consequently increasing hydrolysis of the food reserves stored in the hard endosperm to become more available for the new formed seedlings. Similar observations were also shown by **Shahin *et al*. (2014)** on *Phoenix rupicola*, **Junior *et al*. (2013)** on *Acrocomia aculeate* and and **Shahin *et al*. (2015)** whom found that soaking the seeds of *Dillenia indica* in tap water for 72 h. greatly improved chlorophyll a, b, carotenoids, total soluble sugars and total indoles in the leaves of the new formed seedlings.

According to the results mentioned above, it can be advised to soak the dopulped seeds of *Phoenix roebelenii* O`Brien in tap water for 24 h. in order to get the highest and fastest germination along with the best seedling quality.

Cont. **Tap water (24 h.)**

Photo (1). A comparison between control seedling and the best treatment one (Tap water, 24 h.).

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الملخص العربى

تأثير بعض معاملات ما قبل الإنبات على إنبات بذور وجودة شتلات نوعين من نخيل الزينة المتداول فى مصر

٢- نخيل البلح القزمى (*Phoenix roebelenii* O`Brien)

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أجري هذا البحث تحت الظل بمشتل حديقة أنطونيادس النباتية، معهد بحوث البساتين، الإسكندرية، مصر خلال موسمي ٢٠١٤، ٢٠١٥ لدراسة تأثير معاملات ما قبل الإنبات التالية: ثمار كاملة غير معاملة (كمقارنة)، بذور منزوعة اللحم (النوى : جمع نواة) بدون أى معاملة، نقع البذور منزوعة اللحم فى ماء الصنبور لمدة ٢٤ أو ٤٨ ساعة، نقع البذور منزوعة اللحم فى ماء ساخن (٦٠-٧٠ °م) لمدة ٢٤ ساعة، وكذلك النقع فى حمض الكبريتيك المخفف (٥٠ %) لمدة ٦، ١٢ ساعة على صفات الإنبات لبذور نخيل البلح القزمى (*Phoenix roebelenii* O`Brien) وعلى نمو وجودة الشتلات الناتجة.

أوضحت النتائج المتحصل عليها أن معاملة نقع البذور منزوعة اللحم (النوى) فى ماء الصنبور لمدة ٢٤ ساعة أعطت أعلى نسبة للإنبات فى كلا الموسمين، تلتها فى الموسم الأول معاملة النقع فى الماء الساخن لمدة ٢٤ ساعة، بينما تلتها فى الموسم الثانى زراعة البذور منزوعة اللحم بدون معاملة. ولقد فشلت البذور منزوعة اللحم والمنقوعة فى حمض الكبريتيك المخفف لمدة ٦ ساعات فى الإنبات، بينما أعطت تلك التى نقعت فى هذا الحمض لمدة ١٢ ساعة ١٠ % إنبات فقط فى الموسم الأول. كذلك، فإن أقل عدد للأيام إنقضت سواءً لإحراز أعلى نسبة إنبات (سرعة الإنبات) أو لتحقيق ٥٠ % إنبات (معدل متوسط الإنبات) سجلته أيضاً معاملة النقع فى ماء الصنبور لمدة ٢٤ ساعة فى كلا الموسمين. أما دليل معدل الإنبات فقد زاد معنوياً بمعاملتى نزع اللحم والنقع فى ماء الصنبور لمدة ٤٨ ساعة، لكنه أنخفض بدرجة بسيطة بمعاملة النقع فى ماء الصنبور لمدة ٢٤ ساعة، بينما انخفض معنوياً بمعاملة النقع فى الماء الساخن لمدة ٢٤ ساعة مقارنة بالكنترول فى كلا الموسمين. ولقد أحدثت معظم المعاملات موضع الدراسة تحسناً فى متوسطات دليل قوة الإنبات، حيوية البذور، طول الريشة، قياسات النمو الخضرى والجذرى للشتلات الناتجة، وفى محتوى أوراقها من كلوروفيللي أ، ب، الكاروتينويدات والسكريات الكلية الذائبة وبفروق معنوية مختلفة عند مقارنتها بمتوسطات الكنترول فى معظم الحالات بكلا الموسمين. إلا أن السيادة كانت لمعاملة النقع فى ماء الصنبور لمدة ٢٤ ساعة والتى أعطت أعلى القيم فى معظم القياسات السابقة بكلا الموسمين.

لذلك، يمكن التوصية بنقع البذور منزوعة اللحم لنخيل البلح القزمى *Phoenix roebelenii* (O`Brien) في ماء الصنبور لمدة ٢٤ ساعة قبل زراعتها مباشرة لإحراز أسرع وأعلى نسبة إنبات مع الحصول على شتلات قوية عالية جودة.

Effect of Foliar Applied Benzyladenine and Gibberellic Acid on Vegetative Growth and Chemical ConsTituents of *Dracaena marginata*. (B) Pinched Plants.

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ABSTRACT: The present study was carried-out at Antoniades Research Branch, Horticulture Research Institute, A.R.C. Alexandria, Egypt during the two successive seasons of 2013 and 2014. In this study, we aimed to test the effect of applying foliar sprays of gibberellic acid and benzyladenine in increasing the marketing quality of *Dracaena marginata* plants. Dracaena small plants were planted individually in 30 cm diameter plastic pots. The small plants were pinched to length to 30 cm from soil surface. The plants were sprayed with gibberellic acid at the concentrations of 500, 1000 and 1500 mg/L and benzyladenine at the concentrations of 200, 250 and 300 mg/L. The obtained results showed that spraying with gibberellic acid at 1000 mg/L and benzyladenine at 300 mg/L together increased significantly plant height, leaves number per plant, leaves dry weight, leaves area, stem diameter, stem dry weight, branches number per plant, root length and root dry weight. The obtained results showed that spraying with gibberellic acid at 1000 mg/L and benzyladenine at 250 mg/L together resulted in the highest chlorophyll content, carbohydrates content and nitrogen percentage in the leaves.
Key words: *Dracaena marginata* **-** gibberellic acid **–** benzyladenine.

INTRODUCTION

The genus *Dracaena* belongs to the botanical family Ruscaceae. Its center of origin is located in tropical and subtropical regions of Africa, Asia and Australia. This genus comprises about 40 species **(Bailey and Bailey, 1976)**, but only six species *D. deremensis*, *D. fragrans, D. marginata*, *D. reflex*a, *D. sanderiana*, and *D. surculosa* (*godseffiana*) are cultivated as foliage plants. These species are favored as interior ornamental plants because of their diverse shapes, colors and forms available in the market and because of their ability to survive under low-light conditions with minimum care (**Chen *et al.*, 2002**).

Plant growth regulators (cytokinins and gibberellins) are used in agricultural industry for stimulation and synchronization of flowering and fruit setting, promotion of rooting, reduction of vegetative growth, reduction of lodging of agronomic crops, or defoliation **(Briant, 1974)**. Cytokinins are plant hormones that plants produce naturally and regulate plant growth, including cell division and leaf senescence. There are several commercial plant growth regulators (PGRs) that contain benzyladenine, a synthetic cytokinin **(Padhye *et al.*, 2008)**. It can be applied as a foliar spray or a substrate drench at different concentrations. The useful application concentration differs greatly between ornamental plants and is generally unknown **(Werbrouk *et al.*, 1996)**. The results Obtained with exogenous cytokinins, however, vary depending on the type and concentration of the cytokinins used (**Bosse and Staden, 1989).**

Cytokinines appeared to play an important role in the regulation of cell division, differentiation and organogenesis in developing plants, enhancement of leaf expansion, nutrient mobilization and delayed senescence, **(Skoog and Armstrong, 1970** and **Hall, 1973)**. Gibberellins are commonly used as growth enhancers because they cause cell elongation in the plant. They can be used to partially overcome dormancy, increase flower size, flower number, flower uniformity, and to create standards. A gibberellin overdose will result in a spindly unmarketable plant **(Runkle, 2006** and **Leopold and Kriedmann, 1975)**.

Gibberellins are synthesized from mevalonic acid in young tissues of shoots and developing seeds **(Davies, 1995)**. Transport is via both the xylem and the phloem. The effects of gibberellins vary by plant species. Some plant species respond with an increase in height due to an increase in cell length. Other plant species respond to gibberellins by increasing cell number as well as an increase in size, most likely cell length. Gibberellins prevent the development of lateral buds when applied to decapitated shoots of several species **(Salisbury and Ross, 1969)**.The aim of this research is to study some important traits of Dracaena plants treated with gibberellic acid and benzyladenine on the marketing qualities.

MATERIALS AND METHODS

The present study was carried-out at Antoniades Research Branch, Horticulture Research Institute, A.R.C. Alexandria, Egypt during the two successive seasons of 2013 and 2014. On 10th of March, 2013 and 2014 (in the first and second seasons, respectively) homogenous small plants of *Dracaena marginata* (34-36 cm height and 18-22 leaf per plant in average) were planted individually in plastic pots (30 cm diameter) filled with 8 kg mixture of sand and clay at the ratio of (1:1) by volume. The chemical constituents of the soil were measured as described by **Jackson (1958)** and illustrated in Table (1). On the 10th of March in both seasons, the small plants were pinched to a length of 30 cm of the soil surface. Plants were sprayed with gibberellic acid at concentrations of 500, 1000 and 1500 mg/L and benzyladenine at concentrations of 200, 250 and 300 mg/L, every 30 days starting from on 10th of April till 10th of July in both seasons. The control plants were sprayed with tap water. On 10th of August in both seasons the plants were harvested.

Table (1). Chemical analysis of the used mixture soil for the two successive seasons of 2013 and 2014.

Season	pH	EC (dSm^{-1})	Soluble cations (mg/l)				Soluble anions (mg/l)		
			Ca^{++}	Mg^{++}	Na^{+}	K^{+}	HCO_3^{-}	Cl^{-}	SO_4^{--}
2013	8.24	1.80	1.7	0.9	1.6	0.65	1.3	1.38	1.10
2014	8.08	1.61	1.3	0.6	1.4	0.53	1.0	1.13	0.98

In both seasons, all plants received NPK chemical fertilization using fertilizer (Milagro Aminoleaf 20-20-20) at the rate of 2.0 g per pot each time. Fertilization was repeated every 30 days throughout the growing season (from

the 20th of March till the 20th of July). In addition, weeds were removed manually upon emergence.

Data were recorded as follows:

1.Vegetative growth parameters:

Plant height (cm), leaves number per plant, dry weight of leaves (g), leaves area (cm^2), stem diameter (cm), dry weight of stem (g), branches number per plant, root length (cm) and dry weight of root (g).

2.Chemical analysis determination:

- Total chlorophylls content were determined according to **Moran and Porath (1980).**
- Carbohydrates contents of the leaves were determined according to **Dubios *et al.* (1956).**
- Nitrogen (%) was determined in the digested solution by the modified microkjeldahl method as described by **Pregl (1945).**

The experimental design was a complete randomized block design (RCBD) contained 16 treatments with three replicates; each treatment contained three plants. Data were subjected to analysis of variance (ANOVA) using the SAS program, SAS Institute **(Snedecor and Cochran, 1974)** and the mean values were compared using L.S.D test at 5% level **(SAS Institute, 2002).**

RESULTS

1. Vegetative growth

1.1. Plant height (cm)

Data in Table (2) indicated that gibberellic acid and benzyladenine treatments had a significant effect on the plant height. In both seasons, plants sprayed with gibberellic acid at 1000 mg/L and benzyladenine at 300 mg/L together gave the tallest plant height compared to the control plants. As with other vegetative growth parameters, spraying the plants with gibberellic acid at 1000 mg/L and benzyladenine at 300 mg/L together gave the tallest plants 44.75 and 46.08 cm (in the first and second season, respectively).

1.2. Number of leaves per plant

Data presented in Table (2) showed that, the different gibberellic acid and benzyladenine treatments had a significant effect on the number of leaves per plant of *Dracaena marginata* plants. Plants sprayed using gibberellic acid at 1000 mg/L and benzyladenine at 300 mg/L together forming significantly larger leaves with a mean leaves number of 79.16 and 78.50 (in the first and second seasons, respectively). On the other hand, compared to that of control plants, the lowest number of leaves per plant was found to be 57.00 and 48.16 (in the first and second seasons, respectively).

1.3. Leaves dry weight (g) per plant

Data presented in Table (2) also showed that spraying *Dracaena marginata* plants with gibberellic acid at 1000 mg/L and benzyladenine at 300 mg/L together significantly increased the dry weight of leaves giving values of

22.62 and 25.00 g per plant (in the first and second seasons, respectively), compared to the control 12.23 and 12.26 g per plant (in the first and second seasons, respectively). Accordingly, it can be seen from the data in Table (2) that *Dracaena marginata* plants sprayed with gibberellic acid at 1000 mg/L and benzyladenine at 300 mg/L together increased significantly leaves dry weight compared to other treatments.

1.4. Leaves area (cm^2)

Data presented in Table (2) showed that the different gibberellic acid and benzyladenine treatments had a significant effect on leaves area of *Dracaena marginata* plants. Plants sprayed using gibberellic acid at 1000 mg/L and benzyladenine at 300 mg/L together formed significantly larger leaves (with a mean area of 3084.72 and 3064.38 cm^2 (in the first and second seasons, respectively), than those formed by control plants 1356.72 and 1355.64 cm^2 (in the first and second seasons, respectively).

Table (2). Average values of plant height and number, dry weight and area of leaves *Dracaena marginata* plants as influenced by benzyladenine (BA) and gibberellic acid (GA3) in the two seasons of 2013 and 2014.

Treatments (mg/L)	Plant height (cm)		Number Leaves per plant		Dry weight of leaves (g)		Leaves area (cm^2)	
	2013	2014	2013	2014	2013	2014	2013	2014
Control	36.41	35.75	57.00	48.16	12.23	12.26	1356.72	1355.64
GA500	40.66	39.25	69.33	69.33	16.26	17.79	2623.54	2479.95
GA1000	41.00	39.58	70.16	70.33	18.19	18.85	2627.86	2561.79
GA1500	41.91	40.25	70.66	71.16	18.72	19.04	2717.59	2711.61
BA200	37.33	35.83	58.66	57.00	12.82	15.00	1766.58	1692.35
BA250	36.58	37.75	64.66	61.33	13.25	15.44	1809.16	1728.10
BA300	36.91	37.16	66.16	62.83	13.86	16.12	2008.39	1965.70
GA500 + BA200	38.41	38.58	66.50	63.16	14.75	16.29	2171.86	2080.64
GA500 + BA250	39.25	38.83	66.83	65.66	15.06	16.44	2273.99	2088.07
GA500 + BA300	39.33	38.83	68.66	66.33	15.66	16.50	2309.69	2259.95
GA1000 + BA200	42.25	40.83	77.50	74.83	21.66	20.24	3025.77	3019.17
GA1000 + BA250	43.41	42.25	78.66	75.33	22.10	21.18	3030.35	3049.20
GA1000 + BA300	44.75	46.08	79.16	78.50	22.62	25.00	3084.72	3064.38
GA1500 + BA200	40.00	40.58	72.50	72.50	18.82	19.05	2802.09	2738.34
GA1500 + BA250	41.00	40.58	75.66	73.33	19.61	19.34	2861.03	2882.88
GA1500 + BA300	41.91	42.16	76.16	74.00	20.18	19.58	2996.29	2937.00
L.S.D. at 0.05	**5.19**	**4.36**	**11.78**	**14.08**	**6.99**	**6.19**	**477.94**	**495.43**

1.5. Stem diameter (cm)

Data recorded in Table (3) showed that spraying *Dracaena marginata* plants with gibberellic acid at 1000 mg/L and benzyladenine at 300 mg/L together gave the largest stem diameter1.59 and 1.53 cm as compared with control treatment which gave 1.19 and 1.22 cm (in the first and second season, respectively).

1.6. Dry weight of stem (g)

Data recorded in Table (3) showed that spraying *Dracaena marginata* plants with gibberellic acid at 1000 mg/L and benzyladenine at 300 mg/L together gave the heaviest values of stem dry weight 7.02 and 6.85g (in the first and second seasons, respectively). Whereas, it was found that spraying with tap water (control) decreased the stem dry weight to 5.01 and 5.29g as compared with other treatments.

1.7. Number of branches per plant

Data in Table (3) showed that plants sprayed with gibberellic acid at 1000 mg/L and benzyladenine at 300 mg/L together formed the highest number of branches per plant which gave3.16 and 3.33 in the first and second seasons, respectively. Whereas, control plants gave the lowest number of branches per plant 1.00 and 1.00 (in the first and second season, respectively).

Table (3). Average values of diameter and dry weight of stem and number of branches of *Dracaena marginata* plants as influenced by benzyladenine (BA) and gibberellic acid (GA3) in the two seasons of 2013 and 2014.

Treatments (mg/L)	Stem diameter (cm)		Dry weight of stem (g)		Number branches per plant	
	2013	2014	2013	2014	2013	2014
Control	1.19	1.22	5.01	5.29	1.00	1.00
GA500	1.34	1.38	5.95	6.16	1.00	1.50
GA1000	1.36	1.39	6.06	6.23	1.50	1.83
GA1500	1.37	1.40	6.08	6.27	1.16	1.66
BA200	1.22	1.30	5.41	5.81	1.66	1.66
BA250	1.27	1.32	5.64	5.92	2.16	2.33
BA300	1.27	1.35	5.63	6.07	2.33	2.16
GA500 + BA200	1.28	1.36	5.70	6.11	1.33	1.66
GA500 + BA250	1.32	1.37	5.86	6.13	1.50	2.00
GA500 + BA300	1.32	1.37	5.88	6.14	1.66	1.83
GA1000 + BA200	1.50	1.44	6.65	6.45	2.00	2.00
GA1000 + BA250	1.52	1.52	6.74	6.83	3.00	3.16
GA1000 + BA300	1.59	1.53	7.02	6.85	3.16	3.33
GA1500 + BA200	1.47	1.42	6.50	6.32	1.66	1.66
GA1500 + BA250	1.46	1.43	6.52	6.39	2.33	3.00
GA1500 + BA300	1.49	1.43	6.58	6.43	2.50	3.16
L.S.D. at 0.05	**0.15**	**0.18**	**0.69**	**0.80**	**0.50**	**0.57**

1.8. Root length (cm)

Data recorded in Table (4) showed that spraying *Dracaena marginata* plants with gibberellic acid at 1000 mg/L and benzyladenine at 300 mg/L together gave the highest values of root length116.80 and 114.18 cm as compared with control treatment which gave 95.19 and 87.12 cm (in the first and second season, respectively).

1.9. Dry weight of root (g)

Data recorded in Table (4) showed that spraying *Dracaena marginata* plants with gibberellic acid at 1000 mg/L and benzyladenine at 300 mg/L together gave the largest root dry weight 6.31 and 5.91g (in the first and second seasons, respectively). Whereas, it was found that spraying with tap water (control) decreased the root dry weight to 3.78 and 3.93g (in the first and second seasons, respectively).

Table (4). Average values of root length and root dry weight of *Dracaena marginata* plants as influenced by benzyladenine (BA) and gibberellic acid (GA3) in the two seasons of 2013 and 2014.

Treatments (mg/L)	Root length (cm)		Dry weight of root (g)	
	2013	2014	2013	2014
Control	95.19	87.12	3.78	3.93
GA500	106.32	96.80	4.79	4.70
GA1000	106.98	97.46	5.09	4.85
GA1500	109.38	99.44	5.13	5.00
BA200	97.59	88.44	4.09	4.35
BA250	95.84	93.06	4.33	4.38
BA300	95.84	91.74	4.34	4.45
GA500 + BA200	100.43	95.70	4.43	4.54
GA500 + BA250	102.61	95.92	4.49	4.65
GA500 + BA300	103.05	95.92	4.55	4.67
GA1000 + BA200	110.47	101.20	5.78	5.49
GA1000 + BA250	113.75	104.28	5.90	5.55
GA1000 + BA300	116.80	114.18	6.31	5.91
GA1500 + BA200	104.36	100.10	5.26	5.13
GA1500 + BA250	106.98	100.32	5.29	5.27
GA1500 + BA300	109.38	104.28	5.61	5.33
L.S.D. at 0.05	**13.81**	**10.79**	**1.84**	**1.65**

2. Chemical constituents

2.1. Total chlorophylls content (mg/g F.W)

The results of leaf chemical analysis in Table (5) also showed that the gibberellic acid and benzyladenine treatments had clear effect on the total chlorophylls content. The recorded mean values ranged from 2.39 and 2.40 mg/g in the first and second seasons, respectively, in plants sprayed with gibberellic acid at 1000 mg/L and benzyladenine at 250 mg/L together to 1.95 and 1.99mg/g in the first and second seasons, respectively, in plants sprayed with tap water (control).

2.2. Total carbohydrates content (%)

The results in Table (5) also showed that most of the tested gibberellic acid and benzyladenine concentrations increased the mean total carbohydrates in the leaves of *Dracaena marginata* plants, compared to the control. Among the plants receiving the different treatments, plants sprayed with gibberellic acid at 1000 mg/L and benzyladenine at 250 mg/L together had the highest

carbohydrates in leaves of 19.36 and 19.50 % (in the first and second seasons, respectively).

2.3. Nitrogen percentage in leaves (%)

The results in Table (5) also show that the mean nitrogen content of the leaves was slightly increased by spraying the plants with gibberellic acid at 1000 mg/L and benzyladenine at 250 mg/L together which gave nitrogen contents of 2.29 and 2.34 % (in the first and second seasons, respectively), compared to the control. The lowest values 1.88 and 1.94 % (in the first and second seasons, respectively), were recorded in plants sprayed with tap water (control).

Table (5). Average of chemical constituents of *Dracaena marginata* plants as influenced by benzyladenine (BA) and gibberellic acid (GA3) in the two seasons of 2013 and 2014.

Treatments (mg/L)	Chlorophyll content (mg/g F.W)		Carbohydrates Content in leaves (%) D.W		Nitrogen content (%)	
	2013	2014	2013	2014	2013	2014
Control	1.95	1.99	15.86	16.17	1.88	1.94
GA500	2.05	2.05	16.64	16.66	1.97	2.00
GA1000	2.10	2.15	17.05	17.46	2.02	2.10
GA1500	2.08	2.09	16.85	16.97	2.00	2.04
BA200	2.03	2.04	16.50	16.57	1.96	1.99
BA250	2.12	2.12	17.21	17.20	2.04	2.07
BA300	2.09	2.07	16.98	16.82	2.01	2.02
GA500 + BA200	2.14	2.16	17.39	17.60	2.06	2.11
GA500 + BA250	2.38	2.38	19.31	19.36	2.30	2.32
GA500 + BA300	2.28	2.29	18.47	18.59	2.19	2.23
GA1000 + BA200	2.16	2.17	17.51	17.64	2.08	2.12
GA1000 + BA250	2.39	2.40	19.36	19.50	2.29	2.34
GA1000 + BA300	2.18	2.27	17.72	18.44	2.10	2.21
GA1500 + BA200	2.20	2.21	17.84	17.93	2.12	2.15
GA1500 + BA250	2.30	2.33	18.67	18.93	2.21	2.27
GA1500 + BA300	2.22	2.28	18.00	18.55	2.14	2.22
L.S.D. at 0.05	**0.06**	**0.05**	**0.47**	**0.44**	**0.06**	**0.05**

DISCUSSION

Results of this study and other studies confirm that gibberellic acid and benzyladenine increase some process such as cell wall tension and thus cell water potential decline **(Fathi and Esmaeelpoor, 1999)** and more water absorption to cell and at last increase fresh weight succulence (**Mutui *et al.,* 2001** and **Emongor and Tshwenyane, 2004)**. On the other hand effect of gibberellic acid and benzyladenine on increasing of carbohydrate hydrolysis induction cause to stability of respiration **(De-Hortogh, 1996)**. Effect of gibberellic acid and benzyladenine on preventing of senescence (**Pun *et al.*, 1999**, **Ranwala and Miller, 2000** and **Emongor and Tshwenyane, 2004)** and its effect on chlorophyll synthesis and chloroplast development increasing

prevent from leaves yellowing **(Guo *et al.*, 2003** and **Emongor and Tshwenyane, 2004)**. Thus, gibberellic acid interferes in retard chlorophyll destroy. Therefore, a section of this effect is caused to chlorophyll preservation that is attendant with leaf nitrogen level preservation.

It has been known that the use of growth regulators in agriculture practices is most favourable for promoting and improving plant-growth of different plants. The beneficial effect of gibberellic acid on different plants were recorded by **(Shedeed *et al.,* 1991)** on croton plant, **(Eraki, 1994a)** on Queen Elizabeth rose plants, **(Bedour *et al.,* 1994)** on *Ocimum basillicum.* They concluded that gibberellic acid is used for regulating plant growth through increasing cell division and cell elongation. The effect of cytokinins, especially benzyl adenine, on the plant growth and chemical constituents of different plants have mentioned by **(Eraki *et al.,* 1993)** on salvia plants, **(Mazrou, 1992)** on Datura, **(Mazrou *et al.,* 1994)** on sweet basil, **(Mansoure *et al.,* 1994)** on soybean plants and **(Vijayakumari, 2003)** on *Andrographis panculata.* Cytokinins are important plant hormones that regulate various processes of plant growth and development including cell division and differentiation, enhancement of leaf expansion and nutrient mobilization **(Hassan and El-Quesni, 1989** and **Shudok, 1994)**. The response of plants to cytokinins have been also discussed in more papers such as **(Eraki , 1994b)** on *Hibiscus sabdarijfa* L. plants who mentioned that application of BA significantly increased plant height, number of branches as well as fresh and dry weights of leaves than the control. **Hassanein (1985)** on *Pelargonium graveolens,* **(El-Sayed *et al.*, 1989)** on *Polianthus tuberosa,* **(Menesi *et al.,* 1991)** on *Calendula officinalis* and **(Mazrou *et al.*, 1994)** on sweet basil, found that foliar application of BA increased growth of different organs, active constituents production of these plants and increased total carbohydrates content on comparison to the untreated plants.

According to these points, necessity of using growth regulator to improve marketing quality is completely justified. Among treatments that we used in this study, gibberellic acid 1000 mg/L with benzyladenine 300 mg/L showed good results and their means did not have significant difference with each other, but they showed significant difference with other treatments. Gibberellic acid 1000 mg/L with benzyladenine 300 mg/L gave the best plant height, number of leaves per plant, dry weight of leaves, leaves area, stem diameter, dry weight of stem, number of branches per plant, root length and dry weight of root which significant differences with other treatments. Similar increase in the vegetative growth was recorded by **(Shedeed *et al.*, 1991)** on croton plants, **(Rahman *et al.*, 2004)** on soybean, **(Soad, 2005)** on Jajoba plants, **(Rawia and Bedour, 2006)** on croton plants and **(Soad *et al.*, 2010)** on croton plants.

Gibbberellic acid at 1000 mg/L with benziladenine at 250 mg/L together were the most effective treatment on total chlorophyll, carbohydrates and nitrogen content. This treatment was significantly different with control respecting to total chlorophyll and was significantly different with control. Similar results in the chlorophylls content reported by **(Shedeed *et al.*, 1991)** on croton plants, **(Mousa *et al.*, 2001)** on *Nigella sativa*, **(Rawia and Bedour, 2006)** on

croton plants, **(Soad *et al.*, 2010)** on croton plants and **(Majidian *et al.,* 2012)** on *Zantedesehia aethiopied*. Similar results in the carbohydrates content reported by **(Sheren, 2005)** on flax plants, **(Rawia and Bedour, 2006)** on croton plants, **(Nahed, 2007)** on croton plants and **(Soad *et al.*, 2010)** on croton plants. Similar results in the nitrogen content reported by **(Sayed, 2001)** on *Khaya senegalensis*, **(Mohammed, 2003)** on *Acacia saligna*, **(Soad, 2005)** on Jajoba plants, **(Rawia and Bedour, 2006)** on croton plants, **(Nahed, 2007)** on croton plants and **(Soad *et al.*, 2010)** on croton plants.

CONCLUSIONS

The present results reported about the vegetative growth parameters and chemical compositions of *Dracaena marginata* showed that the best spraying treatments of gibberellic acid at 1000 mg/L and benzyladenine at 300 mg/L together gave the best quality results for plant height, number of leaves, leaves area, stem diameter, branches number and root length of *Dracaena marginata* pinched plants.Generally, the results obtained to sprayed *Dracaena marginata* plants with gibberellic acid and benzyladenine together better than spraying dracaena plants with gibberellic acid or benzyl adenine alone enhanced good vegetative growth and some chemical components of plants *Dracaena marginata* plants.

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الملخص العربى

تأثير رش البنزيل أدنين وحمض الجبريليك على النمو الخضرى والتحليل الكيماوى فى الدراسينا مارجيناتا. (ب) النباتات المطوشة

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تمت هذه الدراسة خلال موسمى ٢٠١٣ و ٢٠١٤ فى مشتل الأفرع البحثية بأنطونيادس – معهد بحوث البساتين – مركز البحوث الزراعية بالإسكندرية. كان الهدف من هذه الدراسة هو معرفة تأثير الرش بحمض الجبرللين والبنزيل أدنين على تحسين جودة نباتات الدراسينا مارجيناتا ورفع قيمتها التسويقية. تم زراعة نباتات الدراسينا الصغيرة فى أوانى بلاستيكية ذات قطر ٣٠ سم. تم تطويش النباتات على أرتفاع ٣٠ سم من سطح التربة. رشت النباتات بحمض الجبرللين بتركيزات (٥٠٠، ١٠٠٠،١٥٠٠ مجم/لتر) كذلك بالبنزيل أدنين بتركيزات (٢٠٠،٢٥٠،٣٠٠ مجم/لتر).

وكانت النتائج المتحصل عليها أظهرت أن رش نباتات الدراسينا بحمض الجبرللين ١٠٠٠ مجم/لتر بالإضافة إلى البنزيل أدنين ٣٠٠ مجم/لتر أعطى نتائج معنوية فى كل من أرتفاع النبات ، عدد الأوراق ، الوزن الجاف للأوراق ، المساحة الورقية ، قطر الساق ، الوزن الجاف للساق ،عدد الأفرع على النبات ، طول الجذور ، الوزن الجاف للجذور. بينما أظهرت نتائج رش النباتات بحمض الجبرلين ١٠٠٠ مجم/لتر بالإضافة إلى البنزيل ادنين ٢٥٠ مجم/لتر أعطى نتائج معنوية فى كل من محتوى الكلوروفيل الكلى ونسبة الكربوهيدرات الكلية ، نسبة النيتروجين فى الأوراق.

Effect of Pre-harvest Foliar Application of Citric Acid, Malic Acid and Tryptophan on The Growth, Flowering and Post-harvest Vase Life of tuberose Plants (B) Effect of Pre-harvest Treatments on Post-harvest Vase Life

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ABSTRACT: Tuberose (*Polianthes tuberosa* L.), is one of the most famous cut flowers used due to its delicate fragrance and commercial demand, nevertheless, the vase life of the inflorescence declines rapidly at home. To overcome this problem an experiment was conducted to find a suitable pre-harvest foliar application which provides the longest vase life of tuberose. Three foliar applications were used in the form of malic acid, citric acid and tryptophan after planting the bulbs with concentrations of (0, 100, 200 and 300 mg/L) for each chemical. Cut inflorescences were then placed into a standard vase solution containing 4% sucrose and 200 mg/L of salicylic acid. Results showed that malic acid at the concentration of (300 mg/L), significantly affected all the vegetative parameters tested with the highest vase life 12.00 and 12.33 days compared with the control (8.33 and 7.66 days). Malic acid also gave the highest total chlorophyll and carbohydrates in the inflorescences of tuberose as compared with the control.

Key word: *Polianthes tuberosa* - malic acid – citric acid - tryptophan - vase life.

INTRODUCTION

Tuberose (*Polianthes tuberosa* L.), spikes of ivory flowers are prized for their fragrance and has long been cherished for the aromatic oils extracted from its fragrant flowers. It is one of the most important bulbous ornamentals as a member of Agavaceae family.

Although tuberose has a high potential for a long vase life after harvesting, it declines rapidly at home. Tuberose inflorescences (spikes) bear (10-20) pairs of florets which open acropetally. Consumers' carelessness, including neither recutting stem ends nor changing the vase solutions are the major factors in reducing the vase life of cut flowers (**Jowkar and Salehi, 2005**). Vase life of cut tuberose flowers is usually short. Vase life of cut flowers is related to physiochemical processes and reduces through ethylene production and bacterial contamination in vase solution **(Nowak and Rudnicki, 1990; van Doorn, 1997; Alaey *et al.*, 2011).** Short vase life is highly influenced by water loss and wilting during transpiration **(van Doorn, 1997).** Some treatments have been applied to increase the vase life of cut flowers by regulating water balance, distribution of assimilates, delaying senescence and blocking microbial agents **(Alaey et al., 2011).** Water balance is a main factor determining quality and longevity of cut flowers **(da Silva, 2003)**. The major form of vascular occlusion is the blockage of xylem vessels by air emboli and

microorganisms **(van Doorn, 1997).** Microorganisms, especially bacteria and fungi which grow in preservative solutions have a main adverse effect on the longevity of cut flowers. These microorganisms and their products plug the stem ends and restrict the water absorption, which reduce the longevity of cut flowers **(van Doorn, 1997; Alaey *et al.*, 2011)**. Microbes can also produce ethylene and secrete toxic compounds, also pectinase and accelerated senescence. Ethylene is major plant growth regulator related to senescence and its external application causes accelerated senescence **(Reid and Wu, 1992).** Several agents have been used in cut flower vase solution to extend vase life by improving water uptake **(Lü *et al.*, 2010).**

Endogenous organic acids are the source of both carbon skelton and energy for cells and are used in the respiratory cycle and other biochemical pathways. Therefore, they can influence the vase life (**da Silva, 2003**). Malic acid is metabolized in plant mitochondria by reaction of malic emzyme, (**Talebi *et al.*, 2014**). Malate is a common reserve anion playing a role in the plant vacuole as counter ion for K and Ca. They also recorded that pre-harvest treatment of citric acid (0.15 w/v) increased the mean vase life of cut lilium flowers from 11.8 in control treatment to 14 days (**Darandeh and Hadavi, 2012**).

Eidyan *et al.* (2014) reported that citric acid spray (0.1% w/v) increased the vase life of tuberose cut flowers and increased the size of bulblets in a synergism with folia Fe. Citric acid is a six carbon organic acid, having a central role in citric acid cycle in mitochondria that creates cellular energy by phosphorylative oxidation reactions (**Willis *et al.*, 1981**). Results on the application of citric acid on some physiological parameters in tuberose plants were promising (**Ghazijahani *et al.*, 2014**). Tryptophan has an indirect role on the growth via auxin synthesis. Whereas it was suggested several alternative roles of IAA synthesis in plants, all starting from tryptophan, thus when tryptophan is supplied to most plant tissues, IAA was formed, (**Taha, 2005**).

The present study aimed to evaluate the effect of malic acid, citric acid and tryptophan as biostimulants, for increasing the ornamental performance of the tuberose post-harvest as well as to evaluate the use of these organic acid as pre-harvest foliar spray if they could increase the quality and the post-harvest life of cut inflorescences of tuberose.

MATERIALS AND METHODS

The experiment was conducted in the Faculty of Agriculture, Alexandria University, Egypt during the two successive seasons of 2013 and 2014. Tuberose corms with average of 3.8 cm diameter and 70.0g of fresh weight were obtained from a commercial farm at El-Kanater El-Khayreya. Corms were planted in a 30 cm plastic pot in sandy soil on the 13th of May 2013 and 2014 in the two seasons, respectively.

The starting date of spraying was after sprouting of corms after 15 days from planting, in the two seasons of 2013 and 2014. Pre-harvest foliar sprays

with citric acid (0, 100, 200 and 300 mg/L), malic acid (0, 100, 200 and 300 mg/L) and tryptophan (0, 100, 200 and 300 mg/L) were used as the following scheme:

- The first spraying was after sprouting 30 days at the 4th of July.
- The second spraying was after sprouting 45 days at the 18th of July.
- The third spraying was after sprouting 60 days at the 1th of August.
- The fourth spraying was after sprouting 75 days at the 15th of August.

The tuberose inflorescences were cut when two florets were opened per spike to follow up the vase life. Cut flowers were transported to the laboratory under dry conditions; they were recut before treatments to the length of 70 cm, then put placed in a standard solution containing 4% sucrose and 200 ppm salicylic acid in distilled water as was described by **(Kazemi *et al.*, 2012)** in the first and second seasons, respectively. The vase life and floret opening of cut inflorescences were considered terminated when the number of senesced florets exceeded the number of opened ones, according to **(Waithaka *et al.*, 2001).** Room temperature was 26ºC ±1 and total humidity was 70% ±2. The following data were recorded after cutting the inflorescence:

1. Flowering characteristics:

- Number of flowers per spike.
- Inflorescence fresh weight (g).
- Inflorescence dry weight (g).
- Rachis length (cm).

2. Postharvest characteristics:

- **Inflorescence vase life (days):** calculated as the number of days from starting the vase life conditioning to the fading stage.
- **Inflorescence fresh weight loss (g):** Primary fresh weight of the inflorescence - Fresh weight of the inflorescence at the fading stage.
- **Loss of flower fresh weight percentage (L.F.F.W):** It was determined at the fading stage as the flowing formula as described by **(Abou-Dahab *et al.*, 2013).**

$$\textbf{L.F.F.W. (\%)} = \frac{Initial\ fresh\ weight - Final\ fresh\ weight}{Initial\ fresh\ weight} \times 100$$

- **Flower fresh weight / flower dry weight ratio (FWR):** At the fading stage the flowers were oven dried at 75°c for 48 hours to get the flower dry weight (F.D.W.) then the fresh weight was divided on the dry weight as described by (**Ibrahim, 2013).**

$$\textbf{FWR} = \frac{\text{Fresh weight per plant (g)}}{\text{Dry weight per plant (g)}}$$

3. Chemical analysis:

- Total chlorophylls in the spike leave: were determined in fresh spikes with SPAD instrument after five days as described by **(Yadava, 1986).**
- Total carbohydrates content in flower spike was determined as % D.W. as described by (**Dubios *et al.*, 1956**).

The layout of the experiment was a randomized complete blocks design (RCBD), with 10 treatments and 3 replicates, each replicate consisted of 3

plants. The data of the two seasons were statistically analyzed according to **(Snedecor and Cochran, 1967)** using L.S.D. at 0.05 of probability.

RESULTS AND DISCUSSION

1. Flowering characteristics

1.1. Number of Flowers per Spike

The data in Table (1) showed that the highest number of flowers per spike was obtained using malic acid at 300 ppm. (30.66 and 31.00 floret per spike in the first and second seasons, respectively). However, the lowest number of flowers per spike was found in the control 24.00 and 23.00 floret per spike in the first and second seasons, respectively. The increase in the number of flowers of spike sprayed with malic acid at 300 ppm supports the results reported by **Jowkar and Salehi (2005)** on *Polianthes tuberosa.*

Generally, the average increase of the number of flowers per spike sprayed with malic acid at 300 mg/L was 30.66 and 31.00 in the first and second seasons, respectively, the extent of any fall in the first grade (Class I) of export which is how far along flowers number per spike between 25-30 flowers, **(GOEIC, 1988)**. Well, we found that the increase of the number of flowers per spike at control is 24.00 and 23.00 in first and second seasons, respectively, the extent of any fall in the second grade (Class II) for export which is how far along flowers number per spike between 20 – 25 flowers **(GOEIC, 1988)**.

1.2. Cut inflorescence fresh weight (g)

The heaviest inflorescence fresh weight was obtained using a pre-harvest application of malic acid at 300 ppm (73.50 g in the first season and 200 mg/L79.31g in the second season, respectively). While the lowest inflorescence fresh weight was found in the control treatment (45.91 and 43.51 g in the first and second seasons, respectively), as recorded in Table (1). Increases in the cut inflorescence fresh weight of flower as a result of malic acid treatments have been reported by **Talebi *et al.* (2014)** on *Gazania rigens*.

1.3. Cut inflorescence dry weight (g)

The cut inflorescence dry weight was the highest when malic acid was applied at 300 mg/L (13.87 g in the first season) and 200 mg/L malic acid in the second season (14.87 g), as was recorded in Table (1). The lowest inflorescence dry weight was recorded for the control (8.66 and 8.16 g in the first and second seasons, respectively). Those results were in agreement with those found by **Talebi *et al.* (2014**), who found that using 300 g of malic acid as foliar spray, significantly increased the dry weight of *Gazania rigens* L.

1.4. Rachis length (cm)

Results in Table (1) showed that the longest rachis length was obtained with 300 mg/L of malic acid treatment (30.00 in both first and second seasons), and the shortest one was obtained in the control (24.33 and 24.66 cm in the first and second seasons, respectively). A similar increase in the rachis length as a result of malic acid treatment was recorded by **Talebi *et al.* (2014)** on *Gazania rigens*.

Malic acid significantly decreased the number of bacteria in vase solution and increased vase life compared to the control. Malic acid prevented vascular blockage by reducing the number of bacteria in vase solution. Bacteria in vase solution block vessels on the cut surface. Stem occlusion reduced the water uptake **(van Meeteren, 1978).** Some bacteria in vase solution produce ethylene, which induces vascular blockage and senescence. The use of other organic compounds such as salicylic acid, citric acid and ascorbic acid for increasing the vase life of cut flowers has been reported by some researchers **(Darandeh and Hadavi, 2012; Jamshidi *et al.*, 2012).**

Table (1). Average of flowering characteristics of *Polianthes tuberosa* plants as influenced by citric acid, malic acid and tryptophan in the two seasons of 2013 and 2014.

Treatments		Number of Flower per Spike		Cut inflorescence fresh weight (g)		Cut inflorescence dry weight (g)		Rachis Length(cm)	
		2013	2014	2013	2014	2013	2014	2013	2014
Control	000mg/L	24.00	23.00	45.91	43.51	8.66	8.16	24.33	24.66
Citric acid	100mg/L	27.00	25.66	53.98	61.06	10.20	11.45	26.33	26.00
	200mg/L	27.00	27.33	59.43	56.12	11.22	10.52	26.66	26.33
	300mg/L	28.66	28.00	66.81	71.76	12.61	13.46	27.66	27.33
Malic acid	100mg/L	29.00	27.33	65.13	73.95	12.29	13.87	29.00	28.66
	200mg/L	30.33	29.66	70.00	79.31	13.22	14.87	29.66	29.66
	300mg/L	30.66	31.00	73.50	71.55	13.87	13.42	30.00	30.00
Tryptophan	100mg/L	24.33	23.33	47.09	42.72	8.89	8.01	24.33	25.00
	200mg/L	25.66	24.66	55.12	54.94	10.40	10.30	25.00	25.33
	300mg/L	26.33	26.33	57.48	58.46	10.85	10.96	25.33	25.66
L.S.D. at 0.05		1.58	1.15	2.54	3.37	0.48	0.62	0.74	0.78

2. Postharvest characteristics

2.1. Inflorescence fresh weight loss (g)

The data in Table (2) showed that the highest inflorescence fresh weight loss was found in the control (21.95 and 21.62 g in the first and second seasons, respectively), while the lowest inflorescence fresh weight loss was recorded using 300 ppm of malic acid (13.64 and 15.41 g in the first and second seasons, respectively). A similar decrease in the fresh weight loss as a result of malic acid treatment was recorded by **Begri *et al.* (2014)** on carnations cut flowers.

2.2. Inflorescence vase life (days)

The data presented in Table (2) showed that the highest value of vase life was found using 300 ppm malic acid treatment, which reached (12.00 and 12.32 days in the first and second seasons, respectively). However, the shortest vase life was obtained in the control recording 8.33 and 7.66 days in the first and second seasons, respectively. Our results seemed to be in agreement with the results of (**Begri *et al.,* 2014**), on carnation. They found that a preservative solution containing 1 mM malic acid and 4% ethane resulted in the longest vase life (11.1 days compared to 8.9 days in the control). It is also in agreement with **Eidyan *et al.* (2014**) on tuberose, **Kazemi *et al.* (2012) on c**arnation and **Zamani *et al.* (2011)** on chrysanthemum cut flowers.

2.3. Loss of flower fresh weight (%)

The analysis of variance of the loss of flower fresh weight showed that the lowest flower fresh weight was obtained using a per-harvest foliar spray of malic acid at 300 ppm, it gave a length of 18.55 and 21.53 % in the first and second seasons respectively, compared with the control which gave the highest loss of flower fresh weight (47.85 and 49.68 % in the first and second seasons respectively), as was recorded in Table (2). It was previously concluded that malic acid improves the water balance of the cut tuberose flowers by control of the bacterial populations combined with reduction in water loss **(Kazemi *et al.* 2010).** In this work, our data supported earlier observation suggesting a regulating role of malic acid in water balance of cut flowers. We know that malic acid is an important osmoticum in guard cells that manages stomatal opening **(Allaway 1973** and **Zeiger 1983)**. Therefore, a direct role for malic acid in control of stomata function could be also possible in our experiment. Here, we can conclude that malic acid may have reduced the stomatal conductance in some way to yield such a controlling effect on fresh weight loss.

2.4. Flower fresh weight / flower dry weight ratio

The analysis of variance of the flower fresh weight / flower dry weight ratio showed that the lowest flower fresh weight / flower dry weight ratio was obtained using a per-harvest foliar spray with malic acid at 300 mg/L, it gave 4.31 and 4.22 % in the first and second seasons respectively, compared with the control which gave the highest flower fresh weight / flower dry weight ratio (2.75 and 2.67 % in the first and second seasons respectively), as was recorded in Table (2). Data analysis showed that the effect of malic acid was significant on fresh and dry matter (Table 2). Results showed that malic acid in proper concentration increased dry matter of cut tuberose flowers. Positive effect of malic acid on fresh and dry matter is probably due to its antimicrobial properties. The present results are in agreement with those reported by **Jamshidi *et al.* (2012)** who showed that malic acid decreased microbe's population and increased dry weight.

Preferential solution uptake of cut flowers incubated in malic acid suggesting a possible decrease in xylem blockage due to reduced microbial growth and ethylene production. Positive effect of malic acid may be attributed to its antimicrobial activity that reduce bacterial population and resulted in increase the vessels conductivity and water uptake. Low water uptake by cut flowers is often due to occlusions located mainly in the basal stem end **(He *et al.*, 2006)** and microorganisms and their decay products are a common cause of stem end blockage **(van Doorn, 1997; Williamson *et al.*, 2002).** In many cut flowers, suppression of microbial growth in the vase solution results in delayed wilting **(van Doorn, 1997)**.

Table (2). Average of postharvest characteristics of *Polianthes tuberosa* plants as influenced by citric acid, malic acid and tryptophan in the two seasons of 2013 and 2014.

Treatments		Inflorescence fresh weight loss (g)		Inflorescence vase life (day)		Loss of flower fresh weight (%)		Flower fresh weight / flower dry weight ratio	
		2013	2014	2013	2014	2013	2014	2013	2014
Control	000 ppm	21.95	21.62	8.33	7.66	47.85	49.68	2.75	2.67
Citric acid	100 ppm	18.93	19.70	9.33	9.00	35.07	32.41	3.43	3.60
	200 ppm	17.49	18.60	10.00	9.66	29.43	33.19	3.73	3.55
	300 ppm	18.44	17.99	10.33	10.33	27.60	25.11	3.83	3.99
Malic acid	100 ppm	16.62	17.22	11.00	11.33	25.51	23.27	3.94	4.08
	200 ppm	15.74	16.43	11.33	11.66	22.48	20.65	4.10	4.18
	300 ppm	13.64	15.41	12.00	12.33	18.55	21.53	4.31	4.22
Tryptophan	100 ppm	21.35	20.85	8.66	8.66	45.35	48.97	2.89	2.71
	200 ppm	21.46	20.63	8.66	9.00	38.95	37.61	3.23	3.32
	300 ppm	20.53	20.01	9.66	9.66	35.68	34.28	3.40	3.49
L.S.D. at 0.05		1.47	1.43	0.93	0.73	2.25	2.50	0.12	0.13

3. Chemical analysis

3.1. Total chlorophyll content in the spike leaves

The total chlorophylls content using (SPAD) unit was the highest using malic acid treatment at 300 ppm as shown in Table (3) (32.49 and 32.84 SPAD in the first and second seasons, respectively). The lowest chlorophyll content was obtained in the control 26.17 and 24.61 in the first and second seasons, respectively. These results are in agreement with those found by **Darandeh and Hadavi (2012**), who noted that a pre-harvest foliar application of malic acid surprisingly increased the chlorophyll content significantly in lilium cv. Brunello, **Kazemi *et al.* (2012)** on **c**arnation and **Zamani *et al.* (2011)** on chrysanthemum cut flowers. **(Darandeh and Hadavi, 2012)** on Lilium revealed that malic acid increased the content of chlorophyll significantly than the control. These workers demonstrated that chlorophyll content was highest in cut flowers treated. Study of **Kazemi *et al.* (2010)** on the effect of malic acid on cut carnation flowers revealed that the total chlorophyll of flowers treated malic acid was the maximum compared to the other concentrations and control. The differences of chlorophyll content between treatments could be attributed to a various amount of malic acid taken up by cut flowers **(Kazemi *et al.*, 2010).**

3.2. Total Carbohydrate content in inflorescence (% D.W.)

As shown in Table (3) the highest total carbohydrates content was found using a pre-harvest foliar application of malic acid at 300 ppm which gave 22.93 and 22.88 % in the first and second seasons, respectively. While, the lowest total carbohydrates content was obtained in the control (17.90 and 18.78 % in the first and second seasons, respectively). The results indicated that the carbohydrate content significantly increased as a result of using Malic acid. Treatment of 300 ppm Malic acid solution significantly increased carbohydrate content in cut flowers. In agreement with our result, **Kazemi *et al.* (2011)** reported that treatment with Malic acid significantly extends the vase life.

Table (3). Average of chemical constituents of *Polianthes tuberosa* plants as influenced by citric acid, malic acid and tryptophan in the two seasons of 2013 and 2014.

Treatments		Total Chlorophyll content in the spike leaves (SPAD)		Total Carbohydrates content in inflorescence (%)	
		2013	2014	2013	2014
Control	000 ppm	26.17	24.61	17.90	18.78
Citric acid	100 ppm	28.67	27.92	19.07	20.45
	200 ppm	28.67	29.10	19.44	21.07
	300 ppm	29.64	30.27	20.80	21.90
Malic acid	100 ppm	30.37	31.25	21.53	22.24
	200 ppm	31.13	32.08	21.87	22.78
	300 ppm	32.49	32.84	22.93	22.88
Tryptophan	100 ppm	27.20	25.96	18.29	18.22
	200 ppm	27.94	26.57	18.78	20.64
	300 ppm	28.37	27.43	19.07	20.76
L.S.D. at 0.05		0.78	0.74	0.63	0.59

CONCLUSION

Cut tuberose flowers have relatively short vase life. Enhancing the vase life of cut flowers is important. Malic acid has some roles in plants, it extends the vase life and postharvest quality of tuberose cut flowers if applied in proper concentration. In the present study, the maximum vase life was observed in flowers held in solution containing 300 ppm malic acid.

The current study proved that malic acid was found to be a superior treatment for tuberose cut inflorescence. Citric acid was found to be good in such characters. The fact that they affect cut flowers of tuberose could make it promising to be used as a combined treatment, which can have a synergistic effect.

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الملخص العربي

تأثير معاملات ما قبل الحصاد عن طريق الرش بحمض الستريك وحمض الماليك والتربتوفان على النمو والإزهار وحياة ما بعد الحصاد لنباتات التبروز

(ب) تأثير معاملات ما قبل الحصاد على عمر الزهرة بعد الحصاد

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يعتبر التبروز احد أشهر أنواع أبصال الزينة المزهرة المستخدمة لجمالها والطلب التجارى عليها، وذلك على الرغم من أن هذه النورات تذبل سريعا فى الفازات داخل المنازل. وللتغلب على هذه الظاهرة تم إجراء تجربة لتقييم وأختبار المعاملة المناسبة لرش النباتات قبل الحصاد والتى قد تعطى أطول عمر للأزهار بعد الحصاد. تم أستخدام ثلاث معاملات من الرش أثناء نمو النباتات وقبل الحصاد لكل من حمض الماليك وحمض الستريك والتربتوفان وذلك

بتركيزات (٣٠٠,٢٠٠,١٠٠) مجم/لتر لكل مادة بالأضافة إلى معاملة الكنترول. بعد ذلك تم وضع النورات فى محلول حفظ بالفازات يحتوى على ٤% سكروز بالإضافة إلى ٢٠٠ مجم/لتر من حمض السلساليك فى الماء المقطر.

تشير النتائج لتفوق حمض الماليك فى كل القياسات الماخوذة بعد الحصاد وخاصة عمر النورات بالأيام والذى زاد من الكونترول (٨.٣٣ و ٧.٦٦ يوم) فى كلا الموسمين على الترتيب إلى (١٢.٠٠ و ١٢.٣٣ يوم) فى كلا الموسمين على الترتيب . كذلك أعطى حمض الماليك أعلى محتوى من الكلوروفيل والكربوهيدرات فى نورات التبروز مقارنة بالكنترول.

In vitro Propagation and *Ex vitro* Acclimatization of Potato (*Solanum tuberosum* L.) Using Nodal Cutting Explants

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ABSTRACT: Potato (*Solanum tuberosum* L.) is an economic tuberous crop cultivated worldwide in the temperate, tropical and subtropical zones. It occupies the fourth largest food crop following wheat, rice and maize. The aim of this study is to establish a protocol for *in vitro* initiation, multiplication, rooting and *ex vitro* acclimatization of potato plants (*Solanum tuberosum* L.) cultivars Lady Balfour and Bellini. This study was carried out in the plant tissue culture laboratory, the Faculty of Agriculture, Saba basha, Alexandria University, Egypt during the period from 2013 to 2016. An efficient and reliable protocol for *in vitro* propagation and *ex vitro* acclimatization of potato (*Solanum tuberosum* L.) was optimized. Nodal cutting explants were inoculated on various initiation or establishment media with different combinations of NAA and KIN and the neoformed shoots were cultured on proliferation (multiplication) media with different combinations of NAA and BAP for the development of multiple shoots, and the elongation media to elongate of the neoformed shoot. The subsequent elongated shoots were rooted, and acclimatized *ex vitro*, successfully. The best medium for shoot initiation was MS medium supplemented with 1.0 mg/l KIN. The favorable medium for multiplication was the tested medium augmented with 2.0 mg/l BA and 0.250 mg/l NAA. In addition, the most effective medium for elongation was the used medium enriched with 0.250 mg/l NAA. Furthermore, *in vitro* the shoots showed healthy root development when the tested medium was supplemented with combination of 1.0 mg/l IBA and 0.50 mg/l NAA (rooting stage).The combination of sand:perlite:peatmoss (1:3:3, v:v:v) was used as substrates for the hardening of the *in vitro* plantlets, as a potting mix, was the best suited mix for the acclimatization of plantlets *ex vitro*.

Key words: *In vitro* culture, *Solanum tuberosum* L, nodal cuttings, initiation, multiplication, rhizogenesis, *ex vitro* acclimatization.

INTRODUCTION

The tetraploid (2n = 4x = 48) cultivated potato (*Solanum tuberosum* L.) belongs to the family solanaceae which includes tomato, eggplant, and peppers (Haque *et al*., 1996 b). It is the fourth most cultivated food crop after wheat, rice and maize, and the most important dicotyledonous crop (Moeinil *et al*., 2011). The world dedicated 19.4 million tonnes per hectares in 2013 for potato cultivation. The average world farm yield for potato was 19.4 tonnes per hectare, that the world production of potatoes in 2013 was about 376.5 million tonnes and about 33 million tonnes of potato seeds (FAOSTAT, 2013).

In Egypt, potato has an important position among all vegetable crops, where about 20% of total area devoted for vegetable production was cultivated with it and the cultivated area of potato was 165000 hectares and its production was 4.5 million metric tonnes (MT) and about 408,000 MT of potato seeds. Potato ranks second in the list of the Egyptian agricultural exports after cotton, of which 171.012

metric tonnes were export to Europe and some Arab countries for 2013 seasons (FAOSTAT, 2013).

In Egypt, importation of certified potato tubers costs very high. Therefore, alternative methods to obtain potato tubers which can be practiced locally and maintain free of diseases have to find, one of these methods is *in vitro* propagation.

Potato is highly amenable to tissue culture micropropagation has became established methods of rapidly multiplying cultivars for potato production as well as for germplasm conservation (Donnelly *et al*., 2003 and Gopal *et al*., 2005). The main advantage of potato micropropagation technology is the production of high quality and uniform plantlets (Naik and Karihaloo, 2007).

Tissue culture techniques are used to propagate potato *in vitro*. Therefore, potato propagation through *in vitro* multiplication results in the rapid production of high quality disease-free-seed potatoes (Nistor *et al*., 2010). As a result, it can solve the limitations that conventionally propagation through tubers had: low multiplication rate and susceptibility to pathogens (Badoni and Chauhan, 2010). *In vitro* propagation methods using sprouts and nodal cutting are more reliable for maintaining genetic integrity of the multiplied clones (Liljana *et al*., 2012).

Furthermore, transferring of tissue culture – derived plantlets to *ex vitro* (acclimatization) is the most critical stage within tissue culture cycle (Abido, 2016). It is known that shoots or plantlets grown *in vitro* are survive under artificial environment, subsequently their growth is not normal; these plant materials have different anatomical and physiological then those morphological characteristics due to their growth *in vitro* (Pospisilova *et al*., 1999). Than, Transferring there materials to *ex vitro* conditions need such acclimatization which differ greatly from *in vitro* conditions (Hossain *et al*., 2009). Among such factors affecting the hardening – off is the potting mixture.

The present study was aimed to establish an efficient and reliable protocol for *in vitro* propagation and *ex vitro* acclimatization of potato *via* nodal cuttings as initial explants of two potato cultivars coined as Lady Balfour and Bellini.

MATERIALS AND METHODS

The experiments regarding the effect of different concentrations of certain growth regulators and their combinations on micropropagation of potato (*Solanum tuberosum* L.) plantlets using nodal cuttings as explants were conducted at the Plant Tissue Culture Laboratory, the Faculty of Agriculture Saba Basha, Alexandria University, during the period from 2013 to 2016.

Plant materials:

Two commercial and certified potato (*Solanum tuberosum* L.) cultivars i.e. Lady Balfour and Bellini were used in this study. Both cultivars were obtained from

the General Committee of Potato Production, the Egyptian company for importation and storage of potato.

Explants preparation and sterilization:

The given tubers were brushed and washed under running water to exclude mud, dirties, and soaked in gibberellin (GA_3) solution concentration of 0.10 g/l for a period of 1-2 hours, then sprightly washed and kept in closed paper bag at 24 ℃ until small sprouts appeared (*ca*. 14 days).

The sprouts of 0.5-1 cm. were collected from the mother plants (i.e. Lady Balfour and Bellini cultivars) in beaker filled with water and kept under running water prior to sterilization in the laminar airflow cabinet. The excised eye buds (sprouts) were rinsed in distilled water, dipped in 70% Ethanol alcohol (C_2H_5OH) for one minute, stirred in 0.1% mercuric chloride ($HgCl_2$) for 3-5 minute with a few drops of wetting agent "Tween-80" (surfactant agent) for five minutes (Ilahi *et al*., 2007). After the surface sterilization of explants was completed, mercuric chloride was decanted and the explants were rinsed with double distilled water thrice, so as to lower the toxic effects of $HgCl_2$ and became ready for manipulation *in vitro*. To overcome phenols' formation materials, they were put in an antioxidant-sterilized solution (100 mg/l ascorbic acid and 150 mg/l citric acid) for 10 minutes. Finally, shoot tip explants of the initiated sprouts were rinsed with sterile distilled water three times and became ready to culture *in vitro*.

Micropropagation stages:

1. Initiation stage:

Explants (shoot tips) were cultured on solidified Murashige and Skoog medium (1962) which solidified with gelrite (3g/l). However, the pH of the tested media was adjusted to 5.7 before adding gelrite, then sterilized autoclaving at 121℃ for 20 min. On cooling of the media, four sterilized shoot tip explants (0.3-0.5 cm) were cultured on the given MS media which contained different concentrations of cytokinin (KIN) at five concentrations: 0.000 (nil), 0.125, 0.25, 0.50 and 1.0 mg/l, in combinations with auxin (NAA) at three concentrations: 0.000 (nil), 0.125 and 0.250 mg/l.

2. Multiplication stage:

For *in vitro* multiplication of virus-free-shoot clone, stock plants were obtained through shoot tip outgrowth using their nodal cuttings with 2 nodes. The excised nodal cuttings explants of the different positions were cultured, randomly, in the multiplication media which supplemented with 1ₒ multiplication treatments' combination between BAP and NAA at (0.00 nil, 0.25, 0.50, 1.00, 2.00) and (0.000 [nil], 0.125, 0.250) mg/l, respectively.

3. Rooting (rhizogenesis) stage:

The obtained shoots of both potato (*Solanum tuberosum* L.) cultivars from the multiplication stages were, individually, separated or excised and cultured on a

rooting medium. The medium contained MS salts, sucrose at 30 g/l. For rooting, two types of auxins were tested; whereas IBA was at four concentrations: 0.000 (nil), 0.250, 0.500 and 1.000 mg/l, designed as factorial experiments layout in completely randomized design (Gomez and Gomez, 1984). Recorded data were analyzed statistically using analysis of variance technique combinations with NAA at three concentrations: 0.000 (nil), 0.250 and 0.500 mg/l.

Generally, each treatment was represented by 3 jars and four explants in each jar (175 ml) containing 20 ml medium. Cultured explants were placed, vertically. Each treatment was replicated three times and each replication has 4 explants. The jars were capped with polypropylene closures.

The culture jars and the tested media were solidified and autoclaved as mentioned – earlier. The explants were cultured on the sterilized media, vertically, and incubated in growth room at 25± 1℃, illuminated with fluorescent lamps (Philips) located 40 cm above the culture jars, giving an average irradiance (*ca*. 40µmol/m²/s). High illumination regimes were set at 16 hr. photoperiods for four weeks to produce *in vitro* virus-free-plantlet.

4. Acclimatization of neoformed plantlets:

The plantlets produced from rooting stage of both cultivars were washed out of solidified medium under running tap water, followed by immersing them into Rizolex-T50 WP (1g/l) [From Sumitomo Chemical Co. Ltd., Osaka, Japan] fungicide for 25 sec. They were, then, transplanted *ex vitro* in small plastic pots (10 cm). For both cultivars, plastic pots contained an autoclaved mixture of the perlite (0,1,2,3,volume) and peatmoss (0,1,2,3,volume); and one constant volume of washed and autoclaved sand.

The perlite has a bulk density of about (0.03- 0.150 g/cm^3) and porosity about 95%, while the peatmoss has a bulk density of about (0.250 g/cm^3) and porosity about (95- 98%). Then, they were arranged in a factorial experiment and finally placed in transparent plastic bags (*ex vitro*), to maintain high relative humidity at80% (RH) and 28±1℃, for hardening-off. However, the tested pots with different media were rearranged' randomly, weekly within same plot to devoid the experimental error.

Ten days later, the plastic bags were perforated for gaseous exchange, then transferred into plastic house (*in vivo*) and continued for further hardening. After three weeks, the plastic bags were removed and the acclimatized plantlets were watered, as needed and fertilized, weekly, with N: P_2O_5: K_2O (20:20:20) equivalent to1g/l (AGRO 4).

Generally, the following characters were recorded per propagule at initiation, multiplication and rooting stages for both tested cultivars after four weeks in culture:

1. Average number of neoformed shoots / propagule.
2. Average shoots lengths (cm) / propagule.
3. Average number of nodes formed / propagule.
4. Average number of leaflets formed / propagule.
5. Average number of roots formed / propagule.
6. Average root length (cm) / propagule (at rooting stage).

Concerning the Acclimatization stage, the following traits were determined:
1. Average survival percentage (%) / plant.
2. Average plant height (cm) / plant.
3. Average number of neoformed branches / plant.

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 DISCUSSION

Achievement of optimal and reliable system for micropropagation of Potato (*Solanum tuberosum* L.) was urgent and in focus. Therefore, a set of experiments was conducted, and the obtained results were presented and discussed in the following sections as follows:

1. Initiation stage:

This stage aimed to reach the best combination of both KIN and NAA for producing virus-free plantlets for both original cultivars of potatoes “Lady Balfour” and “Bellini”. Murashige and Skoog (1962) basal nutrients medium (MS) and 30g/l sucrose, supplemented with various concentrations of KIN in combination with NAA (mg/l) used for initiation stage.

The results of initiation stage of both tested cultivars, i.e. “Lady Balfour and Bellini” are shown in Tables (1and 2) and Figures (1 and 2), each in turn. The recorded data indicated similar performance; whereas, the different levels of KIN and NAA (mg/l) and their interactions; exerted significant effects on the studied traits.

Pertaining the main effect of KIN on initiation stage of “Lady Balfour and Bellini” cvs, the obtained results divulged that there were direct proportional relationships between the tested levels of KIN and the given traits for both cultivars. As KIN levels, increase the average values of both cultivars increased for all studied traits, especially at the higher level (1.000 mg/l) and *vice versa*. As for Lady Balfour cv. (Table 1), at the defined level (1.000 mg/l), the highest average of the number of neoformed shoots, shoot length, number of nodes, leaflets and roots

formed per propagule, as 7.78, 8.63 cm, 8.22, 9.22 and 9.11, respectively. Meanwhile, the lowest averages of studied traits were achieved on KIN – free – medium (0.000 mg/l).Regarding "Bellini" (Table 2), similar performance was noticed as the earlier cultivar; whereas at 1.000 mg/l of KIN, the highest average values were recorded when culture MS medium was augment with the above – mentioned level (i.e. 1.000 mg/l) and *vice versa*. At the defined KIN level, resulted in the highest average of the number of neoformed shoots, shoots length, number of nodes, leaflets and roots formed per propagule, as 8.56, 8.98 cm, 7.78, 8.78 and 9.78, consecutively.

With respect to the main effect of NAA on initiation stages of both cultivars, Tables (1and 2) whereas, there were negative relationships between the given levels and the studied traits except the average number of roots formed per propagule, and *vice versa*.

Regarding "Lady Balfour" cv., data of Table (1) expressed as the highest averages of the number of neoformed shoots, shoots length, number of nodes and leaflets formed per propagule, were 6.93, 7.03 cm, 6.73 and 7.73, orderly at 0.000 (nil) NAA. Meanwhile, the highest average number of roots formed per propagule, *viz* 8.07, when the culture medium was fortified with 0.250 mg/l (NAA).

In similar performance "Bellini" cv. Table (2), expressed as the highest averages for the tested traits e.g. number of neoformed shoots, shoots length, number of nodes and leaflets as 7.27, 7.68 cm, 6.80, 7.80 when the culture medium was NAA free – hormone. Meanwhile, augmenting the culture medium with 0.250 mg/l led to the highest average number of roots formed per propagule (8.73). Pertaining the interaction between both applied growth regulators on the initiation stage studied traits of "Lady Balfour" cv., revealed that MS culture medium, with KIN at 1.000 mg/l and NAA – free – medium, resulted in the highest averages of studied traits, except for average number of roots formed per propagule; whereas MS with KIN at 1.000 mg/l + NAA at 0.250 mg/l, brought about the highest average value. As for the cv. "Bellini", similar performance was clear.

The obtained data could be taken place due to the mode of action of cytokinins as kinetin (KIN), which is taken part in the regulation of cell cycle in plant cells (i.e. regulation of cell division), shoot formation and delay of plant senescence.

Also cytokinins play a critical role, which act as anti-auxin effects (i.e. inhibition of the oxidation of IAA. For instance, KIN (0.04- 1.00 mg/l) alters the activity, distribution, and composition of IAA.IAA oxidase enzymes within tobacco callus cells (Lee, 1974), enhancing the branching (i.e. professing axillary shoots) and reducing apical dominance (George *et al*., 2008). Despite the opposite observation of cytokinins on root initiation as inhibition or delay of root formation (Schraudolf and Reinert, 1959; Harris and Hart, 1964 and Ben - Jaccov *et al*.,

1991), and prevent root growth and promotive effects of auxins on root initiation (Humphries, 1960).

Also, there are reports indicate that cytokinins can sometimes induce or promote root growth (Fries, 1960), or adventitious root formation, in the absence of auxins (Nemeth, 1979). In nearly, all cases only low rates of cytokinins have been effective (George *et al*., 2008). For example, shoots of sugar beet were rooted on MS medium containing 0.5 mg/l KIN and no auxin (Konwar and Coutts, 1990).

The auxins as NAA almost invarialily required to promote the initial growth of plant explants. For instance, George *et al*. (2008) stated that a low concentration of auxin is often beneficial in conjunction with high levels of cytokinin at tissue culture cycle and especially at multiplication stage when shoot multiplication is required, although in some cases cytokinin alone is sufficient.

The indiction of rhizogenesis usually requires an adjustment in the levels of auxins and cytokinins. Boxus and Terzi (1988) advocated the addition of 0.5 mg/l KIN and auxin to the rooting media for strawberries and several woody plants, finding that at this concentration, the cytokinin had a bacteriostatic effect and rooting was not impaired. For instance, Rosa hybrid 'White Dream' cv. required the addition of 1.00 mg/l IBA to BA for root induction and development (George *et al*., 2008). Lam (1977) studied the effect of auxin: Kinetin ratio in the nutrient medium for proliferation of tuber discs of cv. spunta and found that the addition of 0.2 mg/l NAA to the medium appeared to adjust the ratio to the points where normal plantlets with both shoots and roots were produced in a single step.

Regarding the auxin – cytokinin interaction, the balance between auxin and cytokinin growth regulators is most often required for formation of shoots and roots (i.e. organogenesis) as reported by George *et al*. (2008).

The combination of Kinetin and NAA had consistently given good result for improving shoot length of potato. Low concentration of Auxin (0.1 mg/l NAA) plus moderate concentration of cytokinine (0.01 mg/l Kinetin) showed good development of complete plantlets from meristem tips of potato (Badoni and Chauhan, 2009).

Hoque (2010) showed the best shoot and root regeneration on MS medium with 2 mg/l KIN and IAA, whereas Badoni and Chauhan (2009) detected lower concentration of NAA (0.01 mg/l) with Gibberelic Acid (0.25 mg/l) as the best combination for the regeneration of complete plantlets from meristem tips.

Table (1). The effect of different levels of KIN and NAA (mg/l) and their combinations on the initiation stage of Lady Balfour potato culture cultivar after four weeks *in vitro*.

Characters	NAA levels (mg/l)	KIN levels (mg/l)					Average	Significance		KIN X NAA
		0.00	0.125	0.250	0.500	1.000	NAA	KIN	NAA	
(a) Average number of neoformed shoots / propagule										
	0.000	6.33	6.67	6.67	6.67	8.33	6.93a	**	**	*
	0.125	3.67	5.33	5.33	6.33	7.33	5.60b			
	0.250	3.67	5.00	5.33	6.67	7.67	5.67b			
Average(KIN)		4.56d	5.67c	5.78c	6.56b	7.78a				
		L.S.D. (0.05)						**0.59**	**0.46**	**1.03**
(b) Average shoot length (cm) / propagule:										
	0.000	4.80	6.97	6.93	7.03	9.40	7.03a	**	**	**
	0.125	4.40	5.97	6.17	6.80	8.10	6.29b			
	0.250	4.53	5.70	5.87	7.33	8.40	6.37b			
Average(KIN)		4.58d	6.21c	6.32b	7.06b	8.63a				
		L.S.D. (0.05)						**0.18**	**0.14**	**0.32**
(c) Average number of nodes formed / propagule:										
	0.000	4.33	6.00	7.00	7.33	9.00	6.73a	**	**	**
	0.125	4.00	5.33	5.67	6.00	7.67	5.73b			
	0.250	4.67	4.67	4.67	7.33	8.00	5.87b			
Average(KIN)		4.33d	5.33c	5.78c	6.89b	8.22a				
		L.S.D. (0.05)						**0.50**	**0.39**	**0.86**
(d) Average number of leaflets formed / propagule:										
	0.000	5.33	7.00	8.00	8.33	10.00	7.73a	**	**	**
	0.125	5.00	6.33	6.67	7.00	8.67	6.73b			
	0.250	5.67	5.67	5.67	8.33	9.00	6.87b			
Average(KIN)		5.33d	6.33c	6.78c	7.89b	9.22a				
		L.S.D. (0.05)						**0.50**	**0.39**	**0.86**
(e) Average number of roots formed / propagule:										
	0.000	6.67	6.67	7.33	8.00	6.67	6.87c	**	**	**
	0.125	6.67	6.67	8.00	7.67	9.67	7.53b			
	0.250	7.33	7.33	7.00	9.33	11.00	8.07a			
Average(KIN)		5.67d	6.89c	7.44c	8.33b	9.11a				
		L.S.D. (0.05)						**0.69**	**0.63**	**1.20**

- Mean values followed by the same letter (s), are not different significantly.
- L.S.D. (0.05) = Least significant difference test at 0.05 level of probability.
- *,**, NS = significant, high significant, not significant, respectively.

Table (2). The effect of different levels of KIN and NAA (mg/l) and their combinations on the initiation stage of Bellini potato culture cultivar after four weeks *in vitro.*

Characters	NAA levels (mg/l)	KIN levels (mg/l) 0.00	0.125	0.250	0.500	1.000	Average NAA	Significance KIN	NAA	KIN X NAA
(a) Average number of neoformed shoots / propagule										
	0.000	6.67	7.00	7.00	7.00	8.67	7.27a	**	**	**
	0.125	4.00	5.67	5.67	7.33	8.33	6.20b			
	0.250	4.67	6.00	5.67	7.33	8.67	6.47b			
Average(KIN)		5.11d	6.22c	6.11c	7.22b	7.78a				
L.S.D. (0.05)								**0.57**	**0.45**	**0.99**
(b) Average shoot length (cm) / propagule:										
	0.000	5.60	7.73	7.80	7.87	9.40	7.68a	**	**	**
	0.125	5.27	6.83	6.97	7.60	8.83	7.10b			
	0.250	5.37	6.50	6.73	8.17	8.70	7.09b			
Average(KIN)		5.41d	7.02 c	7.17b	7.88b	8.98a				
L.S.D. (0.05)								**0.18**	**0.14**	**0.31**
(c) Average number of nodes formed / propagule:										
	0.000	5.33	6.33	7.33	7.33	7.67	6.80a	**	**	*
	0.125	4.67	5.33	4.67	6.67	7.67	5.80b			
	0.250	4.67	5.33	5.33	6.67	8.00	6.00b			
Average(KIN)		4.89d	5.67c	5.78c	6.89b	7.78a				
L.S.D. (0.05)								**0.54**	**0.42**	**0.93**
(d) Average number of leaflets formed / propagule:										
	0.000	6.33	7.33	8.33	8.33	8.67	7.80a	**	**	*
	0.125	5.67	6.33	5.67	7.67	8.67	6.80b			
	0.250	5.67	6.33	6.33	7.67	9.00	7.00b			
Average(KIN)		5.89d	6.67c	6.78c	7.89b	8.78a				
L.S.D. (0.05)								**0.54**	**0.42**	**0.93**
(e) Average number of roots formed / propagule:										
	0.000	6.33	7.33	8.00	8.67	7.33	7.53c	**	**	**
	0.125	6.33	7.67	8.67	8.33	10.33	8.20b			
	0.250	6.33	8.00	7.67	10.00	11.67	8.73a			
Average(KIN)		6.33d	7.56c	8.11c	9.00b	9.78a				
L.S.D. (0.05)								**0.56**	**0.43**	**0.96**

- Mean values followed by the same letter (s), are not different significantly.
- L.S.D. (0.05) = Least significant difference test at 0.05 level of probability.
- *, **, NS = significant, high significant, not significant, respectively.

Figure (1): Lady Balfour cv.

Figure (2): Bellini cv.

Figures (1and2). Initiation stage of both potato cultivars shoot tip explants cultured for 4 weeks on MS medium supplemented with KIN and NAA at 1.000 and 0.250 mg/l, respectively.

2. Multiplication stage:

The results of multiplication stage of both tested cultivars are shown in Tables (3and 4) and Figures (3and 4). The tabulated results of both cultivars are expressed similar trend; whereas, the various levels of BAP and NAA (mg/l) and their interactions; practiced significant effects on the studied characters.

Respecting the main effect of BAP on multiplication stage of both "Lady Balfour and Bellini" cvs, the obtained results disclosed that augmenting the culture medium with 2.00 mg/l BAP; resulted in the highest average values of studied traits for both cultivars. As for "Lady Balfour" cv. (Table 3 and Fig. 3), at the above – mentioned concentration (2.00 mg/l BAP) produced the highest averages of shoot length, number of nodes, neoformed shoots, leaflets and number of roots formed per propagule, as 8.17cm , 10.22, 12.34,11.22 and 9.11, consecutively. Meanwhile, the lowest averages of tested traits were achieved at 0.250 mg/l, but the lowest number of roots was true at BAP – free – medium.

Regarding "Bellini" cv., as shown in Table (4) behaved similarly as the former cultivar; whereas, the highest averages the studied traits, viz. the highest averages of shoot length, number of nodes, neoformed shoots, leaflets and number of roots formed per propagule were achieved upon fortified the culture media with BAP at 2.00 mg/l, as 8.94 cm, 11.89, 12.00, 12.89 and 9.89, orderly. Meanwhile, the lowest averages were recorded when BAP was added at 0.250 mg/l.

With reference to the main effect of NAA adding NAA at 0.250 mg/l, brought about the highest averages of the studied traits, as shoot length, number of nodes, neoformed shoots, leaflets and roots formed per propagule were 8.78 cm, 9.53, 10.87, 10.53 and 8.47, consecutively.

As for the interaction between both applied growth regulators on multiplication stage of both cultivars, augmenting the culture media with BAP and NAA at 2.00 and 0.250 mg/l brought about the highest averages of all studied traits.

In general , these results could be brought about to the cytokinins mode of action of on stimulation both cell division and promotion growth of axillary shoots in plant tissues culture as, also, found by Tamas(1987), Triginano and Gray (2000) and George *et al*. (2008).

After shoot regeneration, multiplication of shoots was obtained on MS basal medium supplemented with BAP (2.00 mg/l). It was observed that BAP played important role in shoot regeneration. It was observed that BAP played important role in shoot regeneration. Similar results were reported by Yasmin *et al.* (2003) who obtained maximum number of shoots by using BAP at 2 mg/l. The similar

results were, also, obtained by khatun *et al*. (2003). Earlier reports are available on role of BAP in promoting the number of lateral shoot (Uddin, 2002; Hussain *et al*., 2005 and Motallebi-Azar, *et al*., 2011). Similar results were, also, reported by Sarker and Mustafa (2002) that the BAP showed better response in terms of shoot per explants, shoot length, number of nodes and leaves in potato varieties "Lal Pari and Jam Alu". Similar behavior was also observed in varieties as "Diamont, Altamash and Cardinal". The obtained results coincide with the reports of Hoque *et al.* (1996a, 1996b) and Mila (1991) for other potato varieties. Hussain *et al*. (2005) obtained maximum regeneration percentage from nodal explants of potato on MS basal medium with 2.0 mg/l BAP and 0.5 mg/l IAA. Molla *et al.* (2011) also studied the effect of growth regulators on direct regeneration of potato.

However, BAP stimulates the growth of lateral buds, whereas NAA decreases single nodes growth and rooting of potato plantlets (Moeinil *et al*., 2011). However, the growth of explants is slow in such hormones free, cost effective media. Otherwise, the growth rate of explant can be improved by supplementing medium with growth regulators (Yousef *et al*., 2001 and Hoque, 2010). Ammirato (2004) reported that cytokinin at moderate concentrations enhances shoot development. BAP has significant role in cell multiplication, therefore, number of shoots also increased. Also, BA up to 1.0 and 1.5 mg/l showed an increase in number of proliferated shoots and number of nodes /flask (Espinoza *et al*., 1992). It was also observed that BAP played as important role in shoot formation. For instance at lower concentration, shoot numbers were 0.83 but it increased gradually with increase in BAP to 5.00 (Iqbal *et al*., 2005). Percentage of explants producing shoots significantly varied due to the different concentration of BAP. For example, 100% explants survived and produced shoots on BAP at 2 and 3 mg/l (Molla *et al*., 2011). On the other hand, in the absence of NAA which gave the highest mean values could be attributed to the mode of action of endogenous level of auxin which was optimal to achieve these results, which showed that beyond all measurements in the absence of NAA followed by lower level to higher. Therefore, higher concentration of NAA responded the least mean shoot height and number followed of nodes. This could be attributed to the fact that higher concentration of NAA inhibits root and shoot growth (Pennazio and Vecchiati, 1976). In this study most of the positive outcomes resulting from the overlap of both organizations growth regulators, recorded in the absence or low concentrations of both BAP and NAA. Similar results were reported by Sanavy and Moeini (2003). The previous authors showed such significant differences between MS medium and MS medium supplemented with BAP and NAA. There were significant differences between "Agria and Marfona" cultivars. The modified solid (MS) without NAA and BAP was found to be best for the formation of roots and shoots. On the other hand, BAP at low concentrations (0.00 or 0.50 mg/l) was the optimal and showed a significant effect on almost parameters for cultivar Rosetta.

Table (3). The effect of different levels of BAP and NAA (mg/l) and their combinations on the multiplication stage using nodal cutting for Lady Balfour potato cultivar after four weeks *in vitro.*

Characters	NAA levels (mg/l)	BAP levels (mg/l)					Average NAA	Significance		BAP X NAA
		0.00	0.25	0.50	1.00	2.00		BAP	NAA	
(a) Average number of neoformed shoots / propagule										
	0.000	11.00	6.67	9.00	8.33	12.67	9.53b	**	**	*
	0.125	11.67	9.00	9.33	11.00	11.67	10.53a			
	0.250	11.67	8.33	8.67	10.00	12.67	10.27a			
Average(BAP)		11.45b	8.33d	9.00c	9.78c	12.34a				
L.S.D. (0.05)								**0.80**	**0.62**	**1.38**
(b) Average shoot length (cm) / propagule:										
	0.000	7.87	5.17	6.33	7.47	8.00	6.97c	**	**	**
	0.125	7.10	7.17	7.37	7.17	7.33	7.23b			
	0.250	8.67	7.37	7.77	7.40	9.17	8.07a			
Average(BAP)		7.88a	6.57c	7.16b	7.35b	8.17a				
L.S.D. (0.05)								**0.32**	**0.25**	**0.56**
(c) Average number of nodes formed / propagule:										
	0.000	8.00	4.33	4.67	8.67	9.00	6.93b	**	**	**
	0.125	9.67	8.00	8.67	6.67	10.33	8.67a			
	0.250	10.33	6.33	7.33	7.67	11.33	8.60a			
Average(BAP)		9.33b	6.22e	6.89d	7.67c	10.22a				
L.S.D. (0.05)								**0.61**	**0.47**	**1.06**
(d) Average number of leaflets formed / propagule:										
	0.000	9.00	5.33	5.67	9.67	10.00	7.93b	**	**	**
	0.125	10.67	9.00	9.67	7.67	11.33	9.67a			
	0.250	11.33	7.33	8.67	8.67	12.33	9.60a			
Average(BAP)		10.33b	7.22	7.89d	8.67c	11.22a				
L.S.D. (0.05)								**0.61**	**0.47**	**1.06**
(e) Average number of roots formed / propagule:										
	0.000	5.00	6.33	6.67	7.33	6.67	5.00c	**	**	**
	0.125	5.33	6.67	7.00	7.67	9.00	7013			
	0.250	5.33	5.67	6.33	9.33	11.67	7.67a			
Average(BAP)		5.22d	6.22c	6.67c	8.11b	9.11a				
L.S.D. (0.05)								**0.61**	**0.47**	**1.10**

- Mean values followed by the same letter (s), are not different significantly.
- L.S.D. (0.05) = Least significant difference test at 0.05 level of probability.
- *, **, NS = significant, high significant, not significant, respectively.

Table (4). The effect of different levels of BAP and NAA (mg/l) and their combinations on the multiplication stage using nodal cutting for Bellini potato cultivar after four weeks *in vitro*.

Characters	NAA levels (mg/l)	BAP levels (mg/l) 0.00	0.25	0.50	1.00	2.00	Average NAA	Significance BAP	NAA	BAP X NAA
(a) Average number of neoformed shoots / propagule										
	0.000	11.00	6.67	9.00	8.33	12.67	9.53b	**	**	**
	0.125	11.67	9.00	9.33	11.00	11.67	10.53a			
	0.250	11.67	8.33	8.67	10.00	12.67	10.27a			
Average(BAP)		11.89a	8.22d	9.89c	11.11b	12.00a				
L.S.D. (0.05)								**0.76**	**0.59**	**1.32**
(b) Average shoot length (cm) / propagule:										
	0.000	8.57	5.87	7.03	8.20	8.83	7.70c	**	**	**
	0.125	8.20	7.93	8.07	8.00	8.23	8.09b			
	0.250	9.40	8.07	8.50	8.17	9.77	8.78a			
Average(BAP)		8.72a	7.29d	7.87c	8.12b	8.94a				
L.S.D. (0.05)								**0.25**	**0.19**	**0.43**
(c) Average number of nodes formed / propagule:										
	0.000	8.67	5.33	5.67	9.67	11.33	8.13b	**	**	**
	0.125	10.00	8.67	9.33	7.67	12.00	9.53a			
	0.250	11.00	7.33	8.33	8.67	12.33	9.53a			
Average(BAP)		9.89b	7.11e	7.78d	8.67c	11.89a				
L.S.D. (0.05)								**0.66**	**0.51**	**1.14**
(d) Average number of leaflets formed / propagule:										
	0.000	9.67	6.33	6.67	10.67	12.33	9.13b	**	**	**
	0.125	11.00	9.67	10.33	8.67	13.00	10.53a			
	0.250	12.00	8.33	9.33	9.67	13.33	10.53a			
Average(BAP)		10.89b	8.11e	8.78d	9.67c	12.89a				
L.S.D. (0.05)								**0.66**	**0.51**	**1.14**
(e) Average number of roots formed / propagule:										
	0.000	5.67	7.00	7.33	8.00	7.33	7.07c	**	**	**
	0.125	5.33	7.67	7.67	8.67	9.67	7.80b			
	0.250	6.33	7.00	7.33	9.00	12.67	8.47a			
Average(BAP)		5.78d	7.22c	7.44c	8.56b	9.89a				
L.S.D. (0.05)								**0.73**	**0.57**	**1.27**

- Mean values followed by the same letter (s), are not different significantly.
- L.S.D. (0.05) = Least significant difference test at 0.05 level of probability.
- *, **, NS = significant, high significant, not significant, respectively.

Figure (3): Lady Balfour cv.

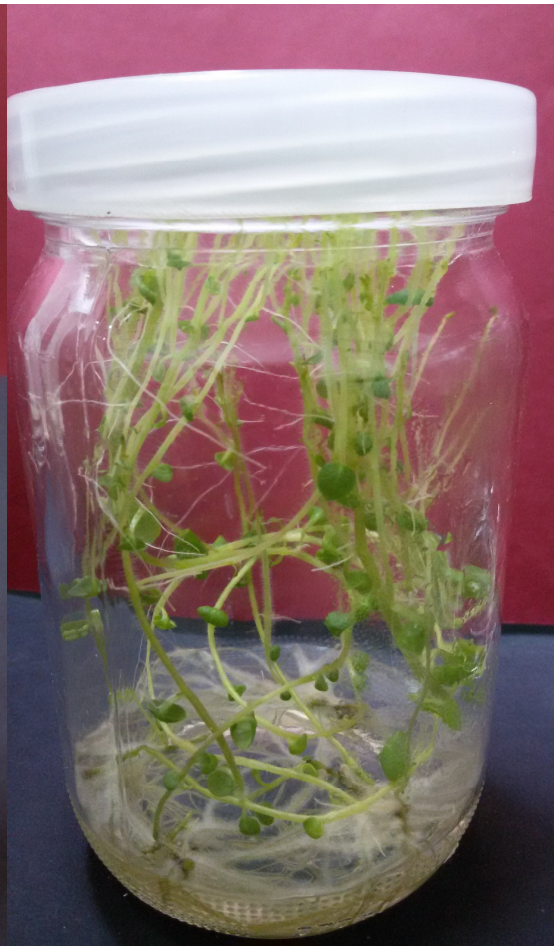

Figure (4): Bellini cv.

Figures (3and4). Multiplication stage of both potato cultivars from newly formed nodal cuttings of initiation stage, upon culturing then for 4 weeks on MS medium fortified with BAP and NAA at 2.00 and 0.25 mg/l, consecutively.

3. Rooting (rhizogenesis) stage:

The results of rooting (rhizogenesis) stage of both tested cultivars are presented in Tables (5and 6) and Figures (5 and 6). The presented results of both cultivars expressed similar trend; whereas, the various levels of both IBA and NAA (mg/l) and their interaction exerted significant effects on the studied traits.

Respecting the main effect of IBA on rooting stage of both "Lady Balfour and Bellini" cvs, the obtained results revealed that IBA – free – medium (0.00 mg/l), brought about the highest averages of shoot length for both cultivars, *viz*. 8.18 and 8.68cm, each in turn. Meanwhile, augmenting the culture media for both tested cultivars, i.e. "Lady Balfour and Bellini" cvs. with 0.500 mg/l IBA, resulted in the highest averages of number of nodes , *viz*. 8.67 and 9.47, in series. Also, fortifying the culture media with 1.00 mg/l IBA for both tested cultivars, i.e. "Lady Balfour and Bellini" led to the highest averages of root length and number of roots per propagule, as 8.75 cm and 15.07 for the former, and 9.17cm and 16.13 for the later.

Respecting the main effect of NAA, the recorded results showed that adding NAA – free – media (0.00 mg/l), led to the highest averages of shoot length of both "Lady Balfour and Bellini" cvs. as 7.46 and 8.00 cm, respectively. Likewise, fortifying the culture media with NAA at 0.250 mg/l, led to the highest averages of number of nodes per propagule for both "Lady Balfour and Bellini" cvs., as 8.60 and 9.40, orderly. Meanwhile, augmenting the culture media with NAA at 0.500 mg/l, resulted in the highest averages of both root length and number per propagule as 7.73 cm and 12.30 for the former and 8.32 cm and 13.10 for the later, in order.

Pertaining the interaction between the various tested levels of both applied growth regulators, showed that augmenting the culture medium with nil levels (plant growth regulators – free – medium) led to the highest averages of shoot length for "Lady Balfour and Bellini" cvs., as 8.88, and 9.36 cm, respectively.

Also, adding NAA at 0.250 without IBA to the highest averages of number of nodes per propagule for both cultivars as 9.00 and 9.60, each in turn. Likewise, adding IBA and NAA at 1.000 and 0.500, respectively, led to the highest averages of root length for "Lady Balfour and Bellini" cvs., as 9.46 and 9.64 cm, consecutively. Likewise, at the above – mentioned combination of both levels of growth regulators, led to the highest averages of number of roots per propagule as 16.80 for the former cultivar and 18.20 for the latter one.

This results coud be explaind on the bases that auxin induced number of responses which involved cell division, cell enlargement, protein and nucleic acids synthesis which are concomitants 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 obtained results in this study were further confirmed by the previous findings of Komalavalli and Rao (2000); Sarker and Shaheen (2001); Munshi *et al.* (2004); Awal *et al.* (2005); Rajani and Patil (2009); Waseem *et al*. (2011) who suggested IBA as the best auxin for root induction and development.

Table (5). The effect of different levels of IBA and NAA (mg/l) and their combinations on the rooting stage of Lady Balfour potato culture cultivar after four weeks *in vitro*.

Characters	NAA levels (mg/l)	IBA levels (mg/l) 0.000	0.250	0.500	1.000	Average NAA	Significance IBA	NAA	IBA X NAA
(a) Average shoot length (cm) / propagule:									
	0.000	8.88	7.60	7.90	5.46	7.46a	**	**	**
	0.250	8.10	7.46	6.48	5.26	6.83b			
	0.500	7.56	6.46	5.60	4.50	6.03c			
Average(IBA)		8.18a	7.17b	6.66c	5.07d				
L.S.D. (0.05)							**0.21**	**0.18**	**0.36**
(b) Average number of nodes formed / propagule:									
	0.000	7.40	6.20	8.60	5.40	6.90c	**	**	**
	0.250	9.00	8.40	8.60	8.40	8.60a			
	0.500	7.00	7.40	8.80	7.40	7.65b			
Average(IBA)		7.80b	7.33c	8.67a	7.07c				
L.S.D. (0.05)							**0.44**	**0.38**	**0.76**
(c) Average root length (cm) / propagule:									
	0.000	5.46	7.66	7.66	7.88	7.17c	**	**	**
	0.250	5.72	7.20	7.78	8.90	7.40b			
	0.500	5.92	7.08	8.44	9.46	7.73a			
Average(IBA)		5.70d	7.31c	7.96b	8.75a				
L.S.D. (0.05)							**0.26**	**0.23**	**0.46**
(d) Average number of roots formed / propagule:									
	0.000	5.40	8.60	9.60	12.40	9.00c	**	**	**
	0.250	8.40	9.80	13.00	16.00	11.80b			
	0.500	9.80	10.20	12.40	16.80	12.30a			
Average(IBA)		7.87d	9.53c	11.67b	15.07a				
L.S.D. (0.05)							**0.57**	**0.49**	**0.98**

- Mean values followed by the same letter (s), are not different significantly.
- L.S.D. (0.05) = Least significant difference test at 0.05 level of probability.
- *, **, NS = significant, high significant, not significant, respectively.

Table (6): The effect of different levels of IBA and NAA (mg/l) and their combinations on the rooting stage of Bellini potato culture cultivar after four weeks *in vitro*.

Characters	NAA levels (mg/l)	IBA levels (mg/l) 0.000	0.250	0.500	1.000	Average NAA	Significance IBA	NAA	IBA X NAA
(a) Average shoot length (cm) / propagule:									
	0.000	9.36	8.16	8.46	5.98	8.00a	**	**	**
	0.250	8.62	8.06	7.02	5.88	7.40b			
	0.500	8.06	6.96	6.16	5.04	6.56c			
Average (IBA)		**8.68a**	**7.73b**	**7.21c**	**5.63d**				
		L.S.D. (0.05)					**0.22**	**0.19**	**0.39**
(b) Average number of nodes formed / propagule:									
	0.000	8.40	7.20	9.60	6.40	7.90c	**	**	**
	0.250	9.60	9.40	9.40	9.20	9.40a			
	0.500	8.00	8.40	9.40	8.40	8.55b			
Average (IBA)		**8.67b**	**8.33bc**	**9.47a**	**8.00c**				
		L.S.D. (0.05)					**0.46**	**0.39**	**0.79**
(c) Average root length (cm) / propagule:									
	0.000	5.64	8.26	8.24	8.46	7.65c	**	**	**
	0.250	6.26	7.82	8.38	9.40	7.97b			
	0.500	6.64	7.80	9.20	9.64	8.32a			
Average (IBA)		6.18d	7.96c	8.61b	9.17a				
		L.S.D. (0.05)					**0.30**	**0.26**	**0.52**
(d) Average number of roots formed / propagule:									
	0.000	5.80	9.40	9.80	13.20	9.55c	**	**	**
	0.250	8.80	10.80	13.60	17.00	12.55b			
	0.500	10.40	11.00	12.80	18.20	13.10a			
Average (IBA)		8.33d	10.40c	12.07b	16.13a				
		L.S.D. (0.05)					**0.46**	**0.40**	**0.80**

- Mean values followed by the same letter (s), are not different significantly.
- L.S.D. (0.05) = Least significant difference test at 0.05 level of probability.
- *, **, NS = significant, high significant, not significant, respectively.

Figure (5): Lady Balfour cv.

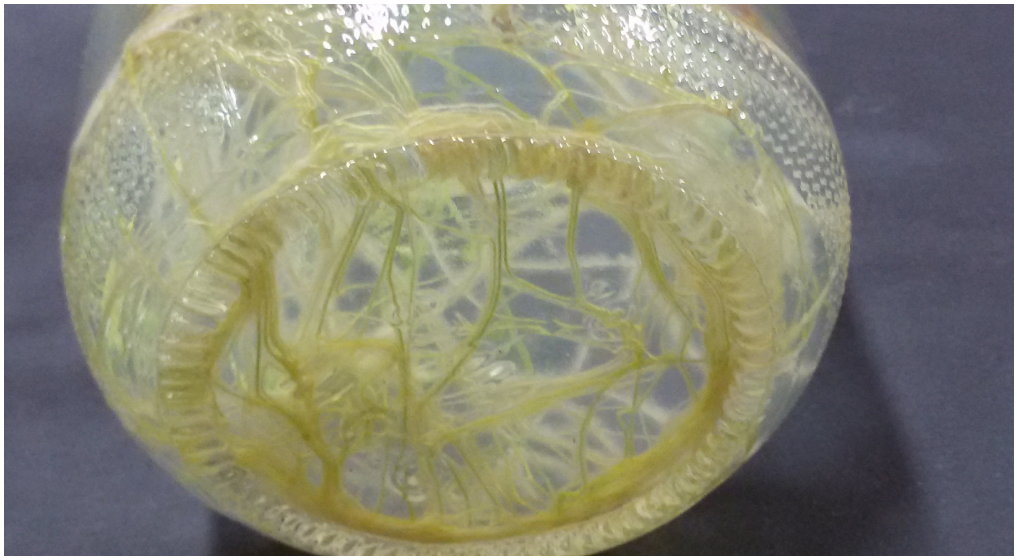

Figure (6): Bellini cv.

Figures (5 and 6). Rhizogenesis stage of both potato cultivars microshoots of multiplication stage, upon culturing then for 4 weeks on MS medium augmented with IBA and NAA at 1.00 and 0.50 mg/l, each in turn.

4. Acclimatization stage:

Respecting the effect of mixtures of perlite and peatmoss (v/v) and their combinations, in addition to fixed volume (1 portion) of sand on acclimatization of neoformed plantlets of both tested cultivars, i.e. Lady Balfour and Bellini are shown in Tables (7and 8), each in turn. However, results depicted in both Tables revealed affecting the studied traits under the study, significantly, by both variables and their interactions.

Generally, the obtained results expressed a proportionate relationship between the tested levels of each variable and the studied traits. For instance, the main effect of perlite levels (v/v) showed that as its volumes increased, the given trait averages increased. Concerning “Lady Balfour” cv., the highest averages of the survival percentage, plant height, and number of neoformed branches per plant were 82.81%, 8.85 and 6.63, respectively, for “Lady Balfour” cv. and 75.06%, 8.08 cm and 5.81, consecutively, for “Bellini” cv. Meanwhile, the lowest averages of studied traits were achieved at nil level (0.0 v/v) of perlite.

As for the main effect of peatmoss, there were a direct proportionate relationship between it and the averages of the studied characteristics, too. Whereas, the highest trait averages were recorded when potting mix contained (3.0 v/v) volumes and vice versa. However, the highest averages of the survival percentage, plant height, and number of neoformed branches per plant for “Lady Balfour” cv. were 84.38%, 7.88 cm and 5.88, respectively. On the other side, the highest averages of the same characteristics of “Bellini” cv. were 78.13%, 7.17 cm and 5.25, consecutively.

With respect to the interaction between both variables, it was clear that adding perlite and peatmoss in equal volumes (3:3), brought the highest averages of the studied traits of both cultivars. As for “Lady Balfour” cv. the highest studied traits were more or less, 100%, 11cm and 7.5, for survival percentage, plant height, and number of neoformed branches, respectively. On other hand, the highest studied traits averages of Bellini cultivar were 100%, 9.63cm and 7.00, for the above – mentioned each, orderly.

In this respect, material as peatmoss is one of the most important constituents of media due to its capacity in affecting plant growth either indirectly or directly. Indirectly, improves the physical conditions of media by enhancing aggregation, aeration (8%) and water retention (77%), thereby creating a suitable environment for root growth (Sensi and Loffredo, 1999). On the other hand, perlite is known to have a moderate capacity to retain water (38%) and provide’ aeration (25%) and its neural pH and the fact that it is sterile and weed–free. Hence, it is ideal for use in container growing substratum (Abido, 2016). Also, it is known that perlite decreases the bulk density of the soils and increases the porosity.

A mixture of peat moss and sand in the ratio of 4:1 proved best for growing plantlets of potato (Sanavy and Moeini, 2003) . In conclusion, it is possibe to propagate both potato cultivars coined Lady Balfour and Bellini *in vitro* under reproducible and reliable technique. This protocol will provide the base for the mass production of studied cultivars through *in vitro* technique. Also, the mixture of varying proportions as perlite, peatmoss and sand (3:3:1) can be designated to take advantage of the positive characteristics of each substratum and their interactions, in order to create optimal characteristics of plant growth (best water retention, pH levels, porosity, aeration …….etc.) along with a fixed proportion of washed sand.

Table (7). The effect of different potting mixtures of Perlite and Peatmoss (v/v) and their combinations on the acclimatization of neoformed plantlets of Lady Balfour cultivar after four weeks *ex vitro*.

Characters	Peat. levels (v/v)	Perlite levels (v/v) 0.00	1.00	2.00	3.00	Average Peat.	Significance Per.	Peat.	Per. X Peat.
(a) Average survival percentage (%) / plant									
	0.00	00.00	43.75	62.50	65.25	40.63d	**	**	**
	1.00	50.00	62.50	50.00	81.25	60.94c			
	2.00	50.00	62.50	87.50	93.75	73.44b			
	3.00	62.50	81.25	93.75	100.00	84.38a			
Average(Per.)		40.63d	62.50c	73.44b	82.81a				
L.S.D. (0.05)							**7.91**	**7.91**	**15.81**
(b) Average plant height (cm) / plant:									
	0.00	0.00	4.50	5.70	6.80	4.25d	**	**	**
	1.00	4.30	5.90	6.80	8.40	6.35c			
	2.00	5.10	6.50	7.30	9.20	7.03b			
	3.00	5.30	6.70	8.50	11.00	7.88a			
Average(Per.)		3.68d	5.90c	7.08b	8.85a				
L.S.D. (0.05)							**0.29**	**0.29**	**0.59**
(c) Average number of neoformed branches / plant:									
	0.00	0.00	3.25	4.50	5.50	3.31d	**	**	**
	3.00	3.00	3.75	5.00	6.50	4.56c			
	3.50	3.50	4.75	5.75	7.00	5.25b			
	4.50	4.50	5.50	6.00	7.50	5.88a			
Average(Per.)		2.75d	4.31c	5.31b	6.63a				
L.S.D. (0.05)							**0.46**	**0.46**	**0.92**

- Mean values followed by the same letter (s), are not different significantly.
- L.S.D. (0.05) = Least significant difference test at 0.05 level of probability.
- *, **, NS = significant, high significant, not significant, respectively.

Table (8). The effect of different potting mixtures of Perlite and Peatmoss (v/v) and their combinations on the acclimatization of neoformed plantlets of Bellini cultivar after four weeks *ex vitro*.

Characters	Peat. levels (v/v)	Perlite levels (v/v) 0.00	1.00	2.00	3.00	Average Peat.	Significance Per.	Peat.	Per. X Peat.
(a) Average survival percentage (%) / plant									
	0.00	00.00	50.00	56.25	50.00	39.06a	**	**	**
	1.00	50.00	68.75	50.00	68.75	59.34c			
	2.00	50.00	56.25	81.25	87.50	68.75b			
	3.00	56.25	68.75	87.50	100.00	78.13a			
Average (Per.)		39.06d	60.94c	68.75b	75.06a				
		L.S.D. (0.05)					**6.91**	**6.91**	**13.81**
(b) Average plant height (cm) / plant:									
	0.00	0.00	4.00	5.18	6.25	3.86 d	**	**	**
	1.00	3.80	5.38	6.25	7.85	5.82 c			
	2.00	4.63	5.88	6.75	8.58	6.46 b			
	3.00	4.75	6.23	8.08	9.63	7.17a			
Average (Per.)		3.30d	5.37c	6.57b	8.08a				
		L.S.D. (0.05)					**0.30**	**0.30**	**0.59**
(c) Average number of neoformed branches / plant:									
	0.00	0.00	2.50	3.50	4.75	2.69d	**	**	*
	3.00	2.75	3.50	4.00	5.50	3.94c			
	3.50	3.25	4.25	5.00	6.00	4.63b			
	4.50	4.25	4.75	5.00	7.00	5.25a			
Average (Per.)		2.56d	3.75d	4.38b	5.81a				
		L.S.D. (0.05)					**0.47**	**0.47**	**0.93**

- Mean values followed by the same letter (s), are not different significantly.
- L.S.D. (0.05) = Least significant difference test at 0.05 level of probability.
- *, **, NS = significant, high significant, not significant, respectively.

Figure (7). Lady Balfour cv. **Figure (8): Bellini cv**

Figures (7and8). Acclimatization stage of neoformed plantlets of both potato cultivars *ex vitro* for 4 weeks on potting mixtures of sand, Perlite and Peatmoss (1:3:3), orderly.

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الملخص العربي

الإكثار المعملي الدقيق والأقلمة خارج أوعية الزراعة للبطاطس بإستخدام العقد الساقية كأجزاء نباتية

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يعد محصول البطاطس محصول درني إقتصادي واسع الإنتشار في المناطق المعتدلة والإستوائية وشبه الإستوائية. فهو يحتل المركز الرابع في المحاصيل الغذائية الهامة بعد القمح والأرز والذرة. إن الهدف من هذه الدراسة هو إيجاد بروتوكول للتنشئة والتضاعف والتجذير المعملي وكذلك الأقلمة خارج أوعية الزراعة لصنفي البطاطس ليدي بالفور والبيليني. تم تنفيد هذه الدراسة في معمل زراعة الأنسجة النباتية – قسم الإنتاج النباتي كلية الزراعة (سابا باشا) – جامعة الإسكندرية – مصر خلال الفترة الزمنية من ٢٠١٣ الى ٢٠١٦. لقد تم إيجاد وتعظيم بروتوكول كفء ويعتمد عليه للإكثار المعملي الدقيق والأقلمة في البطاطس. تمت زراعة العقل الساقية كأجزاء نباتية على بيئات التنشئة بتركيزات مختلفة من الأوكسين NAA والكينتين KIN وكانت المجاميع الخضرية الناشئة قد زرعت على بيئات التضاعف (التكاثر) والتي تضمنت تركيزات مختلفة من الأوكسين NAA والسيتوكينين BAP لتكوين مجاميع خضرية عديدة وبيئات لاستطالة المجاميع الخضرية حديثة التكوين. وكانت المجاميع الخضرية التي استطالت قد تم تجذيرها، وأقلمت بنجاح خارج أوعية الزراعة. وكانت أفضل بيئة للتنشئة هي بيئة مورشيج وسكوج MS المزودة بالكينتين عند ١ملجم/لتر. والبيئة المفضلة للتضاعف كانت البيئة المختبرة والمزودة بالسيتوكينين BAP بتركيز ٢ ملجم/لتر، والأوكسين NAA عند تركيز ٠.٢٥٠ ملجم/لتر. وبالإضافة لذلك، كانت البيئة الأكثر فعالية للإستطالة هي بيئة MS المزوده بالأوكسين NAA بتركيز ٠.٢٥٠ ملجم/لتر. والأكثر من ذلك، أوضحت المجاميع الخضرية قوة وصحة وكونت جذوراً عندما كانت البيئة المختبرة مزودة بتوليفة من الأوكسين IBA والأوكسبن NAA (مرحلة التجذير) بتركيزات ١ ، ٠.٥ ملجم/لتر على التوالي. كما إن توليفة من بيئة الخلط من (الرمل : البيرليت : البيتموس) بنسب (١ : ٣ : ٣) كانت قد استخدمت لتقسية النبيتات المعملية كأفضل بيئة خلط مناسبة لأقلمة النبيتات خارج المعمل.

Effect of Irrigation Methods on The Cantaloupe Yield in El-khatatba Region Under Climatic Change and Soil Conditions

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ABSTRACT: El-Khatatba located at latitude 30° 52′ 66″ and Longitude 30 ° 38′ 11″. Rise above sea level between 20 meters to 50 meters. Cantaloupe is an important cultivation for export. El-Khatatba is one of the villages on the Sadat City. Where Cantaloupe plants (*Cucumis melo* L.) grown in the two growing seasons in summer (February) and in Nile (August) in sandy soil used in the region of four methods of irrigation / feddan age crop of cantaloupe (Flood, Drip, pivot, Sprinkler irrigation). These study that starting from 2012, 2013, 2014, and 2015. Drip Irrigation gave the highest yield of cantaloupe crop as percentage during the four years (54%, 61%, 65% and 66%), respectively. The Larger area for growing cantaloupe crop in the case of drip irrigation (49%,55%, 56% and 57%) on respectively. Which data are available under the change of temperature, wind speed and evapotranspiration conditions.
Keywords: Irrigation Methods, Cantaloupe yield, Climate variability, El-Khatatba area

INTRODUCTION

The newly reclaimed lands suffers from increasing rise in temperature and climate impacts on the water, and as a result, the small changes of climate increase the number of individuals at risk of hunger, due to the largely reclaimed desert areas (FAO, 2001).Thus, increases of extreme climate events will lead to a reduction in crop yields on average the effects of climate change (Fischer *et al.,* 2003).The increase in surface temperature lead to a decrease in water dissolved oxygen content, patterns blending or mixing between water quality, the ability to self-purification and an increase in the proliferation of algae, a phenomenon of eutrophication (Hassanien and Medany, 2007; Hegazy *et al.,* 2008), it is also known that the increase in evapotranspiration leads to reduce water availability, salinization of water resources and low groundwater levels (Tarjuelo *et al.,* 2000).An increase in evapotranspiration as a result of higher air temperatures prolong the growing season and increase the use of irrigation water and soil salinization (FAO, 1985). The high temperature leads to a decrease in groundwater levels in the interior, which affects the way of irrigation area (Fischer *et al.,* 2007). The high temperature climate change lead to the low level of water availability of groundwater, add that overexploitation in water stored in the aquifers, including increase in water supply costs for any use as a result of the need to pump water from deeper and more distant levels (Hafi *et al.,* 2009: Shah, 2009).The global warming will lead to several risks including the decline in the quantity and quality of water in many arid and semi-arid areas (El-Marsafawy, 2008).Between 1960 -1990 temperature rose from 3-3.5 ° C and is expected by 2050 to increase by another 2 ° C (Coolay and Gleick, 2011; Coolay *et al.,* 2009) There is a connection between climate change and economic growth recommends the development of irrigation systems in the

case of climate change (UNFCC, 2007) Water storage, changing irrigation methods and water requirements need huge investments, so we must raise the efficiency of irrigation methods used in a water shortage (Abdelrazek, 2007; Hoffman *et al.,* 1990).Choose the appropriate method of irrigation, Development of irrigation methods and crop suitability need to integrated water management include climate change to increase the efficiency of irrigation (FAO, 2008). The objective of this research is to evaluate irrigation methods through Cantaloupe yield (economic crop), under conditions of climate change.

MATERIALS AND METHODS

I- LOCATION AND CLIMATIC:

El-Khatatba area in Menofya province is a desert region constitutes the western boundary of the Nile Delta encountered 15 Km away from the Rossetta branch of the River Nile. El-Khatatba located at latitude 30° 52′ 66″ and Longitude 30° 38′ 11″. Rise above sea level between 20 meters to 50 meters. It falls within the northeast territory of Sadat City and Wadi El Natrun (located 25 Km southwest) as shown in Fig. 1. The climate of the study area falls within arid and semi-arid zones with average temperatures, average humidity and evaporation (Table 1).

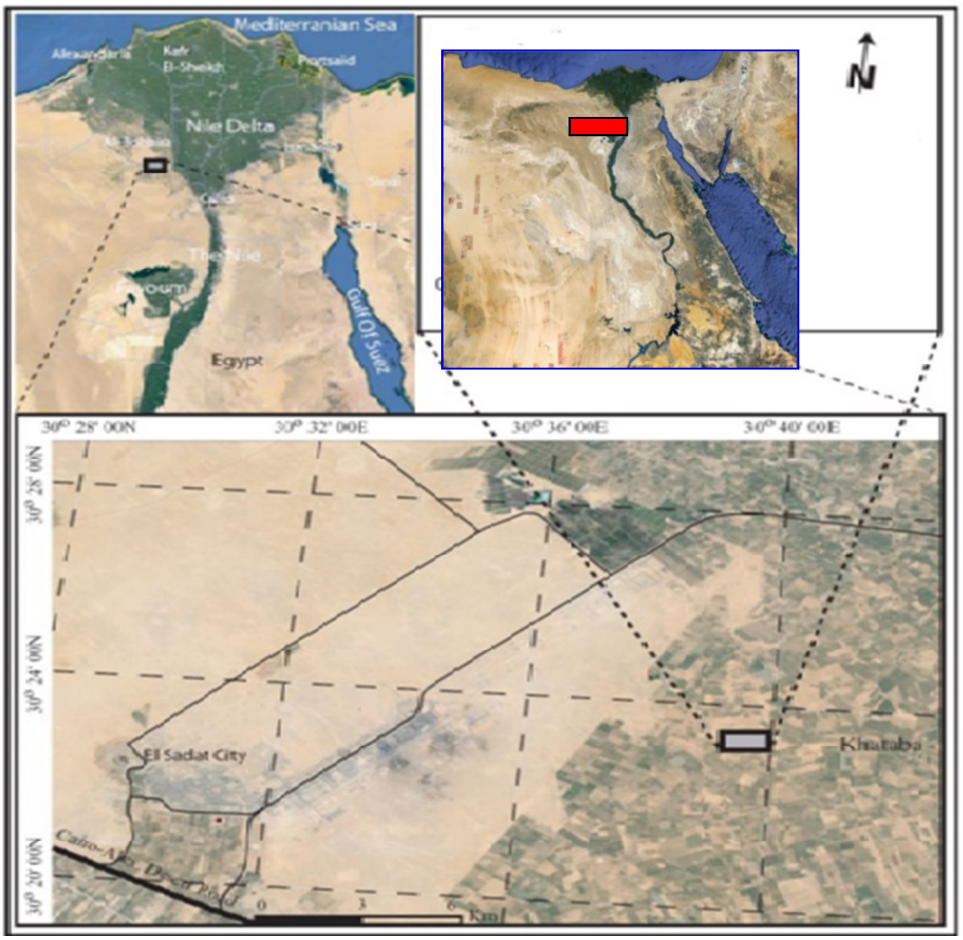

Fig (1). Location map of the study area

Table (1). Average climate during the year's cantaloupe crop cultivation

		Years			
Climate	Unite	2012	2013	2014	2015
Maximum emperature	C^0	13.0	18.5	20.2	23.1
Minimum Temperature	C^0	11	10	15	14
Relative Humidity	%	60	70	66	65
Wind speed	Km/day	95	85	196	105
ET_o	mm/day	1.99	2.32	4.12	6.50

Source: Nobaria station

II- SOIL SAMPLING:

Soil samples from the surface layer were collected from 4 locations irrigated with 4 irrigation methods represented by 3 replicate in El-Khatatba area. The soil samples were analyzed according to the following methods:

1- Soil bulk density using core sampler, as described by (Richards, 1954).
2- Soil hydraulic conductivity (K cm/ hr) using the constant head test for disturbed coarse textured soils as described by (Baruah and Barthakur, 1997).
3- Mechanical analysis using the pipette method, as cited by (FAO, 1970) Sodium hexametaphosphate and sodium carbonate were used as dispersing agent. Soil texture was determined using the texture triangle diagram, (Soil Survey Staff, 1998).
4- Electrical conductivity (EC dS/m) of the saturated soil extracts using a conductometer (Jackson, 1958).
5- Soil reaction (pH) of the saturated soil paste was determined using Beckman's pH meter (Jackson, 1958).
6- Total carbonate content was estimated volumetrically by Collin's calcimeter (Williams, 1948).
7- Total gypsum was determined by precipitation with acetone (Richards, 1954).
8- Organic matter was determined following Walkley and Black method (Jackson, 1958) the obtained data were presented in Table 2.

Table (2). Soil analysis of the study area under various irrigation methods

		Irrigation Methods			
Parameter	**Units**	**Flood**	**Drip**	**Sprinkler**	**Pivot**
Bulk density	Mg/m^3	1.24	1.21	1.65	1.84
K_h	cm/ hour	6.31	2.24	1.52	6.1
Sand	%	92.25	91.35	92.26	93
Silt	%	3.39	4.38	4.41	3.92
Clay	%	4.36	4.27	3.33	4.35
Textural class	-----	Sandy	Sandy	Sandy	Sandy
ECe	dS/m	3.9	4.1	5.2	4.5
pH	-----	7.75	7.78	7.8	7.9
$CaCO_3$	%	47	29	42	2
Gypsum	%	15	3	24	27.2
O.M	%	0.66	0.67	0.51	0.49

III- WATER SAMPLES:

Water samples were taken from the sourcs of irrigation represented by three water wells in the region and three replicates per well and stored in clean glass bottles (WPCF, 1998) for the analysis of the major contents of water.
The water samples were analyzed according to the following methods:

1- pH determined using Beckman's pH meter (Jackson, 1958).
2- Electrical conductivity (EC dS/m) using conductometer (Jackson, 1958).
3- Soluble cation were determined as follows: calcium and magnesium were determined titrimetrically, using the versenate method; sodium and potassium, using flame photometer (Page *et al.,* 1982).
4-Soluble anions were determined as follows:
Soluble carbonate and bicarbonate by acid titration, chloride by titration with standard silver nitrate and sulfate by EDTA method as described by (Jackson, 1973).

SAR (Sodium Adsobtion Ratio) was calculated as:

$$SAR = \frac{[Na^+]}{\sqrt{\frac{[Ca^{2+}+Mg^{2+}]}{2}}}$$

Where Na^+, Ca^{++} and Mg^{++} refer to their concentrations in meq/l (Donahue *et al.,* 1990). The obtained results of water samples analyzed were found in Table 3.

Table (3). Mean composition of wells water used for irrigation

	Characteristics									
			Cation (meq/L)				Anion (meq/L)			SAR
	EC(well water)	pH	Na^+	K^+	Ca^{+2}	Mg^{+2}	HCO^-_3	Cl^-	SO_4^{--2}	
Well no.1	(254 mg/l) (0.41dS/m)	7.2	2.3	0.2	2.2	2.1	0.6	3.8	2.4	1.27
Well no.2	(249 mg/l) (0.39 dS/m)	7.5	2.4	0.2	2.3	2.3	1.8	3.9	1.5	1.29
Well no.3	(246 (mg/l) (0.38 dS/m)	7.3	2.8	0.2	3.2	2.7	2.2	2.5	4.2	1.32

IV- CANTALOUPE YIELD

1- Cantaloupe yield calculation:

The data collected from Foreign trade data warehouse-Egypt, Control over exports and imports body-Egypt.
Yield (tons) calculated *Total Area X yield feddan
Ex: 340 X 7.4=2516 tons in each area

2- Plant roots length:

Plant roots length is measured by using roots meter (GI- 203 ROOTMETER CID, Inc. USA)

Table (4). Ranges of maximum effective rooting depth (Zr), and soil water depletion fraction for stress (p), of Cantaloupe crops (FAO, 2012)

Crop	Maximum Root Depth[1], Zr (m)	Depletion Fraction[2] (for ET mm/day) p
c. Vegetables – Cucumber Family (*Cucurbitaceae*)		
Cantaloupe	0.9-1.5	0.45

Source: (Natural Resources Management and Environment Department) (FAO, 2012)

1-The larger values for (Zr) are for soils having no significant layering or other characteristics that can restrict rooting depth. The smaller values for Zr may be used for irrigation scheduling and the larger values for modeling soil water stress or for rainfed conditions.

2-The values for p apply for ETc ≈ 5 mm/day. The value for p can be adjusted for different ETc according to p = p table 3 + 0.04 (5 – ETc) Where p is expressed as a fraction and ETc as mm/day

3-How we can available water (S_a) and net irrigation dose (d) calculated?

Irrigation takes place when the permissible percentage (p) of available water (S_a) is depleted from the root depth, i.e. to replenish the depleted water. Therefore: Net depth of irrigation dose is calculated as:

$$(d)\ (mm) = (S_a \times p)\ D$$

Where S_a is the available water in millimeters per meter, p is the permissible depletion (fraction) and D is the root depth (m). Example: Where
S_a = 99 mm/m, p = 0.5, D = 0.4 m,

The net irrigation dose (d) in millimeters to replenish the moisture deficit is:

$$d = 99 \times 0.5 \times 0.4 = 19.8 \text{ mm.}$$

V-Statistical analysis:

All obtained data of soil, plant and water were statistically analyzed. The data were analyzed using statistical software SYSTAT- 12. One-way analysis of variance was carried out to compare the means of different treatments and least significant differences at $P < 0.05$ were obtained using Duncan's multiple range test (DMRT) (Duncan, 1955).

RESULTS AND DISCUSSION

Table 5 shows that the cultivated area with cantaloupe in the El-Khatatba area in decline, especially at the year 2015, area cultivated cantaloupe crop in the El-Khatatba decrease. We found the last significant difference between the cultivated areas the height significant in 2015. The areas per year are 2012

(1290), 2013 (1444), 2014 (1410), 2015 (1262) feddan. The cause of low cantaloupe area is to stop the export to overseas. In 2015 drip irrigated area increased compared with another method (716 feddan) Because of the lack of water in the region Figure (2).

Table (5). Soil that use different methods of irrigation for cantaloupe crop area in the years from 2012 to 2015

Irrigation Methods	Years / Area (feddan)*				Change between 2012-2015 (feddan)
	2012	2013	2014	2015	
Flood	340 (%26)	294 (%20)	282 (%20)	255 (%20)	-85
Drip	630 (%49)	798 (%55)	791(%56)	716 (%57)	+86
Sprinkler	120 (%9)	179 (%12)	187 (%13)	182 (%14)	-62
Pivot	200 (%16)	173 (%12)	150 (%11)	109 (%9)	-91
L.S.D	1.8	2.4	3.2	3.4	
Total Area	1290	1444	1410	1262	-28

* hectare = 2.381 feddan
Foreign trade data warehouse-Egypt, Control over exports and imports body-Egypt

As it can be seen in Figure 2 the proportion of drip irrigation Area (Cantaloupe crop percentage) increased in the four years where the yield increased under drip irrigation conditions from 2012 to 2015 (9.3, 10.8, 11.9, 12.5 tons / feddan), respectively as shown in (Table 6)

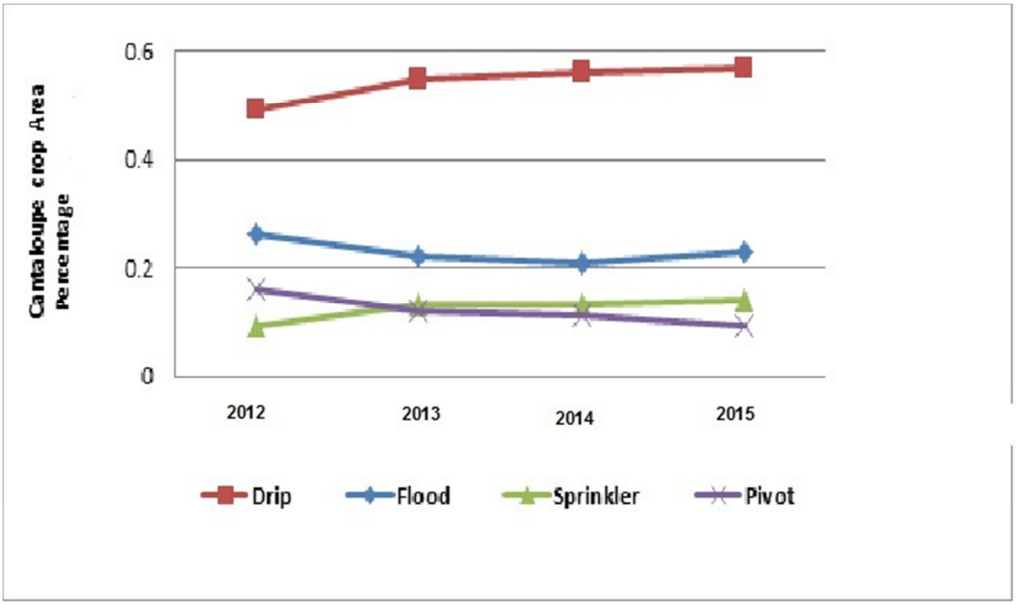

Figure (2). Irrigation methods for irrigated Cantaloupe crop Area Percentage (feddan) grown in El-Khatatba during 2012, 2013, 2014, 2015

Table (6). Cantaloupe yield// feddan production (tons) under different methods of irrigation

Irrigation Methods	Years / Yield (tons)				Change between 2012-2015 Ton/ feddan* *
	2012	2013	2014	2015	
Flood	7.4*	8.4	7.3	8.2	0.8
Drip***	9.3	10.8	11.9	12.5	3.2
Sprinkler	9.1	9.3	9.4	9.4	0.3
Pivot	7.2	7.8	8.3	8.3	1.1
L.S.D	1.5	1.7	1.8	1.8	

*The price of a kilogram of Cantaloupe from 0.75 to 1.0 Egyptian pound
* * hectare = 2.381 feddan
*** During 2015, drip irrigation system/ feddan (type of drive unit) cost 1300 Egyptian pound compared to the cost of sprinkle irrigation system/ feddan (type of drive unit) cost 2400 Egyptian pound and pivot system/ feddan (type of drive unit) cost 3000 Egyptian pound are higher in the same year

Whenever cantaloupe production decreased in the cultivated area is generally under different irrigation conditions of 136 565 tones from those of previous years as in Table 7.

This is because the low productivity of cantaloupe crop during the four years due to a low efficiency of the irrigation process, where the ability of surface irrigation efficiency 40-50%, increased salinity of about 20% and 5% alkaline Khatatba soil (Saloman, 1984).

Table (7). Total Cantaloupe yield under different methods of irrigation

Irrigation Methods	Years /Total Yield (tons)				Change between 2012-2015 (Ton)
	2012	2013	2014	2015	
Flood	2516*	2469.6	2058.6	2091.0	-425
Drip	5859	8618.4	9412.9	8950.0	3091
Sprinkler	1092	1664.7	1757.8	1710.8	618.8
Pivot	1440	1349.4	1245.0	904.70	-535.3
Total Yield	10907	14102.1	14474	13656	2749

*Total Area X yield feddan Ex 340 X 7.4=2516 tons in each area
Foreign trade data warehouse-Egypt, Control over exports and imports body-Egypt (Al-Saied, 1998)

Table (8) shows the results of climate change, the amount of evapotranspiration in the region and shows the temperature and wind speed, it explains the overall decline in the productivity of the areas planted cantaloupe under irrigation condition and the farmers prefer to drip irrigation the same result reached to (Rötter and van de Geijn 1999) Fig 3

Table (8). Relationship between Cantaloupe yield percentage and climate change

Cantaloupe yield percentage and clime change *				
Years	**2012**	**2013**	**2014**	**2015**
ETo (mm/day)	1.99	2.32	4.12	9.50
T (C^o) Maximum	13.0	18.5	20.2	23.1
Wind speed (Km/day)	95	85	196	105
EC (dS/m)	3.9	4.1	5.2	4.5
Mg/L	3496	3624	3326	2888
Flood	*23 %	18 %	14 %	15 %
Drip	54 %	61 %	65 %	66 %
Sprinkler	10 %	13 %	12 %	12 %
Pivot	13 %	8 %	9 %	7 %
Total Yield	10907	14102.1	14474.3	13656.5

*Ex: % = Yield of Cantaloupe in 2012 / Total Yield in 2012 …..etc.

Table (8).Shows the Cantaloupe plant is susceptible to injury from salt toxicity (3496, 3624, 3326, and 2888 mg/l). Chloride, sodium and boron are absorbed by the roots and transported to the leaves where they accumulate in harmful amounts; they resulted in leaf burn and leaf necrosis.

Moreover, direct contact during sprinkling of water drops with high chloride content over than 10 meq/l high toxic especially during sprinkling irrigation method (FAO, 1985)) may cause leaf burn in high evaporation conditions under deferent irrigation methods (Abou-Hadid, 2003).

Wind plays an important role in the evapotranspiration process. Strong winds enhance turbulence, removing the water vapour from the plant Cantaloupe more quickly and mixing it into the surrounding drier air.

As shown in Table 8, wind speed values were (95, 85,196,105 Km/day) for the years 2012 to 2015 respectively. In sub- humid and arid climates, wind can also transport sensible heat from dry surroundings into wet fields. While wind primarily responds to atmospheric pressure differences, local turbulence can be strongly influenced by topographic features.

Hence abrupt elevation changes and equivalent effects such as wind barriers can cause increased local turbulence and increased evapotranspiration, (Figure, 3).

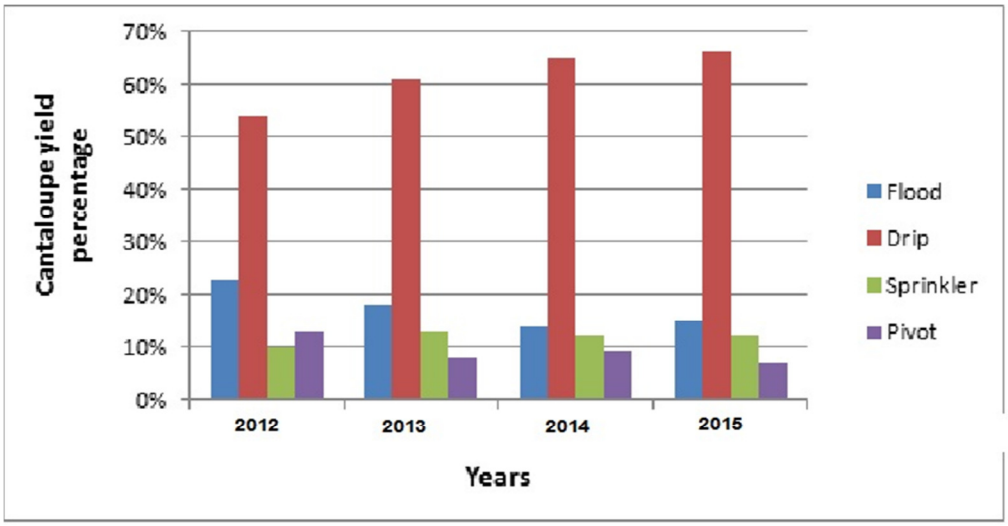

Figure (3). Cantaloupe yield percentage under climatic change

Table (9) shows that the length plant root of cantaloupe irrigated by drip irrigation equal 1.7 meters root depth and in the case of sprinkler irrigation equal 0.65 meters so the sprinkler irrigation efficiency was between 60% - 70% vegetative growth in plant cantaloupe under drip irrigation conditions and yield the highest show significant differences in productivity and a clear comparison between drip irrigation systems and other irrigation, Figure (5). The same result was reached by (Al-Harbi *et al.,* 2008)

Table (9). Ranges of maximum effective rooting depth with irrigation methods in El-Khatatba

Irrigation Methods	Cantaloupe			
	Maximum Root Depth (m)	ETo mm/day	WR (mm)	WUE (kg m^{-3})
Flood	0.85	1.99	350	13.2
Drip	1.70	2.32	250	19.2
Sprinkler	0.65	4.12	200	11.9
Pivot	0.55	6.50	300	18.7
L.S.D	0.018	0.5	26.5	1.7

WUE= Water use efficiency, WR= water requirements, ETo =evapotranspiration

From this study, it is clear that there is a very clear difference between crop water requirements and irrigation or production system water requirements. Crop water requirements refer to the actual water needs for evapotranspiration (ET) which are related to soil type and plant growth, and primarily depend on crop development and climatic factors which are closely related to climatic demands.Irrigation requirements (production system water requirements) are primarily determined by crop water requirement, but also

depend on the characteristics of the irrigation system management practices, and the soil characteristics in the irrigated area (Figure 4).

The amount of water used by a particular crop depends on a number of factors, including crop growth stage and environmental conditions (temperature, wind, relative humidity). The speed at which soil moisture is depleted depends on crop use and the soil type (sand, clay, etc.). Applying adequate amounts of moisture requires a basic understanding of soils and the general water use of the crop. Moisture stress/excess can influence crop yield and survivability (over-wintering) (FAO, 2012).

We recommended use some form of mulch (plastic, organic (straw, bark, shavings). Applying the water either directly to the plants (through a drip system) or using a lower pressure applicator (versus sprinkler application).

apply water in the early morning or evening when temperatures are lower (to reduce evaporative losses) provide adequate nutrients to ensure healthy, deep-rooted plants which maximize water use within the soil profile.

Figure (5) shows the Correlation matrix between maximum effective rooting depths and evapotranspiration ET_o under different irrigation methods in El-Khatatba. So, Limited water resources in the arid and semi-arid regions, and rapid growth rate of population as well as global warming were the major factors that drew the attention towards the way for drip irrigation systems (Abou-Hadid and Medany, 1994).

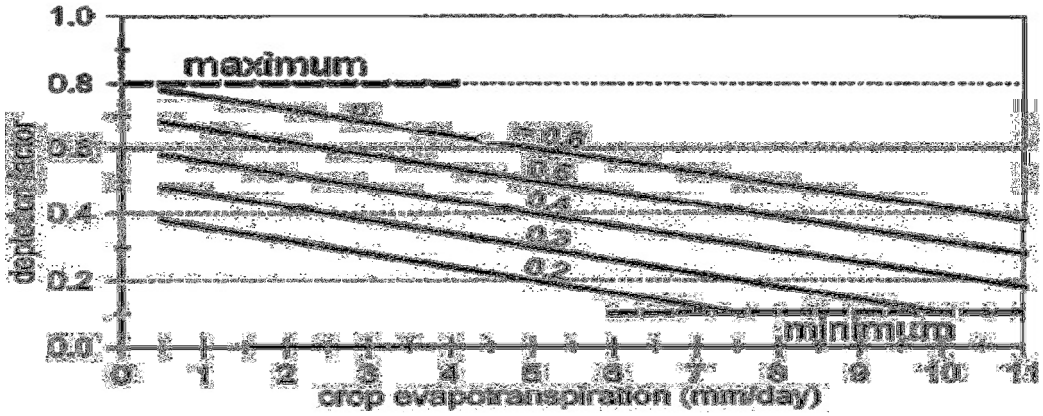

Figure (4). Depletion factor for different levels of crop evapotranspiration (Martin and Gilley, 1993)

Drip irrigation method suitable for most agricultural crop. The use of this method of irrigation leads to the provision amounts of irrigation water, up to (40%) compared to the traditional ways (FAO, 1998). This method also suitable for all types of soil, However the size of the circle in moisturizing soft soil textures is greater than in the rough textures land It also does not hinder service operations during plant growth. Up water-use efficiency in which more than 90 % is difficult to reach using other methods.

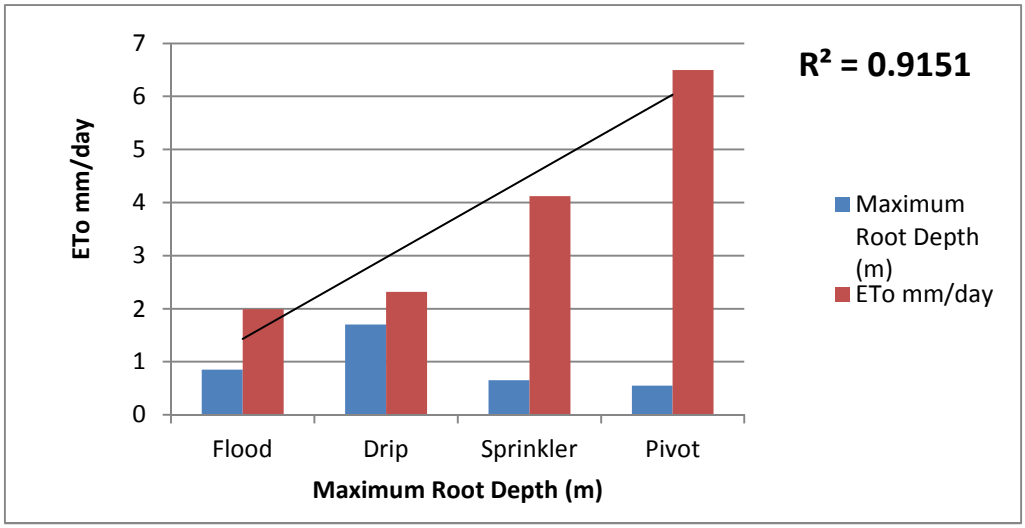

Figure (5). Correlation matrix between maximum effective rooting depthswith Irrigation Methods in El-Khatatba

Agricultural soil-use practices in general exert a major influence on groundwater recharge quality (Haman and Smajstria 2010). Drip irrigation in El-Khatatba area is agricultural policy and manages successful in the face of water shortages climate change and environmental injustice in the new reclaimed soils.The new reclaimed soils need innovative thinking as engineering design as example so that each crops the appropriate perforation or nozzles, the crop needs of rated water or required irrigation. So, in particular, they can increase yields and improve crop quality while at the same time reducing fertilizer, water, and in some cases, energy costs, resulting in higher profits. Additionally, efficiency can improve the reliability of existing supplies and reduce vulnerability to drought and other water-supply constraints.

CONCLUSION AND RECOMMENDATION

Land cultivated with Cantaloupe crop under different irrigation methods, where the cultivated area has decreased under flood irrigation conditions it has also increased under drip irrigation conditions, whenever the amount of cantaloupe crop increased tonnage under the climate variation of temperature conditions, evapotranspiration, wind speed and increase soil salinity. Also, the length of the roots of the Cantaloupe plant was the best we could under the condition of drip irrigation. It is recommended to use drip irrigation system where achieved through productivity in El-Khatatba area.

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الملخص العربي

تأثير طرق الري على إنتاجية نبات الكانتلوب فى منطقة الخطاطبة في ظل التغيرات المناخية وظروف التربة

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**معمل بحوث الأراضي الملحية و القلوية بالإسكندرية – معهد بحوث الأراضي والمياه والبيئة – مركز البحوث الزراعية – الجيزة – مصر

الخطاطبة تقع عند خط عرض// ٦٦/ ٥٢ °٣٠ وخط طول// ١١/ ٣٨ °٣٠ وترتفع فوق مستوى سطح البحر ما بين ٢٠ متر الى ٥٠ متر وهى احدى قرى مدينة السادات وتعتبر زراعة الكانتلوب بها هامة للتصدير حيث يزرع في عروتين صيفي (فبراير) ونيلي (اغسطس) في ارض رملية. تستخدم في المنطقة اربع طرق لري المساحات المزروعة من الكانتلوب وهى الري بالغمر والري بالتنقيط والري بالرش والري المحوري وقد خلصت الدراسة الى انخفاض استخدام جميع طرق الري تدريجيا ابتداء من ٢٠١٢ ، ٢٠١٣ ، ٢٠١٤ ،٢٠١٥ عدا طريقة الري بالتنقيط التي اعطت اعلى نسبة انتاجية من محصول الكانتلوب خلال السنوات الاربع (٥٤ % ، ٦١ %، ٦٥ % و ٦٦ %) على التوالي ، اكبر نسبة فى المساحة لزراعة الكانتلوب في حالة الري بالتنقيط (٤٩% ، ٥٥% ، ٥٦% و ٥٧%) على التوالي والتي توافرت فيها البيانات وذلك تحت ظروف تغير درجة الحرارة وسرعة الرياح والبخر نتح بمنطقة الدراسة.

الكلمات الدلالية : الري بالغمر ، الري بالتنقيط، ، الري بالرش ، والري المحوري، محصول الكانتلوب ، التباين المناخي ، الخطاطبة

Potential Application of *Glomus Intraradices* (AMF) and Different Isolates of PGPR (Biotol) to Enhance the Yield and Quality of Wheat Grown in The Field in Calcareous Soil Under Different Salinity Levels

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ABSTRACT: Two field experiments were carried out at the farm of Nubaria Agricultural Research Station during the two winter seasons of 2012/2013 and 2013/2014, to study the effect of the arbuscular mycorrhizal fungus, *Glomus intraradices* and the plant growth promoting rhizobacteria (Biotol) on growth, yield parameters and chemical contents of two wheat cultivars (Sakha 93 and Gemmeza 9) grown in calcareous soil under four levels of soil salinity and four rates of NPK mineral fertilizers. Results indicated that, wheat plants inoculated with AMF and Biotol together significantly decreased Na shoot content (mg/kg), increased NPK uptake, proline and salicylic acid contents, chlorophyll and grain protein at all the tested salinity levels compared to un-inoculated plants. Under normal salinity level (≤4 dSm^{-1}), dual inoculation with AMF and Biotol resulted total grain yield to 6.5 and 6.7 t/ha for Sakha 93 and Gemmeza 9, respectively, in the presence of NPK100% with a percentage increases of 41 and 29 more than un-inoculated plants. Results clearly indicated that, proline and Salicylic acid content were significantly increased in dual inoculated plants in Sakha 93 comparing to Gemmeza 9 under soil salinity up to 8 dSm^{-1}. The percentage increases were 38.6 and 37.54 for proline and 192.57 and 135.42 for salicylic acid in case of Sakha 93 and Gemmeza 9, respectively, in the presence of NPK75% and soil salinity 8-12 dSm^{-1}. No significant differences were observed among plants inoculated with *G. intraradices* and PGPR either in the presence of 75 or 100% of the recommended dose of NPK. Summing up it could be concluded that inoculation with AMF and Biotol successfully improve the growth, yield and salt stress tolerance of the tested cultivars in calcareous soil.

Key words: arbuscular mycorrhizal fungus, PGPR, salinity, wheat, proline, salicylic acid

INTRODUCTION

Wheat (*Triticum aestivum* L.) is the most important cereal crop in Egypt. Increasing wheat production is an essential national target to fill the gap between production and consumption (Tawfik *et al*. 2006).Salinity is one of the most brutal environmental factors limiting the productivity of crop plants because most of them are sensitive to salinity caused by high concentrations of salts in the soil (Shrivastava and Kumar, 2015). Salinity affects almost all aspects of plant development including: germination, vegetative growth and reproductive development. Soil salinity imposes ion toxicity, osmotic stress, nutrient (N, Ca, K, P, Fe, and Zn) deficiency and oxidative stress on plants, and thus limits water uptake from soil, some elements, such as sodium, chlorine, and boron besides having specific toxic effects on plants. Excessive accumulation of sodium in cell walls can rapidly lead to osmotic stress and cell death (Munns *et al*. 2002). Salinity and drought stresses inhibit the production of auxins, gibberellins, and zeatin in

the roots and leaves of plants (Sakhabutdinova *et al.* 2003; Figueiredo *et al*. 2008; Perez-Alfocea *et al*., 2010).Calcareous soils occupy wide areas in the North African countries such as Egypt. These soils have a high percentage of calcium carbonate and normally basic in their reaction. Low soil fertility and nutrients deficiency in calcareous soils are very common and could be considered the main constraints for agricultural production in some cases (Hilal *et al*. 1990; Awad *et al*. 1996).Several strategies have been developed in order to decrease the toxic effects caused by high salinity on plant growth, such as mycorrhizal fungi (Cho *et al*. 2006 and Kohler *et al*. 2009) and plant growth-promoting bacteria (PGPB) (Kohler *et al*. 2006 and Dimkpa *et al*. 2009).

Under salt stress conditions, plant tolerance and production are complicated mechanisms. Arbuscular mycorrhizal fungi employ different mechanisms to enhance salt tolerance of host plants such as enhancing nutrient acquisition (P, N, Mg and Ca) (Azcon and El-Atrash 1997; Giri and Mukerji 2004 and Sheng *et al*., 2009), inhibiting high uptake of Na and Cl and their transport to plant shoots (Dai *et al*. 2009), improving water uptake (Ruiz-Lozano and Azcon 2000), accumulating of proline and polyamines (Evelin *et al.* 2009) and increasing some of enzymatic antioxidant defense system (SOD and CAT) (Wu *et al*. 2010). Other arbuscular mycorrhizal mechanisms may include an osmotic adjustment, which assist in maintaining the leaf turgor pressure, and effects on the photosynthesis, transpiration, stomatal conductance and water use efficiency (Juniper and Abbott, 1993).

Tank and Saraf (2010) showed that PGPRs which are able to solubilize phosphate, produce phytohormones and siderophores in salt condition promote growth of tomato plants under 2% NaCl stress. PGPR are able to increase AM fungal development by affecting root colonization as well as by enhancing plant N and P uptake (Artursson *et al*. 2006 and Richardson *et al*. 2009). There are different examples of enhanced associations between different bacterial strains including *Bacillus*, *Paenibacillus*, *Pseudomonas* and *Rhizobia* and different AM species including *G. clarum*, *G. intraradices*, *G. mosseae*, and *G. versiforme* (Artursson *et al*. 2006). These stimulating effects include the growth of fungi and germination of then spores, respectively, root colonization of the host plant by AM fungi, the solubilization of phosphate, and the suppression of pathogens (Artursson *et al*. 2006).

The external hyphae of mycorrhizal fungi, which were about 100 times finer than wheat roots and 10 times finer than root hairs, access sites normally not permeable by roots or root hairs, thus reducing the P diffusion distances and increasing the surface area for nutrient absorption. Also, the length of external hyphae of mycorrhizal fungi can be a good predictor of its relative ability to take up P (Manske *et al*. 2000).Proline levels were found to be increased significantly with salinity stress in mycorrhizal plants when compared to non-mycorrhizal plants. Marked increase in proline occurs in many plants during moderate or severe salt stress and this accumulation, mainly as a result of increased proline biosynthesis, is usually the most outstanding change among free amino acids (Hurkman *et al*. 1989). Salicylic acid (SA), a plant phenolic compound is considered as a hormone

like endogenous regulator, and its role in the defence mechanisms against biotic and abiotic stresses has been well characterized (Szalai *et al*. 2009).The aim of this investigation is to study the effect of inoculation with *Glomus intraradices* and/or with different isolates of plant growth promoting rhizobacteria (Biotol) on growth, yield and chemical contents of two wheat cultivars grown under four levels of soil salinity in calcareous soil.

MATERIALS AND METHODS

Soil physicochemical characteristic

of the surface layers (0-30 cm) of the experimental field were as follows pH: 8.28-8.39, $CaCO_3$ %: 23.29-24.34, O.M. %: 0.30-.045, available N: 50.48-40.36 mg/kg, available P: 3.59-3.00 mg/kg and available K: 107.13-85.96 mg/kg. Soil texture was sandy loam (Page *et al*. 1982 and Klute, 1986).

Wheat seeds:

Two wheat (*Triticum aestivum*, L.) cultivars, Sakha 93 and Gemmeza 9, were provided from the Agricultural Research Center, Ministry of Agriculture, Giza, Egypt.

Isolation of microorganisms and inoculums preparation

1. The mycorrhizal strain *Glomus intraradices*, isolated from the Experimental Station of Alexandria University at Abies, (Aboul- Nasr, 1993), was used in both experiments. The inoculum consists of expanded clay aggregates (2-4 mm in diameter, leca), containing chlamydospores and fungus mycelium, which had been produced on *Tagetes erecta* L. (Aboul-Nasr, 2004). Inoculant was thrown at the rate of 100 g per plot under wheat grains. The control plants received the same amount of heat sterilized expanded clay.

2. Biotol was used as plant growth promoting rhizobacteria (PGPR). Biotol contains a mixture of *Bacillus megaterium, B. thuringiensis, B. mycoides, Paenibacillus graminis and P. borealis*. It was obtained from the Soil, Water and Environment Research Institute – Agricultural Research Center, Giza, Egypt. It has added to the ground with the first irrigation after 25 days from sowing.

NPK fertilizers:

Four different rates of NPK fertilizers were used in this study (NPK_{zero}, $NPK_{50\%}$, $NPK_{75\%}$ and $NPK_{100\%}$ of the recommended dose). The recommended doses of N, P_2O_5 and K_2O fertilizers are 240, 108 and 57.6 kg/ha, respectively. Nitrogen fertilizer (Ammonium nitrate 33.5 % N) was added twice in equal doses, at 25 and 45 days after sowing. Mono-calcium phosphate (15.5 % P_2O_5) was added at the time of soil preparation at one dose. Potassium sulphate (48 % K_2O) was added at 45 days after sowing.

Soil salinity levels:

Four places with different salinity levels (EC dSm^{-1}: average 2.8, 5.3, 7.6 and 10.5) were used in these experiments during the two growing seasons.

Field experiment:

Two field experiments were carried out during two winter seasons of 2012/2013 and 2013/2014 at the Agricultural Research Station of Nubaria. The field experiments were laid out in a split–split –plot design with three replicates.

The following parameters were measured:

The percentage of mycorrhizal root length colonization

was estimated when plants were 45, 90 and 120 days old, according to Koske and Gemma (1989). The percentage of AM root colonization was estimated according to Giovannetti and Mosse (1980).

1000 grains weight (g).

1000-grain weight was expressed as the weight of 1000 clean grains in grams.

Grain yield t/ha.

Grain yield was obtained by harvesting one square meter from each sub-sub plot. Plots were bundled, threshed, and then the grain were cleaned and weighted.

Chemical analysis

Plant samples were taken from each plot, at the suitable age, washed with running tap water, then distilled water. Samples were dried at 65ºC till the weight constant. After dryness, the plant samples were milled well and stored for analysis. 0.5g of plant powder was wet-digested with H_2SO_4 – H_2O_2 digest (Lowther, 1980) and the following determinations were carried out in the digested solution.

1. Shoot Na content

It was carried out according to the method described by (Jackson, 1973) using Beckman flame photometer.

2. Nitrogen uptake (kg/ha) and N % in grains

Total nitrogen was determined in digested wheat leaves colormeterically by Nessler's method (Chapman and Pratt, 1978) using 1 ml of nessler solution (35g KI/100 ml d.w + 20g $HgCl_2$/500 ml d.w) +120g NaOH/250 ml d.w. Reading was achieved using wave length at 420 nm by spectrophotometer (Model 390, Agricultural Microbiology Lab at the Faculty of Agricultural Saba-Basha). The percentage of total nitrogen was calculated as follows:

$\% N = NH_4\% \times 0.7764857$

Nitrogen uptake was calculated by multiplication of the N content × plant dry wt. (g).

The same method was use in case of determination N% in grains.

3. Phosphorus uptake (kg/ha)

It was determined in shoots during both seasons by a mixture of sulphuric, nitric and perchloric acids (1: 10: 40 v: v: v) to determine the total phosphorus in wet ash. Phosphorus was determined by the Vanadomolybdate yellow method

(Jackson, 1958) using Millton Ray spectronic 21 D. Phosphorus uptake was calculated by multiplication the P content × plant dry wt. (g).

4. Potassium uptake (kg/ha)

Total potassium content in plant shoots and grains was determined using a mixture of sulphuric, nitric and perchloric acids (1: 10: 40 v: v: v) according to the method described by (Jackson, 1973) using Beckman flame photometer. Potassium uptake was calculated by multiplication the K content × plant dry wt. (g).

Determination of chlorophyll index (SPAD)

Chlorophyll index was measured by chlorophyll meter device (SPAD 502) Ganji Arjenaki *et al*. (2012).

Determination of protein content in grains (%)

Protein was determined as percentage as follows: protein % = N % x 6.24

Determination of proline (mg/g dry wt.)

The content of proline was determined according to Umbreit *et al*. (1972) using the same extract prepared previously for the determination of total proteins and total soluble carbohydrates. 0.5 ml of extract, 1 ml citrate buffer (pH 5), 0.5 ml ninhydrine and 3.5 ml isopropanol solution were added. The optical density was measured spectrophotometerically at 450nm for proline, 492 nm for phenylalanine and 515 nm for arginine. In addition, 0.5 ml of distilled water was used instead of extract in reference cuvette. The concentration of each amino acid was determined according to the prepared standard curves of each corresponding amino acids.

Determination of salicylic acids (mg/100g root dry wt.)

Determination was implemented according to the method of Iqbal and Vaid (2009) and Malamy *et al*. (1992) as follows;

1. One gram of frozen root tissue is ground in 3.0 ml methanol 90% and centrifuged at 6000 r.p.m. for 15 min.
2. The pellet is re-extracted with 3.0 ml 90% methanol and centrifuged for 10.0 min at 4000 r.p.m.

Assay of salicylic acid was carried out using spectrophotometer according to Iqbal and Vaid (2009).

The supernatant from the both extractions in combined and 2.5 ml of these extractions is diluted to 25.0 ml A.d. in volumetric flask

2.5 ml extraction + 0.5 ml FeCl3 5% + 22.0 ml A.d.

Absorbance of the sample was determined using a spectrophotometer set at 360 nm.

Statistical analysis

Data were statistically analyzed by ANOVA, the analysis of variance to test the treatments effect on different measured parameters. Data were analysed using an ANOVA split split design, the differences between the different treatments

combinations were tested using the Duncan's Multiple range method outlined by (Snedecor and Cochran, 1982).

RESULTS

Mycorrhizal root length colonization

The percentage of AM colonization was estimated after 45, 90 and 120 days old. Records of wheat plants, inoculated either with *G. intraradices* alone or with G. *intraradices* and Biotol significantly increased under all the tested levels of soil salinity, compared to un-inoculated plants. The highest percentages of AM colonization were attained after 90 days under $NPK_{75\%}$ and normal soil salinity being, 65.57 and 65.49 for cv. Sakha 93 and 58.56 and 60.39 for cv. Gemmeza 9, respectively. By increasing soil salinity, the percentage of AM colonization significantly decreased (Tables 1, 2 and 3).

Shoot Na content

Results presented in Table (4) showed that, the lowest values of Na contents (mg/kg) were observed under EC ≤4 dSm^{-1} for plants inoculated with G. *intraradices* and Biotol (9.79 and 18.94 mg/kg) under $NPK_{100\%}$ for Sakha 93 and Gemmeza 9, respectively. Un-inoculated plants recorded 18.75 and 26.86 mg/kg Na for both cultivars, respectively, under the same treatments. The same trends were noticed by increasing soil salinity levels.

Chlorophyll index

Chlorophyll index was significantly affected with soil salinity and levels of mineral fertilizers. Under soil salinity level ≤4 dSm^{-1} the highest values of chlorophyll were 55.75 and 49.96 for plants inoculated with AM+Biotol under $NPK_{100\%}$ for the tested wheat cultivars; representing increase percentages 26.73 and 26.31 % over uninoculated ones. No significant differences were observed between NPK_{75} and $NPK_{100\%}$ of the recommended dose of mineral fertilizers. The same trends were observed with increasing the soil salinity levels. Significant differences in chlorophyll contents were found between the wheat cultivars at soil salinity level 8–12 dSm^{-1}. Sakha 93 recorded higher values of chlorophyll, compared to the Gemmeza 9 (Table 5).

NPK uptake (kg/ha)

Data in Tables (6, 7 and 8) reveal that inoculation with the AM fungus and Biotol, significantly increased NPK uptake (kg/ha) when compared to uninoculated ones. Under salinity level ≤4 dSm^{-1} the highest uptake values of N (Table 6) P (Table 7) K (Table 8) were recorded in case of plants inoculated with AM+Biotol under $NPK_{100\%}$ for both the tested cultivars. No significant differences were observed between NPK_{75} and $NPK_{100\%}$ mineral fertilizers. The same trends were observed with increasing the soil salinity levels. The NPK uptake values decreased under soil salinity level 8-12 dSm^{-1}.

Table (1). Effect of wheat inoculation with *Glomus intraradices* and Biotol on the percentage of mycorrhizal root colonization after 45 days from planting in the presence of four levels of soil salinity (averages of the two seasons 2012/2013 and 2013/2014).

Cultivars	NPK Levels	Un-inoc.	AM	Biotol	AM+B	Mean of NPK	Mean of Cultiv.	Cultiv.	NPK	Inoc.	Inoc.* NPK
Parameter		Mycorrhizal root length colonization % EC: average 2.8 dSm^{-1}							L.S.D.$_{0.05}$		
Sakha 93	$NPK_{0\%}$	0.00	14.94	2.24	16.31	$NPK_{0\%}$	9.42a	NS	2.988*	2.317***	NS
	$NPK_{50\%}$	0.00	15.46	1.10	13.70	7.66 b					
	$NPK_{75\%}$	1.10	21.68	2.19	23.49	$NPK_{50\%}$					
	$NPK_{100\%}$	0.00	17.70	2.09	18.76	8.71 b					
Gemmeza 9	$NPK_{0\%}$	0.00	10.99	0.00	16.77	$NPK_{75\%}$	10.07a				
	$NPK_{50\%}$	1.07	16.38	3.26	18.66	12.73 a					
	$NPK_{75\%}$	0.94	26.40	4.48	21.54	$NPK_{100\%}$					
	$NPK_{100\%}$	1.06	17.06	3.32	19.16	9.89ab					
Mean of Inoc.		0.52b	17.58a	2.35 b	18.55a						
Parameter		Mycorrhizal root length colonization % EC: average 5.3 dSm^{-1}									
Sakha 93	$NPK_{0\%}$	0.00	5.35	0.95	6.99	$NPK_{0\%}$	7.28 a	NS	1.813***	1.193***	***
	$NPK_{50\%}$	0.19	15.42	0.00	13.68	3.29 c					
	$NPK_{75\%}$	0.00	19.68	2.19	22.96	$NPK_{50\%}$					
	$NPK_{100\%}$	1.08	11.98	1.71	14.25	6.57 b					
Gemmeza 9	$NPK_{0\%}$	0.00	6.06	0.00	6.96	$NPK_{75\%}$	6.91a				
	$NPK_{50\%}$	1.10	9.18	0.00	13.00	11.24 a					
	$NPK_{75\%}$	1.07	19.24	2.19	22.57	$NPK_{100\%}$					
	$NPK_{100\%}$	1.05	12.85	1.07	14.16	7.27 b					
Mean of Inoc.		0.56c	12.47b	1.01c	14.32a						
Parameter		Mycorrhizal root length colonization % EC: average 7.6 dSm^{-1}									
Sakha 93	$NPK_{0\%}$	0.00	0.88	0.00	2.22	$NPK_{0\%}$	1.93a	NS	0.941***	0.604***	***
	$NPK_{50\%}$	0.22	1.26	0.67	2.57	0.80 b					
	$NPK_{75\%}$	0.00	4.05	2.01	5.56	$NPK_{50\%}$					
	$NPK_{100\%}$	1.11	4.33	1.60	4.43	1.49 b					
Gemmeza 9	$NPK_{0\%}$	0.00	1.11	0.00	2.23	$NPK_{75\%}$	2.11a				
	$NPK_{50\%}$	0.00	1.67	1.61	3.95	3.21 a					
	$NPK_{75\%}$	0.00	6.37	1.67	6.05	$NPK_{100\%}$					
	$NPK_{100\%}$	0.51	2.15	2.22	4.31	2.58 a					
Mean of Inoc.		0.23d	2.73b	1.22c	3.91a						
Parameter		Mycorrhizal root length colonization % EC: average 10.5 dSm^{-1}									
Sakha 93	$NPK_{0\%}$	0.00	0.58	0.00	1.18	$NPK_{0\%}$	1.70a	NS	0.683**	0.564***	NS
	$NPK_{50\%}$	0.22	1.19	0.59	2.99	0.59 c					
	$NPK_{75\%}$	0.28	3.61	1.18	5.16	$NPK_{50\%}$					
	$NPK_{100\%}$	0.61	3.60	1.23	4.82	1.22 bc					
Gemmeza 9	$NPK_{0\%}$	0.00	1.17	0.00	1.78	$NPK_{75\%}$	1.08a				
	$NPK_{50\%}$	0.00	1.77	0.59	2.37	2.1a					
	$NPK_{75\%}$	0.00	2.98	0.59	3.00	$NPK_{100\%}$					
	$NPK_{100\%}$	0.00	1.20	0.00	1.79	1.66ab					
Mean of Inoc.		0.14c	2.01b	0.522c	2.89a						

Table (2). Effect of wheat inoculation with *Glomus intraradices* and Biotol the percentage of mycorrhizal root colonization after 90 days from planting in the presence of four levels of soil salinity (averages of the two seasons 2012/2013 and 2013/2014).

Cultivars	NPK Levels	Un-inoc.	AM	Biotol	AM+B	Mean of NPK	Mean of Cultiv.	Cultiv.	NPK	Inoc.	Inoc.* NPK
Parameter		Mycorrhizal root length colonization % EC: average 2.8 dSm^{-1}							L.S.D.$_{0.05}$		
Sakha 93	$NPK_{0\%}$	0.71	27.45	2.24	31.57	$NPK_{0\%}$	23.97a	NS	4.623***	3.018***	***
	$NPK_{50\%}$	0.61	39.74	1.63	44.30	15.34 d					
	$NPK_{75\%}$	4.48	65.57	6.52	65.49	$NPK_{50\%}$					
	$NPK_{100\%}$	3.25	42.01	3.85	44.25	20.98 c					
Gemmeza 9	$NPK_{0\%}$	0.00	28.57	1.62	30.52	$NPK_{75\%}$	23.99a				
	$NPK_{50\%}$	2.19	34.89	3.82	40.67	33.88 a					
	$NPK_{75\%}$	3.23	58.56	6.81	60.39	$NPK_{100\%}$					
	$NPK_{100\%}$	3.38	51.40	1.63	56.28	25.75 b					
Mean of Inoc.		2.23 c	43.52b	3.52c	46.68a						
Parameter		Mycorrhizal root length colonization % EC: average 5.3 dSm^{-1}									
Sakha 93	$NPK_{0\%}$	0.33	16.06	0.93	18.11	$NPK_{0\%}$	18.56a	NS	1.906***	1.910***	***
	$NPK_{50\%}$	0.28	35.22	0.80	36.62	11.65 c					
	$NPK_{75\%}$	2.14	47.00	4.38	51.42	$NPK_{50\%}$					
	$NPK_{100\%}$	2.17	38.21	1.65	41.69	17.69 b					
Gemmeza 9	$NPK_{0\%}$	1.08	22.11	2.10	32.48	$NPK_{75\%}$	18.09a				
	$NPK_{50\%}$	1.09	30.61	2.17	34.71	24.74 a					
	$NPK_{75\%}$	1.63	41.83	2.18	47.39	$NPK_{100\%}$					
	$NPK_{100\%}$	1.36	31.05	2.68	35.87	19.23 b					
Mean of Inoc.		1.15 c	32.76	2.11c	37.29a						
Parameter		Mycorrhizal root length colonization % EC: average 7.6 dSm^{-1}									
Sakha 93	$NPK_{0\%}$	0.33	10.66	1.30	11.29	$NPK_{0\%}$	11.02a	NS	1.571***	0.985***	***
	$NPK_{50\%}$	1.32	14.06	0.61	16.30	6.23 c					
	$NPK_{75\%}$	1.20	25.78	2.64	30.79	$NPK_{50\%}$					
	$NPK_{100\%}$	0.64	24.87	1.39	33.09	8.39 b					
Gemmeza 9	$NPK_{0\%}$	0.00	10.00	1.24	15.04	$NPK_{75\%}$	10.33a				
	$NPK_{50\%}$	0.00	15.95	1.18	17.74	13.85 a					
	$NPK_{75\%}$	0.00	21.43	2.65	26.31	$NPK_{100\%}$					
	$NPK_{100\%}$	0.00	23.56	3.27	26.93	14.22 a					
Mean of Inoc.		0.44 d	18.29b	1.79	22.19a						
Parameter		Mycorrhizal root length colonization % EC: average 10.5 dSm^{-1}									
Sakha 93	$NPK_{0\%}$	0.28	7.84	1.12	10.55	$NPK_{0\%}$	9.32a	NS	1.289***	0.867***	***
	$NPK_{50\%}$	0.86	11.02	0.56	13.96	5.35 c					
	$NPK_{75\%}$	1.06	21.57	1.67	26.08	$NPK_{50\%}$					
	$NPK_{100\%}$	0.56	20.58	1.40	30.01	7.13 b					
Gemmeza 9	$NPK_{0\%}$	0.00	8.89	1.07	13.09	$NPK_{75\%}$	9.04a				
	$NPK_{50\%}$	0.00	13.44	0.81	16.41	11.71 a					
	$NPK_{75\%}$	0.00	18.87	2.50	21.90	$NPK_{100\%}$					
	$NPK_{100\%}$	0.22	20.53	3.05	23.98	12.54 a					
Mean of Inoc.		0.37 d	15.34b	1.52c	19.49a						

Table (3). Effect of wheat inoculation with *Glomus intraradices* and Biotol on the percentage of mycorrhizal root colonization after 120 days from planting in the presence of four levels of soil salinity (averages of the two seasons 2012/2013 and 2013/2014)

Cultivars	NPK Levels	Un-inoc.	AM	Biotol	AM+B	Mean of NPK	Mean of Cultiv.	Cultiv.	NPK	Inoc.	Inoc.* NPK
Parameter		Mycorrhizal root length colonization % EC: average 2.8 dSm^{-1}							L.S.D.$_{0.05}$		
Sakha 93	$NPK_{0\%}$	1.41	31.80	5.55	33.41	$NPK_{0\%}$	31.65a	NS	4.486***	2.555***	***
	$NPK_{50\%}$	2.31	54.02	3.28	56.04	18.36 d					
	$NPK_{75\%}$	5.58	78.31	10.91	82.09	$NPK_{50\%}$					
	$NPK_{100\%}$	4.34	62.06	7.68	67.64	27.04 c					
Gemmeza 9	$NPK_{0\%}$	0.55	34.06	5.32	34.75	$NPK_{75\%}$	28.64a				
	$NPK_{50\%}$	3.27	43.63	5.46	48.33	41.57 a					
	$NPK_{75\%}$	5.35	69.93	10.21	70.17	$NPK_{100\%}$					
	$NPK_{100\%}$	2.28	55.90	7.14	61.93	33.62 b					
Mean of Inoc.		3.14d	53.71b	6.95c	56.79a						
Parameter		Mycorrhizal root length colonization % EC: average 5.3 dSm^{-1}									
Sakha 93	$NPK_{0\%}$	1.09	22.48	1.84	26.01	$NPK_{0\%}$	22.48a	NS	4.529***	3.463***	***
	$NPK_{50\%}$	1.72	40.71	3.24	47.96	14.99 c					
	$NPK_{75\%}$	3.18	55.75	7.67	60.16	$NPK_{50\%}$					
	$NPK_{100\%}$	1.91	35.04	2.76	48.28	21.74 b					
Gemmeza 9	$NPK_{0\%}$	3.04	27.01	2.87	35.57	$NPK_{75\%}$	21.47a				
	$NPK_{50\%}$	2.16	33.66	4.29	40.22	28.74 a					
	$NPK_{75\%}$	4.32	46.06	5.44	47.36	$NPK_{100\%}$					
	$NPK_{100\%}$	2.94	33.19	5.34	50.04	22.43 b					
Mean of Inoc.		2.55 c	36.74b	4.18c	44.45a						
Parameter		Mycorrhizal root length colonization % EC: average 7.6 dSm^{-1}									
Sakha 93	$NPK_{0\%}$	0.39	13.64	0.89	17.76	$NPK_{0\%}$	13.07a	NS	1.340***	1.308***	***
	$NPK_{50\%}$	0.44	18.21	0.89	21.11	8.96 c					
	$NPK_{75\%}$	1.29	29.29	1.82	36.17	$NPK_{50\%}$					
	$NPK_{100\%}$	0.67	28.68	2.28	35.61	11.06 b					
Gemmeza 9	$NPK_{0\%}$	0.81	16.56	1.64	20.04	$NPK_{75\%}$	13.41a				
	$NPK_{50\%}$	0.56	22.17	1.03	24.04	16.57 a					
	$NPK_{75\%}$	1.69	27.66	4.44	30.18	$NPK_{100\%}$					
	$NPK_{100\%}$	1.91	26.09	2.55	33.16	16.37 a					
Mean of Inoc.		0.97c	22.78b	1.94c	27.26a						
Parameter		Mycorrhizal root length colonization % EC: average 10.5 dSm^{-1}									
Sakha 93	$NPK_{0\%}$	0.83	11.46	2.28	14.24	$NPK_{0\%}$	12.18a	NS	1.583***	1.110***	***
	$NPK_{50\%}$	1.20	14.95	0.59	18.56	7.76 b					
	$NPK_{75\%}$	0.82	31.35	2.04	31.23	$NPK_{50\%}$					
	$NPK_{100\%}$	1.10	27.97	2.40	33.91	9.31 b					
Gemmeza 9	$NPK_{0\%}$	0.22	15.30	1.24	16.50	$NPK_{75\%}$	11.63a				
	$NPK_{50\%}$	0.58	17.81	0.59	20.17	15.15 a					
	$NPK_{75\%}$	1.18	25.09	2.38	27.13	$NPK_{100\%}$					
	$NPK_{100\%}$	1.35	26.08	2.42	28.57	15.42 a					
Mean of Inoc.		0.91c	21.25b	1.69c	23.79a						

Table (4). Effect of wheat inoculation with *Glomus intraradices* and Biotol on Shoot Na content (mg/kg) in the presence of four levels of soil salinity (averages of the two seasons 2012/2013 and 2013/2014)

Cultivars	NPK Levels	Un-inoc.	AM	± %	Biotol	± %	AM+B	± %	Mean of NPK	Mean of Cultiv.	Cultiv.	NPK	Inoc.	Inoc.* NPK
Parameter												L.S.D.$_{0.05}$		
					Shoot Na content (mg/kg) EC: average 2.8 dSm^{-1}									
Sakha 93	$NPK_{0\%}$	45.94	34.19	25.56	41.16	10.40	27.08	41.05	$NPK_{0\%}$	25.46b	3.34*	4.22***	3.46***	NS
	$NPK_{50\%}$	41.27	26.77	35.13	31.20	24.40	21.26	48.48	35.53 a					
	$NPK_{75\%}$	24.07	21.79	9.47	21.59	10.31	20.62	14.34	$NPK_{50\%}$					
	$NPK_{100\%}$	18.75	10.39	44.60	11.54	38.44	9.79	47.78	31.14 b					
Gemmeza9	$NPK_{0\%}$	37.62	33.80	10.14	36.69	2.46	27.76	26.20	$NPK_{75\%}$	29.21a				
	$NPK_{50\%}$	34.78	30.78	11.51	33.07	4.91	29.96	13.86	25.74 c					
	$NPK_{75\%}$	31.36	29.14	7.08	29.54	5.82	27.82	11.29	$NPK_{100\%}$					
	$NPK_{100\%}$	26.86	18.89	29.67	20.30	24.42	18.94	29.47	16.93 d					
Mean of Inoc.		32.58a	25.72 bc		28.14 b		22.90 c							
Parameter					**Shoot Na content (mg/kg) EC: average 5.3 dSm^{-1}**									
Sakha 93	$NPK_{0\%}$	59.37	45.87	22.74	50.55	14.86	40.19	32.30	$NPK_{0\%}$	35.45a	NS	3.53***	2.58***	NS
	$NPK_{50\%}$	41.36	36.94	10.69	40.51	2.07	31.57	23.68	47.19 a					
	$NPK_{75\%}$	36.86	30.99	15.92	34.81	5.56	18.65	49.40	$NPK_{50\%}$					
	$NPK_{100\%}$	30.53	22.75	25.47	30.12	1.34	16.16	47.08	39.64 b					
Gemmeza9	$NPK_{0\%}$	52.67	42.91	18.53	47.41	9.99	38.64	26.64	$NPK_{75\%}$	36.14a				
	$NPK_{50\%}$	48.84	38.35	21.49	46.11	5.58	33.40	31.61	30.83 c					
	$NPK_{75\%}$	39.24	28.41	27.59	33.17	15.48	24.51	37.53	$NPK_{100\%}$					
	$NPK_{100\%}$	31.51	22.88	27.39	28.12	10.75	22.11	29.82	25.52 d					
Mean of Inoc.		42.55a	33.64 c		38.85 b		28.15 d							
Parameter					**Shoot Na content (mg/kg) EC: average 7.6 dSm^{-1}**									
Sakha 93	$NPK_{0\%}$	69.17	49.42	28.55	57.78	16.46	44.77	35.27	$NPK_{0\%}$	46.34a	NS	4.09***	3.00***	NS
	$NPK_{50\%}$	59.96	45.75	23.70	48.90	18.45	38.44	35.89	55.11 a					
	$NPK_{75\%}$	58.35	41.90	28.19	44.45	23.83	35.83	38.60	$NPK_{50\%}$					
	$NPK_{100\%}$	39.29	36.47	7.19	40.20	2.31	30.78	21.65	48.89 b					
Gemmeza9	$NPK_{0\%}$	65.95	53.92	18.25	57.07	13.46	42.81	35.09	$NPK_{75\%}$	42.93a				
	$NPK_{50\%}$	57.29	45.61	20.38	53.15	7.23	42.05	26.61	42.18 c					
	$NPK_{75\%}$	45.68	36.55	19.97	42.72	6.47	32.03	29.87	$NPK_{100\%}$					
	$NPK_{100\%}$	32.73	25.14	23.20	29.24	10.66	24.92	23.88	32.34 d					
Mean of Inoc.		53.55a	41.84 c		46.68 b		36.45 d							
Parameter					**Shoot Na content (mg/kg) EC: average 10.5 dSm^{-1}**									
Sakha 93	$NPK_{0\%}$	75.44	62.62	17.00	70.63	6.38	57.90	23.25	$NPK_{0\%}$	60.89a	6.61*	4.11***	3.69***	NS
	$NPK_{50\%}$	64.30	51.17	20.42	55.26	14.07	45.67	28.99	67.27 a					
	$NPK_{75\%}$	58.59	53.74	8.28	55.08	5.98	38.58	34.14	$NPK_{50\%}$					
	$NPK_{100\%}$	50.20	41.27	17.80	43.96	12.44	33.97	32.23	57.14 b					
Gemmeza9	$NPK_{0\%}$	78.96	65.78	16.69	72.06	8.73	54.79	30.60	$NPK_{75\%}$	49.57b				
	$NPK_{50\%}$	71.40	55.64	22.07	64.57	9.56	49.12	31.20	53.93 b					
	$NPK_{75\%}$	63.98	51.97	18.77	63.19	1.23	40.61	36.25	$NPK_{100\%}$					
	$NPK_{100\%}$	51.03	41.91	17.88	44.54	12.73	33.96	33.45	42.60 c					
Mean of Inoc.		64.34a	53.73 b		58.66 c		44.33 d							

± % Increase or decrease to uninoculated (control) plants

Table (5). Effect of wheat inoculation with *Glomus intraradices* and Biotol on chlorophyll index (SPAD) in the presence of four levels of soil salinity (averages of the two seasons 2012/2013 and 2013/2014)

Cultivars	NPK Levels	Un-inoc.	AM	± %	Biotol	± %	AM+B	± %	Mean of NPK	Mean Of Cultiv.	Cultiv.	NPK	Inoc.	Inoc.* NPK
Parameter			**Chlorophyll index (SPAD) EC: average 2.8 dSm^{-1}**									L.S.D.$_{0.05}$		
Sakha 93	$NPK_{0\%}$	32.72	42.09	28.64	39.73	21.43	44.52	36.07	$NPK_{0\%}$ 36.72 c	45.94a	3.332*	4.179***	2.159***	NS
	$NPK_{50\%}$	38.28	49.20	28.54	45.41	18.63	46.82	22.30						
	$NPK_{75\%}$	41.35	52.34	26.57	47.20	14.14	55.57	34.38	$NPK_{50\%}$ 41.30 b					
	$NPK_{100\%}$	43.56	50.49	15.92	50.53	16.00	55.75	26.73						
Gemmeza9	$NPK_{0\%}$	26.20	36.32	35.76	34.20	27.83	37.45	40.01	$NPK_{75\%}$ 44.85ab	38.99b				
	$NPK_{50\%}$	32.87	39.71	20.80	35.46	7.87	42.66	29.78						
	$NPK_{75\%}$	33.15	44.17	33.24	39.47	19.08	45.57	37.47	$NPK_{100\%}$ 46.98 a					
	$NPK_{100\%}$	39.55	45.61	15.31	40.98	3.60	49.96	26.31						
Mean of Inoc.		36.03d	44.99 b		41.62 c		47.22 a							
Parameter			**Chlorophyll index (SPAD) EC: average 5.3 dSm^{-1}**											
Sakha 93	$NPK_{0\%}$	28.16	31.32	11.24	29.28	4.01	32.91	16.90	$NPK_{0\%}$ 28.73 c	37.45a	NS	2.962***	1.128***	NS
	$NPK_{50\%}$	29.99	38.24	27.50	34.89	16.33	37.60	25.36						
	$NPK_{75\%}$	35.74	45.51	27.35	40.09	12.17	44.62	24.86	$NPK_{50\%}$ 36.73 b					
	$NPK_{100\%}$	37.92	43.85	15.64	43.80	15.50	45.25	19.33						
Gemmeza9	$NPK_{0\%}$	22.23	31.60	41.53	26.81	20.05	27.44	22.87	$NPK_{75\%}$ 41.33 a	37.05a				
	$NPK_{50\%}$	32.04	39.47	23.18	39.51	23.31	42.14	31.52						
	$NPK_{75\%}$	36.27	43.22	19.17	40.89	12.74	44.32	22.20	$NPK_{100\%}$ 42.21 a					
	$NPK_{100\%}$	36.97	44.39	20.06	41.01	10.93	44.46	20.26						
Mean of Inoc.		32.43c	39.7 a		37.03 b		39.84 a							
Parameter			**Chlorophyll index (SPAD) EC: average 7.6 dSm^{-1}**											
Sakha 93	$NPK_{0\%}$	18.10	23.49	29.74	24.94	37.74	29.25	61.54	$NPK_{0\%}$ 23.7 d	31.54a	NS	2.833***	2.095***	NS
	$NPK_{50\%}$	23.10	28.65	24.03	28.22	22.16	30.05	30.10						
	$NPK_{75\%}$	28.05	37.37	33.25	32.05	14.26	39.41	40.49	$NPK_{50\%}$ 26.63 c					
	$NPK_{100\%}$	36.16	40.63	12.36	40.89	13.09	44.25	22.37						
Gemmeza9	$NPK_{0\%}$	13.52	27.62	104.22	23.76	75.65	28.93	113.88	$NPK_{75\%}$ 33.12 b	29.28a				
	$NPK_{50\%}$	17.79	28.66	61.13	26.76	50.45	29.78	67.45						
	$NPK_{75\%}$	23.50	38.08	62.05	31.15	32.58	35.40	50.66	$NPK_{100\%}$ 38.18 a					
	$NPK_{100\%}$	29.11	39.83	36.84	35.13	20.71	39.42	35.45						
Mean of Inoc.		23.66c	33.04 a		30.36 b		34.56 a							
Parameter			**Chlorophyll index (SPAD) EC: average 10.5 dSm^{-1}**											
Sakha 93	$NPK_{0\%}$	13.38	21.07	57.53	21.02	57.16	22.59	68.90	$NPK_{0\%}$ 18.49 c	27.3a	1.233*	2.015***	1.108***	*
	$NPK_{50\%}$	19.96	28.23	41.46	27.13	35.92	28.82	44.41						
	$NPK_{75\%}$	24.23	35.63	47.05	29.75	22.81	34.42	42.06	$NPK_{50\%}$ 25.59 b					
	$NPK_{100\%}$	29.10	33.43	14.89	32.91	13.12	35.19	20.95						
Gemmeza9	$NPK_{0\%}$	10.36	18.73	80.78	17.49	68.86	23.28	124.79	$NPK_{75\%}$ 29.36 a	24.93b				
	$NPK_{50\%}$	20.19	26.28	30.15	24.75	22.58	29.45	45.88						
	$NPK_{75\%}$	24.41	29.47	20.74	27.58	12.99	29.44	20.60	$NPK_{100\%}$ 31.01 a					
	$NPK_{100\%}$	26.36	31.25	18.57	28.41	7.79	31.44	19.29						
Mean of Inoc.		20.99d	28.01 b		26.13 c		29.33 a							

± % Increase or decrease to uninoculated (control) plants

Table (6). Effect of wheat inoculation with *Glomus intraradices* and Biotol on N uptake (kg/ha) in the presence of four levels of soil salinity (averages of the two seasons 2012/2013 and 2013/2014)

Cultivars	NPK Levels	Un-inoc.	AM	± %	Biotol	± %	AM+B	± %	Mean of NPK	Mean of Cultiv.	Cultiv.	NPK	Inoc.	Inoc.* NPK
Parameter												L.S.D.$_{0.05}$		
					N Uptake (kg/ha) EC: average 2.8 dSm^{-1}									
Sakha 93	$NPK_{0\%}$	14.908	37.525	151.71	30.492	104.53	43.428	191.30	$NPK_{0\%}$	65.49a	NS	5.519***	7.09***	**
	$NPK_{50\%}$	20.692	58.805	184.19	48.179	132.84	61.231	195.92	29.47 d					
	$NPK_{75\%}$	41.419	99.613	140.50	77.232	86.47	105.178	153.94	$NPK_{50\%}$					
	$NPK_{100\%}$	64.175	126.311	96.82	92.478	44.10	116.433	81.43	54.41 c					
Gemmeza9	$NPK_{0\%}$	13.72	41.813	204.72	28.380	106.82	32.982	140.36	$NPK_{75\%}$	65.08a				
	$NPK_{50\%}$	23.570	62.426	164.85	66.095	180.42	77.786	230.02	77.8 b					
	$NPK_{75\%}$	34.903	90.744	159.99	65.977	89.03	107.354	207.58	$NPK_{100\%}$					
	$NPK_{100\%}$	59.886	118.167	97.32	95.000	58.63	130.015	117.10	99.47 a					
Mean of Inoc.		32.39c	81.49 a		62.98 b		84.3 a							
Parameter														
					N Uptake (kg/ha) EC: average 5.3 dSm^{-1}									
Sakha 93	$NPK_{0\%}$	6.384	11.980	87.67	16.987	166.10	22.145	246.90	$NPK_{0\%}$	35.35a	NS	4.945***	3.414***	***
	$NPK_{50\%}$	11.705	33.575	186.84	31.677	170.62	41.977	258.61	12.04 d					
	$NPK_{75\%}$	19.429	52.407	169.74	38.678	99.07	50.151	158.12	$NPK_{50\%}$					
	$NPK_{100\%}$	40.466	70.250	73.60	52.723	30.29	75.119	85.63	24.52 c					
Gemmeza9	$NPK_{0\%}$	5.092	9.626	89.02	8.129	59.64	15.963	213.46	$NPK_{75\%}$	28.08a				
	$NPK_{50\%}$	10.202	24.933	144.39	17.944	75.88	24.176	136.96	38.07 b					
	$NPK_{75\%}$	16.960	43.089	154.05	29.901	76.30	53.973	218.23	$NPK_{100\%}$					
	$NPK_{100\%}$	25.615	53.581	109.18	46.544	81.70	63.513	147.95	52.22 a					
Mean of Inoc.		15.73d	37.43 b		30.32 c		43.38 a							
Parameter														
					N Uptake (kg/ha) EC: average 7.6 dSm^{-1}									
Sakha 93	$NPK_{0\%}$	2.208	6.735	205.04	4.630	109.72	8.020	263.27	$NPK_{0\%}$	16.32a	NS	2.716***	1.863***	***
	$NPK_{50\%}$	5.323	14.505	172.48	13.915	161.39	15.887	198.44	5.06 d					
	$NPK_{75\%}$	10.791	23.131	114.34	17.576	62.87	27.374	153.66	$NPK_{50\%}$					
	$NPK_{100\%}$	16.238	39.148	141.09	24.454	50.60	41.956	158.38	10.49 c					
Gemmeza9	$NPK_{0\%}$	2.549	5.950	133.45	4.715	84.98	7.835	207.42	$NPK_{75\%}$	14.83a				
	$NPK_{50\%}$	3.874	12.526	223.30	7.124	83.87	13.756	255.04	19.21 b					
	$NPK_{75\%}$	9.804	28.953	195.31	16.953	72.92	28.802	193.77	$NPK_{100\%}$					
	$NPK_{100\%}$	14.817	32.122	116.79	20.687	39.61	36.504	146.36	27.53 a					
Mean of Inoc.		5.64 d	20.38 b		13.76 c		22.52 a							
Parameter														
					N Uptake (kg/ha) EC: average 10.5 dSm^{-1}									
Sakha 93	$NPK_{0\%}$	1.464	2.025	38.34	1.890	29.14	4.703	221.33	$NPK_{0\%}$	8.92a	NS	2.695***	1.599***	**
	$NPK_{50\%}$	2.600	5.565	114.05	6.596	153.71	8.907	242.58	2.35 d					
	$NPK_{75\%}$	3.570	13.680	283.16	9.593	168.67	18.917	429.81	$NPK_{50\%}$					
	$NPK_{100\%}$	6.827	19.416	184.00	14.510	112.24	23.396	242.21	6.95 c					
Gemmeza9	$NPK_{0\%}$	1.517	2.972	95.93	1.832	20.77	4.381	188.87	$NPK_{75\%}$	8.41a				
	$NPK_{50\%}$	2.494	10.724	330.02	5.658	126.88	13.075	424.27	10.76 b					
	$NPK_{75\%}$	4.290	13.974	225.73	8.622	100.97	13.423	212.88	$NPK_{100\%}$					
	$NPK_{100\%}$	6.065	16.226	167.53	12.288	102.61	18.056	197.69	14.59 a					
Mean of Inoc.		3.35 d	10.57 b		7.62 c		13.11 a							

± % Increase or decrease to uninoculated (control) plants

Table (7). Effect of wheat inoculation with *Glomus intraradices* and Biotol on P uptake (kg/ha) in the presence of four levels of soil salinity (averages of the two seasons 2012/2013 and 2013/2014)

Cultivars	NPK Levels	Un-inoc.	AM	± %	Biotol	± %	AM+B	± %	Mean of NPK	Mean of Cultiv.	Cultiv.	NPK	Inoc.	Inoc.* NPK
Parameter												L.S.D.$_{0.05}$		
						P Uptake (kg/ha) EC: average 2.8 dSm^{-1}								
Sakha 93	$NPK_{0\%}$	1.388	4.457	221.02	2.875	107.07	5.087	266.46	$NPK_{0\%}$	8.60 a	NS	1.789***	1.292***	NS
	$NPK_{50\%}$	2.346	9.555	307.22	6.161	162.58	7.578	222.96	3.08 c					
	$NPK_{75\%}$	4.136	16.468	298.12	9.934	140.17	19.158	363.16	$NPK_{50\%}$					
	$NPK_{100\%}$	6.191	16.867	172.46	12.121	95.79	13.342	115.52	6.72 b					
Gemmeza 9	$NPK_{0\%}$	1.557	4.748	204.98	2.246	44.25	3.258	109.27	$NPK_{75\%}$	8.69 a				
	$NPK_{50\%}$	2.378	8.582	260.92	7.109	198.99	10.032	321.91	12.04 a					
	$NPK_{75\%}$	4.575	15.334	235.13	10.959	139.52	16.884	269.00	$NPK_{100\%}$					
	$NPK_{100\%}$	9.974	15.673	57.14	12.899	29.33	17.720	77.67	12.76 a					
Mean of Inoc.		3.46 c	11.46 a		8.04 b		11.63 a							
						P Uptake (kg/ha) EC: average 5.3 dSm^{-1}								
Sakha 93	$NPK_{0\%}$	0.427	0.934	118.72	1.114	160.89	1.988	365.77	$NPK_{0\%}$	3.43 a	NS	0.749***	0.368***	***
	$NPK_{50\%}$	0.863	3.272	278.96	2.617	203.12	3.332	286.00	0.95 d					
	$NPK_{75\%}$	1.655	5.343	222.88	4.044	144.39	5.812	251.19	$NPK_{50\%}$					
	$NPK_{100\%}$	2.418	7.898	226.59	5.416	123.97	7.748	220.42	2.29 c					
Gemmeza 9	$NPK_{0\%}$	0.333	0.679	103.86	0.616	84.97	1.481	344.72	$NPK_{75\%}$	2.96 a				
	$NPK_{50\%}$	0.974	2.797	187.03	1.735	78.08	2.694	176.41	4.14 b					
	$NPK_{75\%}$	1.785	4.729	164.98	3.188	78.61	6.579	268.60	$NPK_{100\%}$					
	$NPK_{100\%}$	2.131	5.894	176.54	4.871	128.55	6.926	224.99	5.41 a					
Mean of Inoc.		1.32 d	3.94 b		2.95 c		4.57 a							
						P Uptake (kg/ha) EC: average 7.6 dSm^{-1}								
Sakha 93	$NPK_{0\%}$	0.210	0.447	112.84	0.320	52.52	0.754	259.31	$NPK_{0\%}$	1.49 a	NS	0.434***	0.245***	***
	$NPK_{50\%}$	0.368	0.895	143.08	0.686	86.27	1.335	262.57	0.43 c					
	$NPK_{75\%}$	0.523	1.973	277.11	1.351	158.18	2.599	396.76	$NPK_{50\%}$					
	$NPK_{100\%}$	1.440	3.368	133.93	2.621	82.02	5.229	263.19	0.78 c					
Gemmeza 9	$NPK_{0\%}$	0.218	0.517	136.60	0.367	68.00	0.793	263.16	$NPK_{75\%}$	1.55 a				
	$NPK_{50\%}$	0.350	1.061	203.41	0.608	73.80	1.183	238.19	1.83 b					
	$NPK_{75\%}$	1.199	2.872	139.55	1.886	57.36	2.927	144.19	$NPK_{100\%}$					
	$NPK_{100\%}$	1.975	3.932	99.08	2.522	27.71	4.312	118.34	3.04 a					
Mean of Inoc.		0.52 d	1.88 b		1.29 c		2.39 a							
						P Uptake (kg/ha) EC: average 10.5 dSm^{-1}								
Sakha 93	$NPK_{0\%}$	0.074	0.118	59.69	0.101	37.25	0.254	244.17	$NPK_{0\%}$	0.76 a	NS	0.189***	0.171***	***
	$NPK_{50\%}$	0.197	0.541	175.02	0.411	108.77	0.612	211.18	0.16 d					
	$NPK_{75\%}$	0.433	1.262	191.45	0.647	49.41	2.012	364.76	$NPK_{50\%}$					
	$NPK_{100\%}$	0.649	1.753	170.26	1.077	66.02	2.242	245.65	0.58 c					
Gemmeza 9	$NPK_{0\%}$	0.081	0.269	233.48	0.137	70.18	0.323	300.20	$NPK_{75\%}$	0.79 a				
	$NPK_{50\%}$	0.288	0.921	219.95	0.464	61.22	1.299	351.36	1.05 b					
	$NPK_{75\%}$	0.415	1.462	252.18	0.799	92.50	1.661	300.35	$NPK_{100\%}$					
	$NPK_{100\%}$	0.646	1.479	128.87	0.998	54.38	1.757	171.88	1.29 a					
Mean of Inoc.		0.26 d	0.98 b		0.58 c		1.27 a							

± % Increase or decrease to uninoculated (control) plants

Table (8). Effect of wheat inoculation with *Glomus intraradices* and Biotol on K uptake (kg/ha) in the presence of four levels of soil salinity (averages of the two seasons 2012/2013 and 2013/2014)

Cultivars	NPK Levels	Un-inoc.	AM	± %	Biotol	± %	AM+B	± %	Mean of NPK	Mean of Cultiv.	Cultiv.	NPK	Inoc.	Inoc.* NPK
Parameter												L.S.D.$_{0.05}$		
						K Uptake (kg/ha) EC: average 2.8 dSm^{-1}								
Sakha 93	$NPK_{0\%}$	10.890	19.583	79.82	16.520	51.70	34.139	213.49	$NPK_{0\%}$	38.01 a	NS	11.407***	5.325***	***
	$NPK_{50\%}$	23.339	49.610	112.56	33.063	41.67	47.506	103.55	13.95 c					
	$NPK_{75\%}$	26.200	52.899	101.90	36.377	38.84	75.957	189.91	$NPK_{50\%}$					
	$NPK_{100\%}$	31.698	58.118	83.35	48.186	52.02	80.725	154.67	36.47 b					
Gemmeza 9	$NPK_{0\%}$	3.759	11.308	200.86	6.193	64.75	15.092	301.51	$NPK_{75\%}$	36.57 a				
	$NPK_{50\%}$	17.644	45.705	159.04	26.124	48.06	72.081	308.53	44.88ab					
	$NPK_{75\%}$	26.053	48.271	85.28	36.580	40.40	78.374	200.82	$NPK_{100\%}$					
	$NPK_{100\%}$	43.115	75.603	75.35	47.945	47.945	75.458	75.02	53.86 a					
Mean of Inoc.		12.61 d	45.14 b		31.37 c		60.04 a							
						K Uptake (kg/ha) EC: average 5.3 dSm^{-1}								
Sakha 93	$NPK_{0\%}$	2.140	3.866	80.67	2.879	34.57	8.242	285.19	$NPK_{0\%}$	8.99 a	NS	2.161***	1.421***	***
	$NPK_{50\%}$	5.187	11.707	125.69	7.974	53.73	11.795	127.39	3.00 d					
	$NPK_{75\%}$	6.183	11.238	81.76	8.280	33.92	17.382	181.14	$NPK_{50\%}$					
	$NPK_{100\%}$	8.932	14.925	67.10	11.488	28.61	20.732	132.10	7.47 c					
Gemmeza 9	$NPK_{0\%}$	0.882	1.531	73.57	0.999	13.19	2.302	160.88	$NPK_{75\%}$	8.63 a				
	$NPK_{50\%}$	2.641	8.261	212.84	3.994	51.27	11.569	338.13	10.92 b					
	$NPK_{75\%}$	5.774	12.106	109.66	8.335	44.35	19.075	230.34	$NPK_{100\%}$					
	$NPK_{100\%}$	10.229	20.165	97.14	13.590	32.86	19.742	93.00	13.85 a					
Mean of Inoc.		3.06 d	10.35 b		7.32 c		14.52 a							
						K Uptake (kg/ha) EC: average 7.6 dSm^{-1}								
Sakha 93	$NPK_{0\%}$	0.746	1.937	159.52	1.122	50.34	2.306	208.92	$NPK_{0\%}$	4.64 a	NS	1.272***	0.658***	***
	$NPK_{50\%}$	2.581	5.113	98.12	3.643	41.17	4.754	84.20	1.39 d					
	$NPK_{75\%}$	3.301	5.637	70.78	4.515	36.79	8.927	170.45	$NPK_{50\%}$					
	$NPK_{100\%}$	5.283	9.396	77.85	7.121	34.79	13.799	161.19	3.52 c					
Gemmeza 9	$NPK_{0\%}$	0.466	1.032	121.27	0.726	55.61	1.100	135.91	$NPK_{75\%}$	5.49 a				
	$NPK_{50\%}$	1.491	4.724	216.85	1.972	32.26	4.556	205.60	6.29 b					
	$NPK_{75\%}$	3.428	9.446	175.52	5.781	68.62	13.148	283.52	$NPK_{100\%}$					
	$NPK_{100\%}$	6.293	14.651	132.79	7.705	22.43	14.413	129.02	9.08 a					
Mean of Inoc.		1.30 d	6.49 b		4.07 c		8.42 a							
						K Uptake (kg/ha) EC: average 10.5 dSm^{-1}								
Sakha 93	$NPK_{0\%}$	0.318	0.509	59.70	0.398	27.98	0.792	148.65	$NPK_{0\%}$	2.19 a	NS	0.673***	0.497***	***
	$NPK_{50\%}$	1.072	2.075	93.65	1.602	49.53	2.164	101.99	0.57 d					
	$NPK_{75\%}$	1.739	2.962	70.36	2.024	16.41	5.563	219.93	$NPK_{50\%}$					
	$NPK_{100\%}$	2.133	4.124	93.29	3.036	42.30	6.655	211.92	1.89 c					
Gemmeza 9	$NPK_{0\%}$	0.260	0.532	104.31	0.281	7.83	0.730	180.65	$NPK_{75\%}$	2.44 a				
	$NPK_{50\%}$	0.784	2.551	225.24	1.297	65.34	2.607	232.36	2.85 b					
	$NPK_{75\%}$	1.622	3.846	137.14	2.151	32.62	4.452	174.53	$NPK_{100\%}$					
	$NPK_{100\%}$	2.663	5.929	122.66	3.307	24.19	6.138	130.50	3.95 a					
Mean of Inoc.		0.66 d	2.82 b		1.76 c		4.03 a							

± % Increase or decrease to uninoculated (control) plants

1000 grain weight

Results presented in Table (9) showed that the highest value of 1000 grain weight (g) was obtained from Gemmeza 9 plants inoculated with G. *intraradices* (54.59 g) under soil salinity level ≤4 dSm^{-1} and $NPK_{75\%}$. No significant differences were observed between NPK_{75} and $NPK_{100\%}$ mineral fertilizers. At soil salinity 8 – 12 dSm^{-1}, the 1000 grain weight were 40.92 and 35.98 g for plants inoculated with AM+Biotol under $NPK_{100\%}$ for Sakha 93 and Gemmeza 9, respectively.

Grain yield (t/ha)

Results presented in Table (10) indicated that, grain yield due to dual inoculation with *Glomus intraradices* and Biotol resulted the maximum yield of grain (6.723 t/ha) under soil salinity level ≤4 dSm^{-1} and $NPK_{100\%}$ in case of Gemmeza 9. No significant differences were observed between NPK_{75} and $NPK_{100\%}$ mineral fertilizers. When the soil salinity level increased to 8-12 dSm^{-1}, the wheat grain yield decreased. The grain yield was 1.991 t/ha in plants inoculated with AM+Biotol under $NPK_{100\%}$ for Sakha 93, while it was 1.710 t/ha for Gemmeza 9. Significant differences in the grain yield (t/ha) were found between the two wheat cultivars. Sakha 93 recorded highest value of grain yield, compared to Gemmeza 9 under high level of soil salinity.

Grain protein

Wheat plants Inoculated with *G. intraradices* alone or *G. intraradices* + Biotol resulted high values of protein content of wheat grains for both cultivars. Under normal salinity levels ≤4 dSm^{-1}, the highest grain protein content was obtained in case of plants inoculated with mycorrhizal fungus and Biotol (1.39 %) for Gemmeza variety at $NPK_{75\%}$. Under salinity level 8-12 dSm^{-1} the highest protein content was obtained from both cultivars in the presence of $NPK_{100\%}$ with percentage increases 36.31 and 43.96% more than un-inoculated plants, for Sakha 93 and Gemmeza 9, respectively. Significant differences in protein contents were found between the two cultivars, Gemmeza 9 recorded the highest value compared to Sakha 93 (Table 11).

Proline content

Significant differences in shoot proline contents among the two wheat cultivars were recorded by increasing soil salinity levels. Sakha 93 recorded higher values of proline than Gemmeza 9 (Table 12). Data clearly show positive effect of AM inoculation on proline content under the tested levels of soil salinity.

Salicylic acid

Dual inoculation with G. *intraradices* and Biotol significantly increased the salicylic acid concentration at all the tested levels of soil salinity. The percentage increases, as compared to uninoculated control was reached 192.57 and 135.42 for Sakha 93 and Gemmeza 9, respectively, in the presence of $NPK_{75\%}$ and soil salinity 8-12 dSm^{-1} (Table 13).

DISCUSSION

Salinity represents one of the most important environmental stresses since it limits crop plant production which is contrary to the increased demand for food all over the world. Therefore, the studies of salinity tolerance in plants consider a special importance. From the above results we concluded that, wheat inoculated with AM fungus showed significant increases in the percentage of AMF colonization and growth yield parameters compared to un-inoculated plants under different levels of soil salinity. It was clear that, by increasing soil salinity, the percentage of AMF colonization and growth yield parameters significantly decreased. Aroca *et al*. (2013) found that, increasing soil salinity levels lowered the percentage of mycorrhizal root colonization in lettuce plants. Miransari *et al*. (2007) observed that, Zea mays plant inoculated with AM fungi (*Glomus mosseae* and *Glomus etunicatum*)

Table (9). Effect of wheat inoculation with *Glomus intraradices* and Biotol on 1000 grains weight (g) in the presence of four levels of soil salinity (averages of the two seasons 2012/2013 and 2013/2014)

Cultivars	NPK Levels	Un-inoc.	AM		Biotol		AM+B		Mean of NPK	Mean of Cultiv.	Cultiv.	NPK	Inoc.	Inoc.* NPK
				± %		± %		± %						
Parameter			**1000 Grain Weight (g) EC: average 2.8 dSm^{-1}**									L.S.D.$_{0.05}$		
Sakha 93	$NPK_{0\%}$	36.39	42.83	17.70	44.33	21.83	46.91	28.92	$NPK_{0\%}$	47.14a	NS	3.363***	1.049***	NS
	$NPK_{50\%}$	41.03	48.34	17.83	48.03	17.08	48.97	19.36	42.54 c					
	$NPK_{75\%}$	43.89	50.21	14.40	48.22	9.85	53.35	21.54	$NPK_{50\%}$					
	$NPK_{100\%}$	46.14	51.54	11.70	50.16	8.70	53.85	16.72	46.61 b					
Gemmeza 9	$NPK_{0\%}$	38.46	44.37	15.35	42.65	10.88	44.45	15.56	$NPK_{75\%}$	47.99a				
	$NPK_{50\%}$	43.73	48.42	10.73	45.23	3.44	49.18	12.46	49.96ab					
	$NPK_{75\%}$	45.28	54.59	20.58	51.88	14.59	52.26	15.44	$NPK_{100\%}$					
	$NPK_{100\%}$	48.46	53.12	9.61	49.85	2.87	54.27	11.98	51.13 a					
Mean of Inoc.		43.13 d	47.54 c		49.17 b		50.40 a							
Parameter			**1000 Grain Weight (g) EC: average 5.3 dSm^{-1}**											
Sakha 93	$NPK_{0\%}$	34.75	37.08	6.70	36.29	4.44	39.40	13.38	$NPK_{0\%}$	44.69a	NS	1.646***	1.196***	NS
	$NPK_{50\%}$	38.81	44.74	15.28	41.79	7.67	47.81	23.18	36.44 d					
	$NPK_{75\%}$	42.50	49.41	16.27	46.13	8.55	52.01	22.38	$NPK_{50\%}$					
	$NPK_{100\%}$	46.17	52.92	14.62	50.51	9.39	54.73	18.53	44.51 c					
Gemmeza 9	$NPK_{0\%}$	33.33	36.18	8.56	37.03	11.10	37.50	12.50	$NPK_{75\%}$	45.32a				
	$NPK_{50\%}$	42.24	45.37	7.42	46.50	10.09	48.82	15.60	48.622b					
	$NPK_{75\%}$	47.39	50.24	6.00	49.86	5.20	51.45	8.55	$NPK_{100\%}$					
	$NPK_{100\%}$	46.72	50.57	8.24	48.81	4.47	53.14	13.74	50.45 a					
Mean of Inoc.		41.49d	45.81 b		44.61 c		48.11 a							
Parameter			**1000 Grain Weight (g) EC: average 7.6 dSm^{-1}**											
Sakha 93	$NPK_{0\%}$	26.56	32.42	22.07	30.18	13.65	34.67	30.52	$NPK_{0\%}$	37.17a	NS	1.661***	1.428***	NS
	$NPK_{50\%}$	29.09	34.32	20.04	33.32	14.56	39.16	34.62	30.65 d					
	$NPK_{75\%}$	33.44	40.91	22.37	39.40	17.85	42.29	26.49	$NPK_{50\%}$					
	$NPK_{100\%}$	39.74	42.54	7.04	47.47	19.44	48.61	22.31	33.81 c					
Gemmeza 9	$NPK_{0\%}$	26.46	30.73	16.17	31.35	18.49	32.82	24.06	$NPK_{75\%}$	35.71a				
	$NPK_{50\%}$	28.12	34.94	24.27	32.89	16.95	38.02	35.19	38.06 b					
	$NPK_{75\%}$	32.12	39.02	25.05	38.40	23.04	39.84	27.67	$NPK_{100\%}$					
	$NPK_{100\%}$	35.49	42.24	19.01	44.58	25.62	45.31	27.66	43.25 a					
Mean of Inoc.		31.26c	37.22 b		37.19 b		40.09 a							
Parameter			**1000 Grain Weight (g) EC: average 10.5 dSm^{-1}**											
Sakha 93	$NPK_{0\%}$	22.60	27.09	19.84	26.20	15.91	28.97	28.19	$NPK_{0\%}$	32.92a	NS	2.171***	1.098***	*
	$NPK_{50\%}$	23.39	35.03	49.76	32.61	39.39	35.83	53.18	26.43 c					
	$NPK_{75\%}$	30.37	37.42	23.21	36.02	18.59	39.33	29.50	$NPK_{50\%}$					
	$NPK_{100\%}$	33.08	39.71	20.03	38.13	15.24	40.92	23.67	30.82 b					
Gemmeza 9	$NPK_{0\%}$	21.87	28.67	31.12	26.28	20.18	29.77	36.15	$NPK_{75\%}$	30.80a				
	$NPK_{50\%}$	24.16	33.27	37.74	27.62	14.36	34.62	43.31	34.09 a					
	$NPK_{75\%}$	28.02	33.69	20.23	31.40	12.04	36.48	30.16	$NPK_{100\%}$					
	$NPK_{100\%}$	31.99	35.76	11.81	33.26	3.96	35.98	12.47	36.10 a					
Mean of Inoc.		26.94d	33.83 b		31.44 c		35.24 a							

± % Increase or decrease to uninoculated (control) plants

Table (10). Effect of wheat inoculation with *Glomus intraradices* and Biotol on grains yield (t/ha) in the presence of four levels of soil salinity (averages of the two seasons 2012/2013 and 2013/2014)

Cultivars	NPK Levels	Un-inoc.	AM		Biotol		AM+B		Mean of NPK	Mean of Cultiv.	Cultiv.	NPK	Inoc.	Inoc.* NPK
			± %		± %		± %							
Parameter			**Grains Yield (t/ha) EC: average 2.8 dSm^{-1}**									L.S.D.$_{0.05}$		
Sakha 93	$NPK_{0\%}$	2.248	3.013	34.03	3.183	41.59	3.263	45.15	$NPK_{0\%}$					
	$NPK_{50\%}$	3.391	4.704	38.72	4.379	29.14	5.159	52.14	2.74 c					
	$NPK_{75\%}$	4.235	6.132	44.79	4.858	14.71	6.309	48.97	$NPK_{50\%}$	4.66a				
	$NPK_{100\%}$	4.644	6.583	41.75	5.082	9.43	6.543	40.89	4.11 b					
Gemmeza 9	$NPK_{0\%}$	1.731	2.849	64.59	2.468	42.57	3.127	80.65	$NPK_{75\%}$		NS	0.559***	0.299***	**
	$NPK_{50\%}$	2.981	4.474	50.08	3.735	25.29	4.062	36.26	5.69 a					
	$NPK_{75\%}$	4.736	6.304	33.11	5.633	18.94	6.095	28.69	$NPK_{100\%}$	4.50a				
	$NPK_{100\%}$	5.216	6.468	24.00	6.209	19.04	6.723	28.89	5.79 a					
Mean of Inoc.		3.374 c	5.165 a		4.505 b		5.285 a							
Parameter			**Grains Yield (t/ha) EC: average 5.3 dSm^{-1}**											
Sakha 93	$NPK_{0\%}$	1.570	2.722	73.37	2.483	58.15	2.517	60.32	$NPK_{0\%}$					
	$NPK_{50\%}$	2.537	3.455	36.18	3.194	25.89	3.517	38.63	2.36 c					
	$NPK_{75\%}$	3.412	5.358	57.03	3.859	13.10	5.723	67.73	$NPK_{50\%}$	3.62a				
	$NPK_{100\%}$	3.865	5.101	31.98	4.661	20.59	5.593	44.71	3.22 b					
Gemmeza 9	$NPK_{0\%}$	1.729	2.596	50.14	2.554	47.72	2.780	60.78	$NPK_{75\%}$		NS	0.624***	0.269***	**
	$NPK_{50\%}$	2.747	3.754	36.66	3.160	15.03	4.140	50.71	4.43 a					
	$NPK_{75\%}$	3.252	5.303	63.07	3.941	21.18	5.156	58.55	$NPK_{100\%}$	3.73a				
	$NPK_{100\%}$	3.966	5.200	31.11	4.276	7.82	5.749	44.95	4.70 a					
Mean of Inoc.		2.64 c	4.18 a		3.15 b		4.39 a							
Parameter			**Grains Yield (t/ha) EC: average 7.6 dSm^{-1}**											
Sakha 93	$NPK_{0\%}$	0.888	1.340	50.90	10.92	22.97	1.457	64.08	$NPK_{0\%}$					
	$NPK_{50\%}$	1.144	1.629	42.39	1.307	14.25	1.759	53.75	1.19 c					
	$NPK_{75\%}$	١.688	1.935	14.63	1.823	7.99	1.808	7.11	$NPK_{50\%}$	1.79a				
	$NPK_{100\%}$	2.300	2.830	23.04	2.425	5.43	2.940	27.83	1.51 b					
Gemmeza 9	$NPK_{0\%}$	0.771	1.055	36.84	1.266	64.20	1.316	70.68	$NPK_{75\%}$		NS	0.337***	0.149***	***
	$NPK_{50\%}$	1.094	1.686	54.11	1.362	24.49	1.755	60.42	1.64 b					
	$NPK_{75\%}$	1.375	1.744	26.84	1.732	25.96	1.777	29.34	$NPK_{100\%}$	1.71a				
	$NPK_{100\%}$	1.885	2.195	16.45	2.095	11.14	2.285	21.22	2.67 a					
Mean of Inoc.		1.15 c	1.92 b		1.78 b		2.15 a							
Parameter			**Grains Yield (t/ha) EC: average 10.5 dSm^{-1}**											
Sakha 93	$NPK_{0\%}$	0.601	0.907	50.92	0.877	45.92	1.054	75.37	$NPK_{0\%}$					
	$NPK_{50\%}$	0.930	1.268	36.34	1.059	13.87	1.210	30.11	0.832 b					
	$NPK_{75\%}$	1.266	1.886	48.97	1.887	49.05	1.950	54.03	$NPK_{50\%}$	1.39a				
	$NPK_{100\%}$	1.354	1.828	35.01	1.824	34.71	1.991	47.05	1.08 b					
Gemmeza 9	$NPK_{0\%}$	0.541	0.764	41.22	0.818	51.20	0.853	57.67	$NPK_{75\%}$		0.231*	0.253***	0.089***	*
	$NPK_{50\%}$	0.852	1.149	34.86	0.907	6.45	1.262	48.12	1.43 a					
	$NPK_{75\%}$	0.941	1.246	32.41	0.958	1.81	1.383	46.97	$NPK_{100\%}$	1.08b				
	$NPK_{100\%}$	1.223	1.684	37.69	1.488	21.67	1.710	39.82	1.64 a					
Mean of Inoc.		0.899 d	1.37 b		1.21 c		1.49 a							

± % Increase or decrease to uninoculated (control) plants

Table (11). Effect of wheat inoculation with *Glomus intraradices* and Biotol on Protein (%) in the presence of different levels of soil salinity (averages of the two seasons 2012/2013 and 2013/2014)

Cultivars	NPK Levels	Un-inoc.	AM		Biotol		AM+B		Mean of NPK	Mean of Cultiv.	Cultiv.	NPK	Inoc.	Inoc.* NPK
				± %		± %		± %						
Parameter			Grain Protein (%) EC: average 2.8 dSm^{-1}									L.S.D.$_{0.05}$		
Sakha 93	$NPK_{0\%}$	0.47	0.81	72.50	0.71	51.67	0.84	78.62	$NPK_{0\%}$	0.95 a	NS	0.125***	0.056***	NS
	$NPK_{50\%}$	0.65	0.95	44.69	0.89	35.64	0.99	50.94	0.73c					
	$NPK_{75\%}$	0.78	1.25	59.73	1.06	34.88	1.25	59.73	$NPK_{50\%}$					
	$NPK_{100\%}$	0.92	1.23	33.12	1.16	25.86	1.27	37.38	0.92b					
Gemmeza 9	$NPK_{0\%}$	0.59	0.84	41.53	0.71	20.03	0.85	44.18	$NPK_{75\%}$	1.04 a				
	$NPK_{50\%}$	0.79	1.03	29.38	0.98	23.77	1.08	36.54	1.15a					
	$NPK_{75\%}$	1.04	1.30	25.22	1.16	11.70	1.39	34.17	$NPK_{100\%}$					
	$NPK_{100\%}$	1.03	1.33	29.60	1.18	14.47	1.38	33.86	1.18a					
Mean of Inoc.		0.78 c	1.09 a		0.98 b		1.13 a							
Parameter			Grain Protein (%) EC: average 5.3 dSm^{-1}											
Sakha 93	$NPK_{0\%}$	0.31	0.52	68.93	0.47	53.28	0.75	140.96	$NPK_{0\%}$	0.79 b	0.089*	0.112***	0.065***	NS
	$NPK_{50\%}$	0.50	0.89	77.35	0.79	57.50	0.83	65.57	0.57c					
	$NPK_{75\%}$	0.70	1.02	46.47	0.83	18.47	1.03	47.89	$NPK_{50\%}$					
	$NPK_{100\%}$	0.87	1.07	23.66	1.02	17.80	1.12	29.57	0.79b					
Gemmeza 9	$NPK_{0\%}$	0.38	0.67	74.60	0.64	66.20	0.81	113.15	$NPK_{75\%}$	0.92 a				
	$NPK_{50\%}$	0.64	0.94	46.22	0.79	23.20	1.01	57.90	0.97a					
	$NPK_{75\%}$	0.88	1.15	31.25	1.09	24.58	1.12	28.03	$NPK_{100\%}$					
	$NPK_{100\%}$	0.91	1.30	43.09	1.08	18.80	1.27	39.46	1.07a					
Mean of Inoc.		0.65 c	0.94 a		0.84 b		0.99 a							
Parameter			Grain Protein (%) EC: average 7.6 dSm^{-1}											
Sakha 93	$NPK_{0\%}$	0.24	0.46	95.97	0.37	55.96	0.59	150.22	$NPK_{0\%}$	0.65 a	NS	0.043***	0.042***	NS
	$NPK_{50\%}$	0.39	0.59	49.35	0.49	24.49	0.68	72.42	0.49d					
	$NPK_{75\%}$	0.56	0.89	58.35	0.73	30.89	0.89	58.73	$NPK_{50\%}$					
	$NPK_{100\%}$	0.71	0.96	36.03	0.84	19.33	1.03	45.80	0.57c					
Gemmeza 9	$NPK_{0\%}$	0.42	0.65	56.73	0.55	32.64	0.69	64.86	$NPK_{75\%}$	0.72 a				
	$NPK_{50\%}$	0.49	0.73	48.94	0.55	11.29	0.69	41.52	0.79b					
	$NPK_{75\%}$	0.66	0.88	32.39	0.82	23.29	0.96	44.17	$NPK_{100\%}$					
	$NPK_{100\%}$	0.73	0.92	25.50	0.84	15.23	0.95	30.76	0.87a					
Mean of Inoc.		0.52 d	0.76 b		0.65 c		0.81 a							
Parameter			Grain Protein (%) EC: average 10.5 dSm^{-1}											
Sakha 93	$NPK_{0\%}$	0.18	0.31	68.17	0.26	42.00	0.31	68.17	$NPK_{0\%}$	0.38 a	NS	0.044***	0.022***	NS
	$NPK_{50\%}$	0.28	0.40	45.91	0.37	34.91	0.40	45.52	0.28c					
	$NPK_{75\%}$	0.36	0.45	25.30	0.37	3.56	0.47	31.83	$NPK_{50\%}$					
	$NPK_{100\%}$	0.40	0.53	34.93	0.45	14.51	0.54	36.31	0.36b					
Gemmeza 9	$NPK_{0\%}$	0.22	0.32	45.74	0.30	35.83	0.35	60.90	$NPK_{75\%}$	0.39 a				
	$NPK_{50\%}$	0.27	0.38	39.19	0.34	27.40	0.42	54.47	0.40b					
	$NPK_{75\%}$	0.37	0.40	9.60	0.37	1.55	0.42	15.46	$NPK_{100\%}$					
	$NPK_{100\%}$	0.44	0.60	36.51	0.50	14.22	0.63	43.96	0.51a					
Mean of Inoc.		0.31c	0.42a		0.37b		0.44a							

± % Increase or decrease to uninoculated (control) plants

Table (12). Effect of wheat inoculation with *Glomus intraradices* and Biotol on proline (mg/100 g shoot dry wt.) in the presence of four levels of soil salinity (averages of the two seasons 2012/2013 and 2013/2014)

Cultivars	NPK Levels	Un-inoc.	AM	± %	Biotol	± %	AM+B	± %	Mean of NPK	Mean of Cultiv.	Cultiv.	NPK	Inoc.	Inoc.* NPK
Parameter		Proline content (mg/100 g shoot dry wt.) EC: average 2.8 dSm^{-1}										L.S.D.$_{0.05}$		
Sakha 93	$NPK_{0\%}$	42.73	59.65	39.60	59.07	38.24	64.92	51.93	$NPK_{0\%}$	85.54a	NS	9.167***	4.981***	*
	$NPK_{50\%}$	63.68	83.15	30.58	73.31	15.13	89.04	39.82	57.47d					
	$NPK_{75\%}$	74.76	109.86	46.95	89.15	19.24	111.76	49.49	$NPK_{50\%}$					
	$NPK_{100\%}$	86.17	123.43	43.23	108.70	26.14	129.39	50.15	84.16c					
Gemmeza 9	$NPK_{0\%}$	47.98	60.37	25.84	62.24	29.74	62.75	30.79	$NPK_{75\%}$	92.12a				
	$NPK_{50\%}$	68.35	103.67	51.67	84.02	22.93	108.07	58.11	101.77b					
	$NPK_{75\%}$	77.11	117.44	52.29	107.48	39.37	126.63	64.21	$NPK_{100\%}$					
	$NPK_{100\%}$	98.42	121.09	23.03	109.26	11.01	119.05	20.96	111.94a					
Mean of Inoc.		69.90c	97.33 a		86.65 b		101.45 a							
Parameter		Proline content (mg/100 g shoot dry wt.) EC: average 5.3 dSm-1												
Sakha 93	$NPK_{0\%}$	36.81	53.70	45.90	47.72	29.64	58.63	59.28	$NPK_{0\%}$	82.78 a	NS	8.613***	3.055***	NS
	$NPK_{50\%}$	56.92	74.18	30.33	72.08	26.64	87.90	54.42	49.41 c					
	$NPK_{75\%}$	78.48	111.27	41.77	92.79	18.23	125.87	60.38	$NPK_{50\%}$					
	$NPK_{100\%}$	85.32	113.50	33.03	99.66	16.81	129.69	52.01	69.89 b					
Gemmeza 9	$NPK_{0\%}$	38.66	53.39	38.10	49.08	26.94	57.29	48.18	$NPK_{75\%}$	76.65 a				
	$NPK_{50\%}$	45.56	79.14	73.71	66.53	46.05	76.82	68.62	96.44 a					
	$NPK_{75\%}$	80.10	94.62	18.13	88.92	11.01	99.49	24.21	$NPK_{100\%}$					
	$NPK_{100\%}$	89.89	99.91	11.14	100.48	11.78	106.52	18.50	103.12 a					
Mean of Inoc.		63.97d	84.96 b		77.16 c		92.78 d							
Parameter		Proline content (mg/100 g shoot dry wt.) EC: average 7.6 dSm^{-1}												
Sakha 93	$NPK_{0\%}$	29.05	38.85	33.70	32.51	11.88	40.24	38.50	$NPK_{0\%}$	49.75 a	10.863*	7.424***	2.644***	NS
	$NPK_{50\%}$	28.86	40.46	40.22	38.72	34.19	43.12	49.44	30.33 b					
	$NPK_{75\%}$	46.26	65.57	41.72	59.14	27.83	69.08	49.31	$NPK_{50\%}$					
	$NPK_{100\%}$	55.05	73.04	32.67	62.00	12.62	74.07	34.54	34.53 b					
Gemmeza 9	$NPK_{0\%}$	17.90	28.00	56.44	25.34	41.55	30.72	71.65	$NPK_{75\%}$	37.49 b				
	$NPK_{50\%}$	21.00	35.50	69.02	31.46	49.81	37.09	76.59	52.13 a					
	$NPK_{75\%}$	31.90	50.61	58.69	42.60	33.57	51.86	62.60	$NPK_{100\%}$					
	$NPK_{100\%}$	43.79	52.03	18.81	46.55	6.29	53.59	22.36	57.52 a					
Mean of Inoc.		34.23c	48.01 a		42.29 b		49.97 a							
Parameter		Proline content (mg/100 g shoot dry wt.) EC: average 10.5 dSm^{-1}												
Sakha 93	$NPK_{0\%}$	25.36	28.44	12.13	28.06	10.64	31.23	23.13	$NPK_{0\%}$	37.83 a	10.852*	2.652***	0.997***	*
	$NPK_{50\%}$	28.26	37.30	32.01	36.95	30.76	40.87	44.61	24.25 d					
	$NPK_{75\%}$	34.44	45.85	33.13	39.76	15.43	47.74	38.60	$NPK_{50\%}$					
	$NPK_{100\%}$	36.81	49.34	34.04	45.29	23.05	49.65	34.90	29.72 c					
Gemmeza 9	$NPK_{0\%}$	16.23	21.08	29.88	19.29	18.85	24.32	49.79	$NPK_{75\%}$	25.50 b				
	$NPK_{50\%}$	19.40	25.01	28.93	22.51	16.08	27.50	41.76	34.39 b					
	$NPK_{75\%}$	22.34	28.60	28.03	25.70	15.06	30.72	37.54	$NPK_{100\%}$					
	$NPK_{100\%}$	27.12	33.00	21.68	30.46	12.34	34.75	28.13	38.30 a					
Mean of Inoc.		26.24d	33.58 b		31.00 c		35.85 a							

± % Increase or decrease to uninoculated (control) plants

Table (13). Effect of wheat inoculation with *Glomus intraradices* and Biotol on salicylic acid (mg/100g root fresh wt.) in the presence of four levels of soil salinity (averages of the two seasons 2012/2013 and 2013/2014)

Cultivars	NPK Levels	Un-inoc.	AM		Biotol		AM+B		Mean of NPK	Mean of Cultiv.	Cultiv.	NPK	Inoc.	Inoc.* NPK
			± %		± %		± %							
Parameter		Salicylic Acid (mg/100g root fresh wt.) EC: average 2.8 dSm^{-1}										L.S.D.$_{0.05}$		
Sakha 93	$NPK_{0\%}$	35.75	72.64	103.21	65.64	84.22	74.38	108.07	$NPK_{0\%}$	97.11a	NS	35.014***	13.003**	NS
	$NPK_{50\%}$	54.92	82.10	49.49	72.47	31.96	82.50	50.21	58.00 c					
	$NPK_{75\%}$	57.13	108.62	90.14	84.44	47.81	130.32	128.11	$NPK_{50\%}$					
	$NPK_{100\%}$	106.39	174.74	64.25	154.61	45.33	196.84	85.03	80.37 bc					
Gemmeza 9	$NPK_{0\%}$	32.62	63.88	95.81	52.28	60.24	66.69	104.13	$NPK_{75\%}$	97.84a				
	$NPK_{50\%}$	58.05	105.97	82.56	73.14	26.00	113.79	96.03	106.39 b					
	$NPK_{75\%}$	61.83	141.96	129.61	98.83	59.85	168.01	171.74	$NPK_{100\%}$					
	$NPK_{100\%}$	88.61	150.16	69.46	123.57	39.46	166.19	87.55	145.14 a					
Mean of Inoc.		61.91 c	112.51 a		90.65 b		124.83 a							
Parameter		Salicylic Acid (mg/100g root fresh wt.) EC: average 5.3 dSm^{-1}												
Sakha 93	$NPK_{0\%}$	33.10	48.91	47.74	42.87	29.51	55.36	67.22	$NPK_{0\%}$	91.42a	NS	23.330***	12.128***	***
	$NPK_{50\%}$	45.56	79.45	74.40	59.44	30.47	99.69	118.84	42.14 c					
	$NPK_{75\%}$	59.25	134.68	127.32	107.42	81.31	160.75	171.33	$NPK_{50\%}$					
	$NPK_{100\%}$	74.91	153.53	104.96	119.63	59.70	188.15	151.17	77.22 b					
Gemmeza 9	$NPK_{0\%}$	32.97	38.26	16.05	39.48	19.73	46.17	40.04	$NPK_{75\%}$	99.76a				
	$NPK_{50\%}$	44.85	114.91	156.22	60.41	34.69	113.44	152.94	123.41 a					
	$NPK_{75\%}$	76.89	159.55	107.50	114.46	48.85	174.30	126.68	$NPK_{100\%}$					
	$NPK_{100\%}$	90.23	162.42	80.01	144.60	60.26	183.26	103.11	139.59 a					
Mean of Inoc.		57.22 d	111.46 b		86.04 c		127.64 a							
Parameter		Salicylic Acid (mg/100g root fresh wt.) EC: average 7.6 dSm^{-1}												
Sakha 93	$NPK_{0\%}$	22.50	41.18	83.03	32.74	45.53	41.27	83.43	$NPK_{0\%}$	66.53 a	NS	13.41***	11.041***	NS
	$NPK_{50\%}$	26.62	86.62	225.39	58.16	118.50	102.01	283.19	34.48 c					
	$NPK_{75\%}$	40.10	93.54	133.27	73.48	83.26	102.87	156.54	$NPK_{50\%}$					
	$NPK_{100\%}$	62.08	100.06	61.17	72.02	16.01	109.29	76.05	59.54 b					
Gemmeza 9	$NPK_{0\%}$	19.32	40.05	107.26	29.31	51.67	49.46	155.94	$NPK_{75\%}$	64.32a				
	$NPK_{50\%}$	28.43	68.32	140.34	38.82	36.56	67.37	136.99	80.84 a					
	$NPK_{75\%}$	43.23	100.32	132.05	65.72	52.00	127.44	194.76	$NPK_{100\%}$					
	$NPK_{100\%}$	67.87	108.53	59.91	71.93	5.98	138.23	103.66	86.84 a					
Mean of Inoc.		38.77 c	78.49 a		55.27 b		89.16 a							
Parameter		Salicylic Acid (mg/100g root fresh wt.) EC: average 10.5 dSm^{-1}												
Sakha 93	$NPK_{0\%}$	14.05	36.06	55.88	25.34	43.68	39.46	120.07	$NPK_{0\%}$	54.93a	5.640*	9.861***	5.916***	*
	$NPK_{50\%}$	22.95	51.32	86.05	42.08	29.71	51.70	99.60	24.39 d					
	$NPK_{75\%}$	39.70	81.47	120.61	58.20	51.32	93.46	192.57	$NPK_{50\%}$					
	$NPK_{100\%}$	55.87	90.49	90.01	91.17	45.29	90.57	116.21	35.55 c					
Gemmeza 9	$NPK_{0\%}$	14.18	22.11	156.74	20.38	80.37	32.22	180.95	$NPK_{75\%}$	42.75b				
	$NPK_{50\%}$	18.91	35.18	123.63	24.53	83.36	37.75	125.29	60.88 b					
	$NPK_{75\%}$	28.02	61.83	105.21	42.41	46.60	81.99	135.42	$NPK_{100\%}$					
	$NPK_{100\%}$	41.18	78.24	61.97	59.83	63.19	89.03	62.11	74.54 a					
Mean of Inoc.		28.39 d	57.09 b		45.49 c		64.39 a							

± % Increase or decrease to uninoculated (control) plants

Showed significant increases in shoot and root dry weights and root length compared to uninoculated plants under field conditions. The results also show that, the lowest values of Na contents (mg/kg) were observed under EC ≤4 dSm-1 for plants inoculated with *G. intraradices* and Biotol under NPK100% for Sakha 93 and Gemmeza 9. The increased photosynthetic pigments by mycorrhizal colonization in plants is due to the inhibition of Na+ transport, which leads to better functioning of photosynthetic machinery (Borde *et al*. 2010; García-Garrido and Ocampo, 2002). Ragab *et al*. (2008) reported that, when irrigation wheat plants with different levels of salinity led to an increase in the concentration of the sodium component of wheat plants, and decrease NPK uptake, 1000 grain wt. and grain yield compared to wheat plants growing in low salinity. Daughtry *et al*. (2000) and Bojović and Markovic (2009), indicated that, inoculated wheat plant *Triticum aestivum* with AM fungi significantly increased chlorophyll content compared to un-inoculated plants. Since mycorrhization increases the absorption of Mg++ in plants, the synthesis of chlorophyll increases in mycorrhizal plants. Increasing chlorophyll activity in AM-inoculated plants decreases Na+ level under salt stress. The results also show that, inoculation with the AM fungus and Biotol, significantly increased proline and salicylic acid content when compared to uninoculated ones under different levels of soil salinity. Proline accumulation is one of the natural means to adapt to environmental stress conditions. Proline is a non-toxic and good osmolyte and maintains the osmoregulation under salt stress (Rasool *et al*. 2013a, b). Kumar *et al*. (2011) reported that, wheat plant inoculated with *Glomus mosseae* contained increased proline levels compared to non inoculated plants. Salicylic acid (SA), a plant phenolic, is considered as a hormone like endogenous regulator, and its role in the defence mechanisms against biotic and abiotic stresses has been well characterized, (Szalai *et al*. 2009). It also plays an important role in plant growth and plant defense responses to pathogen attack local (hypersensitive response) and systemic acquired resistance, (Durner and Klessig 1996). Zhang *et al*. (2013) reported that, inoculated wheat plants with AM fungi significantly increased salicylic acid contents compared to non AM-inoculated plants. Wheat plants Inoculated with *G. intraradices* alone or *G. intraradices* + Biotol resulted high values of NPK uptake, grain yield and protein contents of wheat grains for both cultivars. Zhu *et al*. (2010) and Mardukhi *et al*. (2011) reported that, wheat plant inoculated with AM fungi significantly increased NPK uptake compared to non AM-inoculated wheat plants. Sari, *et al.* (2002) reported similar results in garlic plants. Douds *et al.* (2005) and Ortas *et al.* (2001) confirmed that the AM hyphae increase the total absorption surface in infected plants which improve its access of immobile elements such as P, Cu, Zn. Kumar *et al.* (2011) and Bojović and Marković (2009) showed that, inoculated wheat plant with AM fungi showed significant increase in 1000 grain weight and grain yield compared to un-inoculated plants. Mycorrhizal colonization can enhance K+ absorption under saline conditions (Sharifi *et al.* 2007; Zuccarini and Okurowska, 2008). Nia *et al.* (2012) reported that, wheat plants inoculated with two *Azospirillum* isolates increased salinity tolerance, the saline-adapted isolate significantly increased grain yield. Afzal and Bano (2008), indicated that, wheat plant *Triticum aestivum* inoculated with *Rhizobium* strains significantly increased in grain yield, P content and protein content compared to uninoculated plants. Richardson *et al.* (2009),

showed that, plants inoculated of with Bacillus and Paenibacillus increased plant growth parameters compared to un-inoculated plants.

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الملخص العربي

امكانية استخدام فطر *Glomus intraradices* وعزلات مختلفة من البكتيريا المنشطة للجذور النباتية (Biotol) لتحسين محصول وجودة القمح النامي في الحقل تحت مستويات مختلفة من ملوحة التربة الجيرية

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تم إجراء تجربتان حقليتان خلال الموسمين الشتويين ٢٠١٢/٢٠١٣ و٢٠١٣/٢٠١٤ بالمزرعة البحثية لمحطة البحوث الزراعية بالنوبارية (الأراضي الجيرية). بهدف دراسة تأثير التلقيح بفطر الميكوريزا الداخلية وبكتريا الجذور المحفزة لنمو النبات (مستحضر البيوتول) تحت أربعة مستويات من ملوحة التربة وأربعة معدلات من التسميد المعدني بعناصر النيتروجين والفوسفور والبوتاسيوم علي النمو ، الصفات المحصولية ، المحتوي الكيميائي لصنفين من القمح (سخا ٩٣ وجميزة ٩) تحت ظروف التربة الجيرية. اشارت النتائج الي ان تلقيح نباتات القمح بفطر الميكوريزا ومستحضر البيوتول معا ادي الي تقليل تركيز عنصر الصوديوم في النباتات لدرجة معنوية وزيادة امتصاص عناصر النيتروجين والفوسفور والبوتاسيوم وايضا محتوي النباتات من البرولين ، حمض السليسليك ، الكلوروفيل ومحتوي الحبوب من البروتين تحت المستويات المختلفة من ملوحة التربة بالمقارنة بالنباتات غير الملقحة. تحت مستوي ملوحة التربة العادي ($\leq$4 dSm^{-}) [1] أدي التلقيح بفطر الميكوريزا و البيوتول معا الي الحصول علي أعلي قيم لمحصول حبوب القمح (٦.٥ و ٦.٧ طن/هكتار) للأصناف سخا ٩٣ وجميزة ٩ علي التوالي عند مستوي تسميد معدني $NPK_{100\%}$ الموصي به في منطقة النوبارية بزيادة قدرها ٤١ و ٢٩ % عن النباتات غير الملقحة. أظهرت النتائج ايضا عدم وجود اختلافات معنوية بين النباتات الملقحة بالميكوريزا والبكتيريا المنشطة لنمو النبات عند مستوي تسميد معدني ٧٥ أو١٠٠% من المعدلات الموصي بها من الأسمدة المعدنية NPK . ويمكن استخلاص أن التلقيح بفطر الميكوريزا ومخصب البيوتول يحسن من النمو وانتاجية نباتات القمح تحت تأثير الإجهاد الملحي.

Estimating the Effect of Wastage in The Most Important Egyptian Crops of Fruits and Vegetables on Its Export Returns

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ABSTRACT: The wastage in the agricultural crops is one of the most Important problems in the agricultural sector it causes a number of negative effects, especially in the Egyptian agricultural exports sector. The decrease in the revenues of the agricultural exports in a relatively large amount is the main negative effect of the waste problem. The results of research showed that the Egyptian exports of orange and potatoes ranked the third and fourth respectively among the main agricultural exports during the period 2000-2011. The average value of Egyptian orange and potatoes exports estimated of about million 176.5 and 97 US$ respectively during 2000-2011 with value share of about 10% and 5% in the total agricultural exports value which estimated of about billion 1.8US$ during the same period. The results of analysis showed that the average wastage of the Egyptian oranges during 1980-2011 reached about 202 thousand tons, with value of about million 76 US$. The results also showed that the average predicted quantity of orange exports during the period 2012-2020 estimated of about 383 thousand tons with predicted value of about million 173US$, whereas the average quantity of potatoes exports the during the period 1980-2011 estimated of about 213 thousand tons with an average value estimated of about million 57US$.The predicted quantity of Egyptian potatoes exports during 2012-2020 estimated of about 643 thousand tons with value predicted of about million 186 US$. The main recommendation of the research could be summered as follows:

- Discussing the problem of wastage in the agricultural crops, through preparing detailed studies, dealing with the waste definition, its nature (quantitative and qualitative), the most important causes and the proposed methods for solving the problem.
- Discussing the suggested methods for solving the problem of wastage in the agricultural crops, from the economic point of view, through preparing the Cost/Benefit analysis for each method.

Keywords: Forecasting; ARIMA; Returns of Exports; Egyptian Fruits and Vegetables.

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الخلاصة والتوصيات

تعد مشكلة الفاقد في المحاصيل الزراعية بصفة عامة ومحاصيل التصدير من الخضر والفاكهة علي وجه الخصوص من أهم المشاكل التي يعاني منها المقتصد الزراعي المصري، حيث يؤدي ذلك الفاقد إلي إنخفاض كبير نسبياً في فائض الإنتاج المتاح للتصدير من تلك المحاصيل، الأمر الذي يؤثر سلباً علي عوائد صادراتها. ولقد أوضحت نتائج البحث أن محصولي البرتقال والبطاطس المصرية إحتلا المرتبة الثالثة والرابعة علي التوالي من حيث الأهمية النسبية مقارنةً بمحاصيل التصدير الزراعية الأخري خلال الفترة ٢٠٠٠-٢٠١١م بمتوسط قيمة بلغ حوالي ١٧٦.٥، ٩٧ مليون دولار لكل منهما علي الترتيب يمثل حوالي ١٠%، ٥% من متوسط قيمة الصادرات الزراعية المصرية والبالغ نحو ١.٨ مليار دولار خلال نفس الفترة. كما أشارت نتائج التحليل الإحصائي للبيانات أن متوسط كمية الفاقد من البرتقال المصري خلال فترة الدراسة بلغ حوالي ٢٠٢ ألف طن ، تقدر قيمتها بحوالي ٧٦ مليون دولار (بأسعار صادرات تلك الفترة)، في حين أوضحت نتائج التنبؤ بكمية الفاقد من البرتقال خلال الفترة ٢٠١٢- ٢٠٢٠م أن متوسط تلك الكمية قدر بحوالي ٣٨٣ ألف طن، تقدر قيمتها بحوالي ١٧٣ مليون دولار (بأسعار صادرات البرتقال التي تم التنبؤ بها خلال فترة التنبؤ). أما بالنسبة لمحصول البطاطس فأوضحت النتائج أن متوسط كمية الفاقد في هذا المحصول خلال الفترة ١٩٨٠-٢٠١١م بلغ حوالي ٢١٣ ألف طن بمتوسط قيمة بلغ حوالي ٥٧ مليون دولار، في حين أشارت تنبؤات الفاقد خلال الفترة ٢٠١٢-٢٠٢٠م إلي أن متوسط كمية الفاقد من محصول البطاطس المصرية قدر بحوالي ٦٤٣ ألف طن، تقدر قيمتها بحوالي ١٨٦ مليون دولار.

ونظراً لما أوضحته النتائج السابقة من ضخامة الفاقد الحالي والمتنبأ به في محصولي البرتقال والبطاطس المصرية، ولضمان العمل علي تقليل الفاقد إلي أقل قدر ممكن بحيث يمكن زيادة المتاح للتصدير من كلا المحصولين و من ثم زيادة حصيلة النقد الأجنبي المتوقعة منهما فإن البحث يوصي بضرورة علاج مشكلة الفاقد في المحاصيل الزراعية بصفة عامة ومحاصيل التصدير علي وجه الخصوص، علي أن يتم ذلك في إطار مشروع قومي متكامل يهتم بدراسة الجوانب النظرية والتطبيقية لتلك المشكلة من خلال اتخاذ تدابير من أهمها:

١- إعداد دراسات تفصيلية لمشكلة الفاقد في المحاصيل الزراعية من حيث مفهومة وطبيعته (كمي – نوعي)، ومراحله وأسبابه وأهم طرق العلاج المقترحة لتلك المشكلة.
٢- إعداد دراسات قياسية تتناول البحث في أهم طرق التنبؤ التي يمكن استخدامها لتقدير الفاقد في المحاصيل الزراعية المختلفة وتحديد أفضل تلك الطرق وأنسبها من خلال حساب مقاييس الأفضليه الخاصة بها.
٣- الاهتمام بالشق الاقتصادي لمشكلة الفاقد والخاص بتقدير القيمة الحالية والمستقبلية للفاقد في أهم المحاصيل الزراعية، بالإضافة إلي تقدير كلٍ من التكاليف اللازمة لعلاج تلك المشكلة من ناحية والعوائد المتوقعة حال علاجها.

التنبؤ بكمية إنتاج وكمية وأسعار صادرات البطاطس المصرية وكذا الفاقد منها خلال الفترة ٢٠١٢-٢٠٢٠م.

يوضح جدول (٦) أفضل الرتب لنماذج الأريما المستخدمة في التنبؤ بكمية الإنتاج وكمية وأسعار صادرات البطاطس المصرية (دولار/طن) وكذا الفاقد منها خلال الفترة ٢٠١٢-٢٠٢٠م، ويوضح جدول (٧) أن متوسط كمية الصادرات المتنبأ بها خلال تلك الفترة قدر بحوالي ٤٦٤ ألف طن تمثل نحو ٩% من متوسط كمية الإنتاج المتنبأ بها خلال نفس الفترة والمقدر بحوالي ٥.٣ مليون طن، كما قدر متوسط قيمة الصادرات المتنبأ خلال نفس الفترة حوالي ١٣٦ مليون دولار، كما أوضحت النتائج الواردة بجدول (٧) أيضاً أن متوسط كمية الفاقد المتنبأ بها من البطاطس المصرية قدر بحوالي ٦٤٣ ألف طن، تمثل نحو ١٢% من متوسط الإنتاج المتنبأ به خلال نفس فترة التنبؤ، كما قدرت القيمة المتنبأ بها لذلك الفاقد بحوالي ١٨٦ مليون دولار (مقيمة بأسعار الصادرات)، وهو الأمر الذي يؤكد علي أن هناك إمكانية لزيادة كمية الصادرات من محصول البطاطس بنفس مقدار الفقد المتنبأ به والبالغ نحو ٦٤٣ ألف طن و من ثم زيادة حصيلة النقد الاجنبي من صادرات ذلك المحصول بحوالي ١٨٦ مليون دولار، شريطة التغلب علي مشكلة الفاقد بحيث يتم توجيه تلك الكميات التي كانت تفقد من البطاطس المصرية نحو زيادة كمية الصادرات منها ، ومن ثم زيادة عوائد صادرات البطاطس بدون أي حاجة إلي استخدام أي موارد إنتاجية إضافية.

جدول (٦). بيان برتب أفضل نماذج الأريما المستخدمة في التنبؤ بكمية وأسعار صادرات البطاطس المصرية وكذا الفاقد منها خلال الفترة ٢٠١٢-٢٠٢٠م

المتغير المتنبأ به	رتبة النموذج المستخدم في التنبؤ
كمية الإنتاج	ARIMA (2.2.1)
كمية الصادرات	ARIMA (2.1.0)
أسعار الصادرات	ARIMA (1.0.0)
كمية الفاقد	ARIMA (0.2.3)

المصدر: نتائج تحليل نماذج الأريما المتحصل عليها بواسطة برنامج SPSS Ver. 22

جدول (٧). التنبؤ بكمية و أسعار صادرات البطاطس المصرية و كذا الفاقد منه خلال الفترة ٢٠١٢-٢٠٢٠م

السنوات	كمية الإنتاج (ألف طن)	كمية الصادرات (ألف طن)	كمية الفاقد (ألف طن)	أسعار الصادرات (دولار/ طن)	قيمة الصادرات (مليون دولار)	قيمة الفاقد (مليون دولار)
2012	4514	555	481	357	198	172
2013	4523	343	507	331	114	168
2014	4818	414	551	310	128	171
2015	5103	545	596	295	161	176
2016	5261	488	640	284	139	182
2017	5462	409	685	275	112	188
2018	5707	452	730	269	122	196
2019	5920	499	774	264	132	204
2020	6122	468	819	261	122	214
المتوسط	**5270**	**464**	**643**	**294**	**136**	**186**

المصدر: نتائج تحليل نماذج الأريما المتحصل عليها بواسطة برنامج SPSS Ver. 22

جدول (٥). تطوركمية الإنتاج والصادرات والفاقد من البطاطس المصرية خلال الفترة ١٩٨٠- ٢٠١١م

لسنوت	كمية الإنتاج (الف طن)	كمية الصادرات (الف طن)	قيمة الصادرات (مليون دولار)	سعر التصدير (دولار/ طن)	كمية الفاقد (الف طن)	القيمة التقديرية للفاقد حال تصديرها (مليون دولار)
1980	1214	144	33	226	123	28
1981	1195	96	26	266	124	33
1982	1184	151	41	271	123	33
1983	1095	140	31	219	112	25
1984	1189	133	37	276	123	34
1985	1478	128	27	211	151	32
1986	1431	108	22	203	146	30
1987	1801	123	24	197	183	36
1988	1862	166	32	190	188	36
1989	1657	156	27	173	168	29
1990	1638	136	22	165	166	27
1991	1786	218	48	220	180	40
1992	1619	209	43	204	164	33
1993	1600	175	32	183	163	30
1994	1325	132	27	201	136	27
1995	2599	419	102	244	267	65
1996	2626	411	80	194	267	52
1997	1803	233	41	177	188	33
1998	1984	228	43	189	203	38
1999	1809	256	46	180	187	34
2000	1770	157	27	175	184	32
2001	1903	186	30	160	194	31
2002	1985	229	43	186	204	38
2003	2039	296	44	148	211	31
2004	2547	382	67	176	257	45
2005	3167	392	77	197	324	64
2006	2313	367	65	178	237	42
2007	2760	390	108	277	283	78
2008	3567	398	176	443	365	162
2009	3659	215	145	676	371	251
2010	3643	299	130	434	379	164
2011	4338	637	251	393	448	176
المجموع	**66586**	**7710**	**1946**	**7634**	**6819**	**1810**
المتوسط	**2081**	**241**	**61**	**239**	**213**	**57**
أعلي قيمة	**4338**	**637**	**251**	**676**	**448**	**251**
أدني قيمة	**1095**	**96**	**22**	**148**	**112**	**25**
الانحراف المعياري	**833**	**125**	**52**	**108**	**86**	**54**

المصدر: جمعت و حسبت من بيانات الصادرات الزراعية المصرية المتاحة علي الموقع الالكتروني لمنظمة الأغذية والزراعة FAO

الفترة ٢٠١٢–٢٠٢٠م، ومن ثم زيادة عائد صادرات ذلك المحصول بحوالي ١٧٣ مليون دولار خلال نفس الفترة فقط إذا تم علاج مشكلة الفاقد في ذلك المحصول.

جدول (٤). التنبؤ بكمية إنتاج وكمية وأسعار صادرات البرتقال المصري وكذا الفاقد منه خلال الفترة ٢٠١٢-٢٠٢٠م.

السنوات	كمية الإنتاج (ألف طن)	كمية الصادرات (ألف طن)	كمية الفاقد (ألف طن)	أسعار الصادرات (دولار/ طن)	قيمة الصادرات (مليون دولار)	قيمة الفاقد (مليون دولار)
2012	3434	1203	344	497	598	171
2013	3532	1178	354	480	565	170
2014	3630	1562	364	467	729	170
2015	3726	1621	373	456	739	170
2016	3822	1731	383	447	774	171
2017	3918	2040	393	439	896	173
2018	4013	2079	402	433	900	174
2019	4107	2272	412	427	970	176
2020	4201	2501	421	423	1058	178
المتوسط	**3820**	**1799**	**383**	**452**	**803**	**173**

المصدر: نتائج تحليل نماذج الأريما المتحصل عليها بواسطة برنامج SPSS Ver. 22

ثانياً: صادرات البطاطس المصرية

يوضح جدول (٥) أن كمية الصادرات من البطاطس المصرية بلغت حوالي ٢٤١ ألف طن كمتوسط للفترة ١٩٨٠–٢٠١١م تمثل نحو ١٢% من متوسط كمية الإنتاج خلال نفس الفترة والبالغ نحو ٢ مليون طن، كما تراوحت تلك الكمية بين حدٍ أدني بلغ حوالي ٩٦ ألف طن في عام ١٩٨١م، وحدٍ أقصي بلغ نحو ٦٣٧ ألف طن في عام ٢٠١١م، كما بلغ متوسط قيمة تلك الصادرات خلال نفس الفترة حوالي ٦١ مليون دولار، كما تراوحت تلك القيمة بين حدٍ أدني بلغ حوالي ٢٢ مليون دولار في عام ١٩٨٦م، و حدٍ أقصي بلغ نحو ٢٥١ مليون دولار في عام ٢٠١١م. و يوضح جدول (٥) أيضاً أن أن متوسط كمية الفاقد من البطاطس بلغ حوالي ٢١٣ ألف طن كمتوسط للفترة ١٩٨٠–٢٠١١م تمثل نحو ١٠%، ٨٨% من متوسط كمية الإنتاج وكمية الصادرات علي الترتيب خلال نفس الفترة، كما تراوحت تلك الكمية بين حدٍ أدني بلغ حوالي ١١٢ ألف طن في عام ١٩٨٣م، و حدٍ أقصي بلغ حوالي ٤٤٨ ألف طن في عام ٢٠١١م، وبافتراض انه تم الحفاظ علي تلك الكميات من الفقد وتوجيهها إلي التصدير، فإن متوسط قيمتها يقدر بنحو ٥٧ مليون دولار، يمثل حوالي ٩٣% من متوسط قيمة الصادرات خلال الفترة ١٩٨٠–٢٠١١م، وتعد تلك القيمة في هذه الحالة قيمة مضافة لصادرات البطاطس المصرية تساعد في زيادة حصيلة النقد الأجنبي لذلك المحصول.

حوالي ٨ مليون دولار في عام ١٩٩٤م، وحدٍ أقصي بلغ نحو ٥٣٨ مليون دولار في عام ٢٠١١م. ويوضح جدول (٢) أيضاً أن متوسط كمية الفاقد من البرتقال المصري بلغ حوالي ٢٠٢ ألف طن كمتوسط للفترة ١٩٨٠-٢٠١١م تمثل نحو ١٠% من متوسط الإنتاج و قرابة ٩٤% من كمية الصادرات خلال نفس الفترة، الامر الذي يشير إلي ضخامة كمية الفاقد من البرتقال خلال تلك الفترة، كما تراوحت كمية الفاقد بين حدٍ أدني بلغ حوالي ٩٧ ألف طن في عام ١٩٨١م، وحدٍ أقصي بلغ حوالي ٣٤٣ ألف طن في عام ٢٠١١م، و بافتراض انه تم الحفاظ علي تلك الكميات من الفقد، و تقييمها بأسعار الصادرات (حال الحفاظ عليها و اضافتها إلي الصادرات)، فإن متوسط قيمتها يقدر بحوالي ٧٦ مليون دولار (مقيمة بأسعار الصادرات خلال نفس الفترة) يمثل حوالي ٨٠% من متوسط قيمة الصادرات خلال الفترة ١٩٨٠-٢٠١١م، حيث تعد تلك القيمة في هذه الحالة قيمة مضافة لصادرات البرتقال المصرية.

التنبؤ بكمية إنتاج وكمية وأسعار صادرات البرتقال المصري وكذا الفاقد منه خلال الفترة ٢٠١٢-٢٠٢٠م

يوضح جدول (٣) أفضل نماذج الأريما المستخدمة في التنبؤ بكمية الإنتاج وكمية وأسعار صادرات البرتقال المصري (دولار/طن) و كذا الفاقد منه خلال الفترة ٢٠١٢-٢٠٢٠م.

جدول (٣). بيان برتب أفضل نماذج الأريما المستخدمة في التنبؤ بكمية إنتاج وكمية وأسعار صادرات البرتقال المصري وكذا الفاقد منه خلال الفترة ٢٠١٢-٢٠٢٠م

المتغير المتنبأ به	رتبة النموذج المستخدم في التنبؤ
كمية الإنتاج	ARIMA (1.1.2)
كمية الصادرات	ARIMA (2.2.0)
أسعار الصادرات	ARIMA (1.0.0)
كمية الفاقد	ARIMA (1.1.2)

المصدر: نتائج تحليل نماذج الأريما المتحصل عليها بواسطة برنامج SPSS Ver. 22

كما يتضح من جدول (٤) أن متوسط كمية صادرات البرتقال المصري المتنبأ بها خلال الفترة ٢٠١٢-٢٠٢٠م قدر بحوالي ١.٨ مليون طن، تمثل نحو ٤٧% من متوسط كمية الإنتاج المتنبأ به خلال نفس الفترة و المقدر بحوالي ٣.٨ مليون طن، كما قدر متوسط قيمة الصادرات المتنبأ بها حوالي ٨٠٣ مليون دولار، كما أوضحت النتائج الواردة بجدول (٤) أيضاً أن متوسط كمية الفاقد المتنبأ به من البرتقال المصري قدر بحوالي ٣٨٣ ألف طن، تمثل نحو ١٠% من متوسط الإنتاج المتنبأ به خلال نفس فترة التنبؤ، و بمتوسط قيمة لذلك الفاقد بلغ حوالي ١٧٣ مليون دولار (مقيماً بأسعار الصادرات). ومن ثم فإن النتائج السابقة تشير إلي حدوث تحسن وزيادة ملحوظة في كمية صادرات البرتقال تعزي بصفة أساسية للزيادة في كمية الإنتاج المتنبأ بها خلال الفترة ٢٠١٢-٢٠٢٠م، كما أوضحت التنبؤات ثبات نسبة الفاقد من البرتقال خلال فترة التنبؤ بدون تغيير يذكر عما كانت علية خلال فترة الدراسة الفعلية (١٩٨٠-٢٠١١م). ومن ثم فإنه يمكن الإشارة إلي أن هناك فرصة كبيرة لزيادة متوسط كمية صادرات البرتقال بحوالي ٣٨٣ ألف طن خلال

جدول (٢). تطور الإنتاج والصادرات والفاقد من البرتقال المصري خلال الفترة ١٩٨٠- ٢٠١١م

السنوات	كمية الإنتاج (الف طن)	كمية الصادرات (الف طن)	قيمة الصادرات (مليون دولار)	سعر التصدير (دولار/ طن)	كمية الفاقد (الف طن)	القيمة التقديرية للفاقد حال تصديرها (مليون دولار)
1980	991	110	39	356	99	35
1981	970	114	47	415	97	40
1982	1315	101	53	520	132	68
1983	1350	148	72	490	135	66
1984	1286	161	76	473	129	61
1985	1274	161	87	537	127	68
1986	1351	75	44	588	135	79
1987	1521	111	70	631	152	96
1988	1350	97	49	507	135	68
1989	1568	154	71	465	157	73
1990	1832	145	49	340	183	62
1991	1892	111	44	400	189	76
1992	2112	103	32	316	211	67
1993	1530	56	17	297	153	45
1994	1763	28	8	293	176	52
1995	1966	42	13	309	197	61
1996	2062	54	17	323	206	67
1997	1957	44	14	318	196	62
1998	1863	218	61	279	186	52
1999	2148	53	16	307	215	66
2000	2092	86	17	192	209	40
2001	2261	258	51	196	226	44
2002	2410	127	27	209	241	50
2003	2380	167	39	235	238	56
2004	2511	258	77	298	251	75
2005	2652	214	75	350	265	93
2006	2851	283	65	231	285	66
2007	2813	272	99	365	281	103
2008	2897	454	239	526	290	152
2009	3182	822	495	602	318	192
2010	3198	636	398	625	320	200
2011	3426	1042	538	516	343	177
المجموع	**64773**	**6704**	**3000**	**12508**	**6478**	**2513**
المتوسط	**2024**	**210**	**94**	**391**	**202**	**79**
أعلي قيمة	**3426**	**1042**	**538**	**631**	**343**	**200**
أدني قيمة	**970**	**28**	**8**	**192**	**97**	**35**
الانحراف المعياري	**666**	**228**	**133**	**132**	**67**	**42**

المصدر: جمعت و حسبت من بيانات الصادرات الزراعية المصرية المتاحة علي الموقع الالكتروني لمنظمة الأغذية والزراعة FAO

و يمكن تلخيص نتائج التحليل الخاصة بكلٍ من البرتقال و البطاطس المصرية علي النحو التالي:

أولاً: صادرات البرتقال المصرية

يوضح جدول (٢) أن كمية الصادرات من البرتقال المصري بلغت حوالي ٢١٠ ألف طن كمتوسط للفترة ١٩٨٠–٢٠١١م، تمثل نحو ١٠% من متوسط الإنتاج خلال نفس الفترة و البالغ نحو ٢ مليون طن، كما تراوحت تلك الكمية بين حدٍ أدني بلغ حوالي ٢٨ ألف طن في عام ١٩٩٤م، وحدٍ أقصي بلغ نحو ١.١ مليون طن في عام ٢٠١١م، كما بلغ متوسط قيمة تلك الصادرات خلال نفس الفترة حوالي ٩٤ مليون دولار، وتراوحت تلك القيمة بين حدٍ أدني بلغ

جدول (١). تطور قيمة أهم محاصيل التصدير الزراعية في مصر بالمليون دولار خلال الفترة ٢٠٠٠: ٢٠١١م

السنوات	الأرز	القطن	البرتقال	البطاطس	البصل الجاف	العنب	الفاصوليا الجافة	الفراولة	أخري	المجموع
2000	112.57	132.27	16.56	27.39	12.37	1.88	19.89	0.12	175.46	**498.49**
2001	133.85	186.00	50.62	29.75	14.21	1.29	8.93	0.32	180.42	**605.40**
2002	105.55	329.70	26.54	42.62	23.56	1.82	10.49	0.89	213.78	**754.95**
2003	149.93	365.87	39.19	43.97	33.01	2.93	5.56	1.47	271.55	**913.47**
2004	232.16	483.02	76.88	67.23	36.49	11.44	11.79	2.14	353.40	**1274.54**
2005	311.03	180.55	74.91	77.45	31.00	16.83	11.05	1.74	432.06	**1136.63**
2006	302.13	132.80	65.27	65.35	23.90	21.92	14.17	6.36	446.33	**1078.23**
2007	402.61	152.97	99.14	108.09	36.09	59.69	29.51	12.06	587.02	**1487.18**
2008	191.11	185.37	238.94	176.15	41.56	91.93	26.16	32.81	1056.52	**2040.53**
2009	475.93	87.49	494.75	145.41	168.56	225.38	92.22	86.51	2555.93	**4332.17**
2010	377.85	137.35	397.52	129.56	170.40	115.01	17.05	48.00	1307.64	**2700.38**
2011	17.10	264.33	538.16	250.65	215.62	210.06	69.44	58.72	3368.69	**4992.78**
المجموع	2811.83	2637.72	2118.47	1163.62	806.76	760.17	316.27	251.14	10948.79	**21814.75**
المتوسط	234.32	219.81	176.54	96.97	67.23	63.35	26.36	20.93	912.40	**1817.90**
الأهمية النسبية (%)	**12.89**	**12.09**	**9.71**	**5.33**	**3.70**	**3.48**	**1.45**	**1.15**	**50.19**	**100**

المصدر: جمعت و حسبت من بيانات الصادرات الزراعية المصرية المتاحة علي الموقع الالكتروني لمنظمة الأغذية والزراعة (FAO)

د) إختبار Ljung-Box (LB):

أما في حالة العينات الصغيرة فيفضل تطبيق إختبار Ljung-Box (LB) والذي يتبع كذلك توزيع مربع كاي $\chi 2$ ، بدرجات حرية m و التي تعبر عن عدد فترات الابطاء.

$$LB = n(n+2)\sum_{k=1}^{m}\left(\frac{\hat{\rho}_k^2}{n-k}\right) \sim \chi_m^2$$

فإذا كانت قيمة LB المحسوبة أكبر من الجدولية فإن قيمة معامل الارتباط الذاتي بين قيم المتغير موضع الدراسة تكون معنوية و بالتالي تكون السلسلة الزمنية غير مستقرة والعكس صحيح.

- **أسس المفاضلة بين النماذج المستخدمة في التنبؤ:**

هناك عدد من المقاييس تستخدم في المفاضلة بين النماذج المستخدمة في التنبؤ، ومن أهمها:

١. متوسط القيم المطلقة للأخطاء Mean Absolute Error (MAE)
٢. متوسط مربع الأخطاء Mean Squared Error (MSE)
٣. متوسط الأخطاء النسبية المطلقة Mean Absolute Percentage Error (MAPE)
٤. متوسط الأخطاء النسبية المربعة Mean Percentage Squared Error (MPSE)
- معامل التحديد للنموذج R^2

وجدير بالذكر أنه بالنسبة للمقاييس الأربعة الأولي فإنه يتم المفاضلة بين النماذج المستخدمة في التنبؤ وبعضها البعض علي أساس إختيار النموذج صاحب أقل متوسط للأخطاء سواء الأخطاء المطلقة أو المربعة أو المطلقة النسبية، أما بالنسبة لمعامل التحديد فيتم اختيار النموذج صاحب أعلي معامل تحديد و بشرط اختبار استقرار السلاسل الزمنية وإحداثه في حالة عدم توفره قبل البدء في حساب تلك المقاييس.

النتائج والمناقشات:

الأهمية النسبية لصادرات الفاكهة والخضر المصرية :

يوضح جدول (١) أن صادرات البرتقال المصري احتلت المرتبة الثالثة من بين محاصيل التصدير الزراعية المصرية خلال الفترة ٢٠٠٠: ٢٠١١م بمتوسط قيمة بلغ حوالي ١٧٦.٥ مليون دولار تمثل قرابة ١٠% من متوسط قيمة الصادرات الزراعية المصرية والبالغ نحو ١.٨ مليار دولار خلال نفس الفترة، في حين جاءت صادرات البطاطس المصرية في المرتبة الرابعة، بمتوسط قيمة بلغ حوالي ٩٧ مليون دولار، تمثل نحو ٥% من متوسط قيمة الصادرات الزراعية خلال الفترة سالفة الذكر، لذا فإن البحث سيتناول بالدراسة والتحليل صادرات محصول البرتقال كأهم محصول تصديري من الفاكهة في مصر، و كذا صادرات البطاطس المصرية كأهم محاصيل التصدير من الخضر.

$$\rho_k = \frac{\gamma_k}{\gamma_0}$$

$$\hat{\gamma}_k = \frac{\sum (Y_t - \bar{Y})(Y_{t+k} - \overline{Y})}{n}$$

$$\hat{\gamma}_0 = \frac{\sum (Y_t - \hat{Y})^2}{n}$$

حيث n ترمز لحجم العينة، k ترمز لعدد الفجوات الزمنية، Y_t ترمز للمتغير موضع الدراسة، $\bar{Y}$ ترمز لمتوسط العينة.

ب) دالة الإرتباط الذاتي الجزئي Partial Auto Correlation Function (PACF):

تدرس دالة الارتباط الذاتي الجزئي الارتباط الجزئي بين قيم نفس المتغير في فترتين زمنيتين مختلفتين بفرض ثبات الفترات الأخري، وتفيد قيمة معامل الارتباط الجزئي في تحديد رتبة نموذج الانحدار الذاتي Autoregressive Model. وتجدر الإشارة إلي أن تطبيق نماذج الأريما علي سلاسل زمنية غير مستقرة يؤدي إلي الحصول علي تنبؤات غير دقيقة، هذا فضلاً علي أن تقدير الانحدار للسلاسل الزمنية غير المستقرة يؤدي إلي الحصول علي انحدار زائف من خصائصة كبر قيمة معامل التحديد و زيادة غير حقيقية في درجة معنوية معالم الدالة الانحدارية عنه في حالة تحويل السلسلة ذاتها إلي سلسلة مستقرة، ، فضلاً علي ظهور مشكلة الارتباط الذاتي بين البواقي والتي يمكن التأكد منها بتطبيق اختبار ديربن– واتسون Durbin-Watson Test.

ج) إحصائية Q لـ بوكس وبيرز Box and Pierce:

ويستخدم هذا الإختبار في حالة العينات كبيرة الحجم لاختبار معنوية معامل الارتباط الذاتي ACF حيث n حجم العينة و m عدد فترات الإبطاء، وتتوزع Q حسب توزيع كاي $\chi 2$ بدرجة حرية m ومستوي المعنوية الذي يحدده الباحث. فإذا كانت قيمة Q المحسوبة أكبر من الجدولية فإن قيمة معامل الارتباط الذاتي بين قيم المتغير موضع الدراسة تكون معنوية وبالتالي تكون السلسلة الزمنية غير مستقرة ويلزم علاج عدم استقرار السلسلة في تلك الحالة و العكس صحيح بمعني أنه إذا كانت قيمة Q المحسوبة أصغرمن الجدولية فإن قيمة معامل الارتباط الذاتي بين قيم المتغير موضع الدراسة تكون غيرمعنوية ولا تختلف معنوياً عن الصفرو بالتالي تكون السلسلة الزمنية مستقرة، ويمكن بالتالي تطبيق نماذج الأريما مباشرة علي قيم السلسلة الزمنية للمتغير محل الدراسة.

$$Q = n \sum_{k=1}^{m} \hat{\rho}_k^2$$

$$Y_t = (\theta_0 + \beta_0) + \sum_{i=1}^{i=p} \theta_i Y_{t-i} + \sum_{j=1}^{j=q} \beta_j \varepsilon_{t-j} + \varepsilon_t$$

٤- نماذج الانحدار الذاتي والمتوسطات المتحركة المتكاملة

Auto-Regressive Integrated Moving Average Models (ARIMA)(p,d,q)

عادة ما تكون العديد من السلاسل الزمنية غير مستقرة، ويعني ذلك عدم ثبات المتوسط وعدم تجانس التباين لتلك السلاسل، ومن ثم يتم تحويل بيانات السلسلة غير المستقرة إلي بيانات سلسلة مستقرة من خلال التكامل بين طريقة الإنحدار الذاتي والمتوسطات المتحركة والذي يتم من خلال حساب الفروق بين قيم المتغير التابع في الفترات الزمنية المختلفة من الرتب ١ وقد يستمر حساب الفروق إلي الرتبة d وحتي يتحقق الاستقرار المنشود. و يتم أخذ الفروق من الدرجة الأولي علي النحو التالي:

$$\Delta Y_t = Y_t - Y_{t-1}$$

فإذا لم تستقر السلسلة تأخذ الفروق من الدرجة الثانية كما يلي:

$$\Delta^2 Y_t = \Delta\Delta Y_t = \Delta Y_t - \Delta Y_{t-1} = Y_t - 2Y_{t-1} + Y_{t-2}$$

فإذا لم تستقر السلسلة يستمر أخذ الفروق من الدرجات الأعلي حتي تمام الاستقرار للسلسلة الزمنية، و الجدير بالذكر أنه كلما زادت رتبة الفروق زادت المعادلات الخاصة بها تعقيداً، كما يتطلب ذلك استخدام سلاسل زمنية طويلة نسبياً حيث أن عملية أخذ الفروق للسلسلة الزمنية الأصلية تؤدي إلي نقص في مشاهدات السلسلة الجديدة و يزداد ذلك النقص بزيادة رتبة أو درجة الفروق المحسوبة، و تشير النتائج العملية لتطبيق نماذج التنبؤ أن عملية استقرار السلاسل الزمنية تحدث في الغالب بعد أخذ الفروق من الرتبة الأولي أو الثانية أو الثالثة علي الأكثر.

كما يلزم أيضاً عمل التحويل اللوغاريتمي لبيانات السلسلة الزمنية في حالة عدم تجانس التباين لها، ثم يلي ذلك إحتساب النموذج في الصورة ARMA من الرتبة (p,q) بعد إحداث الاستقرار سالف الذكر في السلسلة الزمنية محل الدراسة.

و يجدر بالذكر أن رتبة نموذج الانحدار الذاتي AR (p) يمكن تحديدها بناءً علي حساب معامل الارتباط الذاتي الجزئي Partial Auto Correlation Function (PACF) بين قيم السلسلة ، كما أنه يمكن تحديد رتبة نموذج المتوسطات المتحركة لعنصر الخطأ MA(q) من خلال حساب قيمة معامل دالة الارتباط الذاتي Auto Correlation Function (ACF) لقيم السلسلة موضع الدراسة.

و يشتمل تطبيق النماذج السابقة علي حساب عدد من المعاملات الإحصائية الهامة و التي من أهمها:

أ) دالة الإرتباط الذاتي Auto Correlation Function (ACF):

تدرس دالة الإرتباط الذاتي الإرتباط بين القيم المتتالية للمتغير وتعتبر دليلاً علي استقرار السلسلة الزمنية عندما يكون معامل الإرتباط الذاتي P_k مساوياً للصفر أو لا يختلف معنوياً عنه، كما تفيد في تحديد رتبة نموذج المتوسطات المتحركة كما سبق ذكره، و يمكن حساب معامل الإرتباط الذاتي P_k علي النحو التالي:

١- نموذج الانحدار الذاتي: Auto-Regressive Model (AR)

تعتمد القيمة الحالية للمتغير التابع Y_t في هذا النموذج علي قيم نفس المتغير في الفترات السابقة ($Y_{t-1}, Y_{t-2}, \ldots Y_{t-p}$) بفترات إبطاء تتراوح من (1: P) و يسمي ذلك بالإنحدار الذاتي من الرتبة P ويمكن توضيح هذا النموذج بالمعادلة التالية:

$$Y_t = \theta_0 + \theta_1 Y_{t-1} + \theta_2 Y_{t-2} + \ldots\ldots + \theta_p Y_{t-p} + \varepsilon_t$$

حيث:

θ_0 : تعبر عن ثابت المعادلة.

θ_P،.... θ_3، θ_2، θ_1 : تعبر عن معاملات الانحدار للمتغير موضع الدراسة.

ε_t : تعبر عن عنصر الخطأ العشوائي الخاص بنموذج الانحدار الذاتي.

و يجب أن يكون مجموع معاملات الإنحدار لذلك النموذج أقل من الواحد الصحيح ويسمي شرط الثبات.

٢- نموذج المتوسطات المتحركة: Moving Average Model (MA)

يتوزع المتغير التابع Yt في هذا النموذج كدالة في الخطأ العشوائي لفترات إبطاء تتراوح من (1:q) وبذلك يسمي نموذج متوسط متحرك من الرتبة q ويمكن تمثيل هذا النموذج بالمعادلة التالية:

$$Y_t = \beta_0 + \beta_1 \varepsilon_{t-1} + \beta_2 \varepsilon_{t-2} + \ldots\ldots + \beta_q \varepsilon_{t-q}$$

حيث: β_0 تعبر عن ثابت المعادلة.

β_q،.....، β_2، β_1 : تعبر عن معاملات الانحدار لعنصر الخطأ العشوائي في الفترات السابقة.

ε_t : تعبر عن عنصر الخطأ العشوائي.

ويجب أن يكون مجموع معاملات الإنحدار أقل من الواحد الصحيح ويسمي شرط الإنعكاس

٣- نماذج الانحدار الذاتي والمتوسطات المتحركة المختلطة

Auto-Regressive Moving Average Model (ARMA) (p,q)

العديد من النماذج لا توجد بشكل إنحدار ذاتي أو متوسطات متحركة فقط إنما توجد بشكل مختلط من الانحدار الذاتي والمتوسطات المتحركة وتسمي هذه النماذج بالنماذج المختلطة من الانحدار الذاتي والمتوسطات المتحركة من الرتبة (p,q) ويرمز لها بالرمز ARMA(p,q) ويمكن تمثيل هذا النموذج بالمعادلة التالية:

$$Y_t = \theta_0 + \theta_1 Y_{t-1} + \theta_2 Y_{t-2} + \ldots\ldots + \theta_p Y_{t-p} + \varepsilon_t + \beta_0 + \beta_1 \varepsilon_{t-1} + \beta_2 \varepsilon_{t-2} + \ldots\ldots + \beta_q \varepsilon_{t-q}$$

ومن ثم يمكن كتابة نفس المعادلة السابقة علي الصورة:

المصرية الاجمالية في نفس العام، الأمر الذي يؤكد علي أهمية صادرات الخضر والفاكهة كمصدر هام من مصادر الدخل الزراعي المصري، وكمصدر هام لزيادة حصيلة النقد الأجنبي التي تدخل إلي خزينة الدولة.

مشكلة الدراسة:

يعاني المقتصد الزراعي المصري من ضخامة فاقد المحاصيل الزراعية بصفة عامة، ومحاصيل التصدير من الخضر والفاكهة علي وجه الخصوص، وتتعدد صور ومراحل ذلك الفاقد إلا أن أهم تلك الصور تتمثل في الفاقد الكمي في تلك المحاصيل خلال مسلكها التسويقي ، والذي يحدث بسبب التلف أو العطب نتيجة أسباب من أهمها عدم ملائمة العبوات، وسوء التخزين والنقل ، والإصابة الحشرية بسبب عدم توفير الظروف المناخية الملائمة أثناء التخزين والنقل، الأمر الذي يؤدي بالتبعية إلي فقد قدر كبير نسبياً في عوائد الصادرات لتلك المحاصيل، مما يؤثر سلباً علي مصدر هام من مصادر الدخل الزراعي في مصر من ناحية، كما يؤثر سلباً علي حصيلة النقد الأجنبي من صادرات تلك المحاصيل ويؤدي إلي تزايد عجز الميزان التجاري الزراعي المصري من ناحية أخري.

هدف الدراسة:

يهدف البحث أساساً إلي دراسة تأثير الفاقد الحالي والمستقبلي في أهم محاصيل التصدير من الخضر والفاكهة في مصر علي عوائد الصادرات لتلك المحاصيل، والتنبؤ بالزيادة المتوقعة في عائد الصادرات إذا تم التغلب علي مشكلة الفاقد وتدنيته إلي أدني كمية ممكنة.

الطريقة البحثية:

لتحقيق أهداف البحث، تم استخدام أساليب التحليل الإحصائي الوصفي والكمي لدراسة الأهمية النسبية لمحاصيل التصدير من الخضر والفاكهة في مصر، لإختيار أهم تلك المحاصيل لإجراء الدراسة عليها، وكذلك تم استخدام نماذج الأريما ARIMA MODELS باستخدام برنامج التحليل الإحصائي SPSS Ver. 22 للتنبؤ بكمية وأسعار وقيمة أهم صادرات الخضر والفاكهة في مصر، وكذا التنبؤ بكمية وقيمة الفاقد من تلك المحاصيل حتي عام ٢٠٢٠م، ومن ثم يمكن التنبؤ بالزيادة المتوقعة في عائد الصادرات إذا تم التغلب علي مشكلة الفاقد.

مصادر البيانات:

اعتمد البحث في تحقيق أهدافه علي البيانات الثانوية الخاصة بالصادرات الزراعية المصرية وكذا بيانات الفاقد لتلك المحاصيل خلال الفترة ١٩٨٠: ٢٠١١م، والتي تم الحصول عليها من الموقع الإلكتروني للمنظمة الدولية للأغذية و الزراعة (FAO) المتاح علي الشبكة الدولية للمعلومات Internet.

الاطار النظري لنماذج الأريما* (ARIMA):

يمكن إجراء عملية التنبؤ الدقيق بقيم المتغيرات الاقتصادية من خلال استخدام نماذج الأريما وتغذيتها ببيانات السلاسل الزمنية لتلك المتغيرات، حيث تتضمن تلك العملية علي المراحل والنماذج التالية:

تقدير تأثير الفاقد في أهم المحاصيل المصرية من الفاكهة والخضر علي عوائد صادرات تلك المحاصيل

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الملخص: تعد مشكلة الفاقد في المحاصيل الزراعية بصفة عامة ومحاصيل التصدير من الخضر والفاكهة علي وجه الخصوص من أهم المشاكل التي يعاني منها المقتصد الزراعي المصري، حيث يؤدي ذلك الفاقد إلي إنخفاض كبير نسبياً في فائض الإنتاج من تلك المحاصيل، الأمر الذي يؤثر سلباً علي عوائد صادراتها. ولقد أوضحت نتائج البحث أن محصولي البرتقال والبطاطس المصرية إحتلا المرتبة الثالثة والرابعة علي التوالي من حيث الأهمية النسبية لقيمة محاصيل التصدير الزراعية خلال الفترة ٢٠٠٠-٢٠١١م بمتوسط بلغ حوالي ١٧٦.٥، ٩٧ مليون دولار لكل منهما علي الترتيب تمثل حوالي ١٠%، ٥% من متوسط إجمالي قيمة الصادرات الزراعية المصرية والبالغ نحو ١.٨ مليار دولار خلال نفس الفترة. كما أشارت نتائج تحليل البيانات أن متوسط كمية الفاقد من البرتقال المصري خلال فترة الدراسة بلغ حوالي ٢٠٢ ألف طن ، تقدر قيمتها بحوالي ٧٦ مليون دولار (بأسعار صادرات تلك الفترة)، في حين أوضحت نتائج تقديرات التنبؤ لكمية الفاقد من البرتقال خلال الفترة ٢٠١٢- ٢٠٢٠م أن متوسط تلك الكمية قدر بحوالي ٣٨٣ ألف طن، تقدر قيمتها بحوالي ١٧٣ مليون دولار (بأسعار صادرات البرتقال التي تم التنبؤ بها خلال فترة التنبؤ). أما بالنسبة لمحصول البطاطس فأوضحت النتائج أن متوسط كمية الفاقد لهذا المحصول خلال الفترة ١٩٨٠-٢٠١١م بلغ حوالي ٢١٣ ألف طن بمتوسط قيمة بلغ حوالي ٥٧ مليون دولار، في حين أشارت تنبؤات الفاقد خلال الفترة ٢٠١٢-٢٠٢٠م إلي أن متوسط كمية الفاقد من محصول البطاطس المصرية قدر بحوالي ٦٤٣ ألف طن، تقدر قيمتها بحوالي ١٨٦ مليون دولار.

الكلمات الدلالية: التنبؤ ، أريما ، عوائد الصادرات ، الخضر والفاكهة المصرية

مقدمة:

تعتبر الزراعة المصرية أحد الأعمدة الهامة في بنيان الاقتصاد المصري، حيث بلغت قيمة الدخل الزراعي المصري (المنظمة العربية للتنمية الزراعية، ٢٠١٣) حوالي٣٥.٨ مليار دولار في عام٢٠١٢ تمثل حوالي١٤.٥ % من اجمالي الدخل القومي المصري والبالغ نحو٢٤٧.٤ مليار دولار في نفس العام، كما تعتبر قيمة الصادرات الزراعية مكون هام ورئيسي من مكونات الصادرات الكلية، حيث بلغت قيمة الصادرات الزراعية في عام٢٠١٢ حوالي٣.٨ مليار دولار ، تمثل نحو١٢.٥ % من اجمالي قيمة الصادرات الكلية المصرية والبالغة نحو٣٠.٥ مليار دولار في ذات العام. و تعتبر صادرات الخضر والفاكهة بصفة خاصة من أهم الصادرات الزراعية المصرية، حيث بلغت قيمة صادرات الخضر والفاكهة في مصر نحو ١.٩٩ مليار دولار في عام٢٠١٢ تمثل حوالي ٥٢ % من قيمة الصادرات الزراعية

المحتويات

هيئة التحرير

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كلية الزراعة – سابا باشا

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