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Editorial Board

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Priorities of Agricultural Utilization for Some New Areas of El-Minia Governorate Desert fringe - Egypt

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ABSTRACT: Due to the continuous decrease of agricultural lands, it is necessary to identify the most relevant lands for sustainable agriculture development at desert areas in which being socially equitable. The main objective of this study is to determine priorities of agricultural utilization for some areas at the western desert fringe of El-Minia Governorate. The selected area is bounded by longitudes 30° 30` 00``E and 30° 45` 00``E and latitudes 28° 26` 56``N and 28° 46` 1``N, covering an area of approximately 124691 feddan. It includes five new village of El-Minia namely; new Al-Atf, new Ash ShaykhMas'ud, new Al-Bahnasa, new Al-Hema and new Abu Algod villages. Soils of the area were surveyed using 90 profiles. Seventeen soil profiles were chosen to represent dominant landforms of the area. Soil samples were collected for further laboratory analysis to determine their properties. Based on ground truth data, laboratory analysis and imagery interpretation in cooperation with geographic information system (GIS) utilities, the geomorphic map was generated and nine geomorphic units could be differentiated. These are; pediment; alluvial fans and outwash plains; upper, moderate and lower rubble terraces; old river terraces; dissected plateaus; wind-blown sand dunes; hilly areas and rock out crops. Soils of these landforms were investigated and classified mainly as *Lithic Torripsamments, Typic Torripsamments, Typic Torriorthents*, *Typic Haplogypsids, Calcic Haplosalids, and Typic Haplocalcids* subgroups. They were grouped into four soil mapping units varying in soil depth and gravel content. Land capability was assessed to define the most suitable areas for agricultural production using MicroLEIS microcomputer program (CERVATANA capability model). Soils of the area classified into two capability classes, moderate-S (37.1 %) and non productive-N (36.13 %), while rest of the area belong to dissected plateau, hilly terrain and dunes. Further, three capability subclasses were recognized abbreviated as S3 l, S3 lr, and N l in accordance to limitations type and severity. Priorities of Agricultural Utilization Model (PAUM) was designed. Four priority grads were identified where the first priority in the studied area occupy 25.84 % of the total terrain and belongs mainly to soils of alluvial fans and outwash plains, lower rubble terraces, and partially old river terraces. Only new AshShaykh Mas'ud village belongs to the first priority for agricultural utilization, while, other investigated villages were classified as third priority. The study is considered of vital importance for decision makers through the management of natural resources in desert fringe.

Key Words: El-Minia Governorate, desert fringe, soil characteristics, land capability, agricultural utilization priorities.

INTRODUCTION

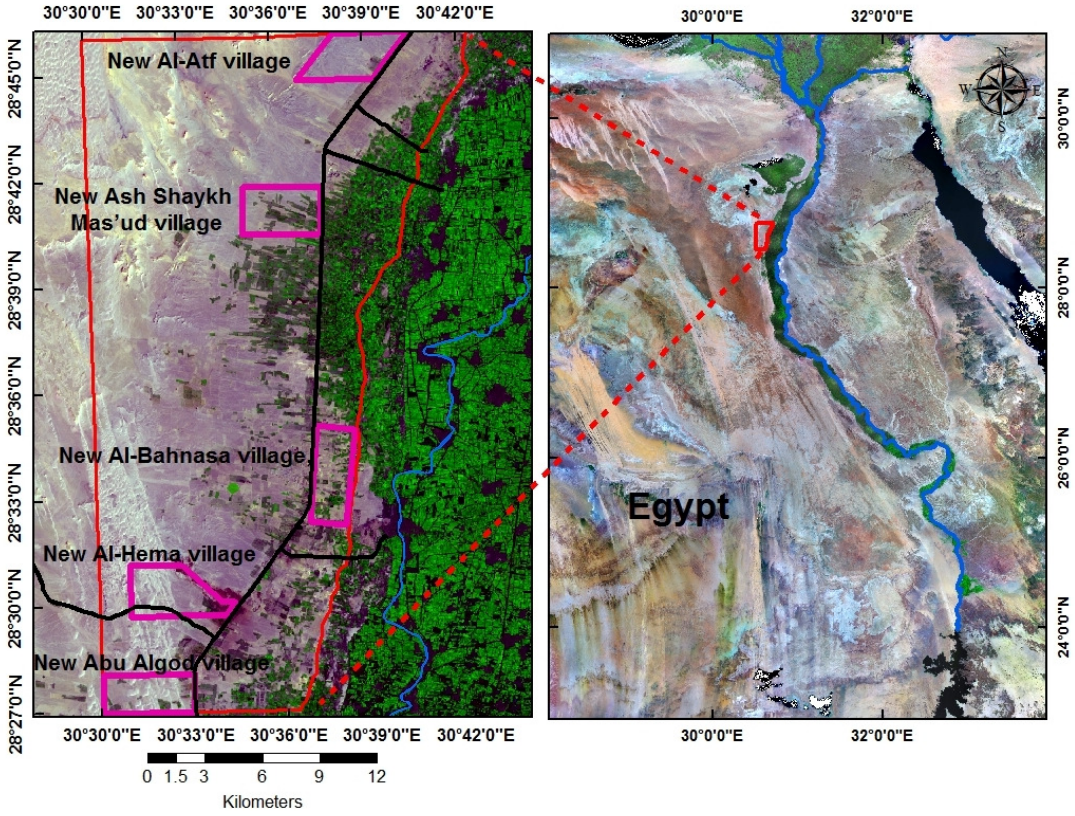
In the framework of the steps taken by the Egyptian government to preserve the agricultural land from infringement risks through urban encroachment, the Ministry of Housing, Utilities and Urban Communities have been selected new areas to establish a national project to develop the desert fringes of old cities and villages. That mega project started in 2007 aiming to create about 400 new villages

of the Delta and the Nile Valley desert fringes. New urban or rural communities are planned to increase the cultivated area of Egypt, thus preserving the agricultural land. Twenty four locations were chosen at the desert fringes of El-Minia Governorate to develop new villages. These locations at the western desert fringe of El-Minia could be considered the most important horizontal expansion at Middle of Egypt. From agricultural point of view, DRC staff (2014) found obvious soil constrains associated to some areas of selected new villages; such as rough topography, soil shallowness, coarse texture soils, extremely lime content, soil salinization and sand dunes encroachment.

The area under investigation is located to the west of the Nile Valley within El-Minia desert fringes. It extends from west of Matai district in the south to west of Al-Idwah district in the north; bounded by longitudes 30° 30` 00``E and 30° 45` 00``E and latitudes 28° 26` 56``N and 28° 46` 1``N, covering an area of approximately 124691 feddan. The area continue northward, widening from about 5 km near Matai district in the south to about 9 km at latitude of Dahrut and then gradually narrowing again to some 4 kms, just west of Al-Idwah district in north. The area includes five locations of new villages over about 2857, 2380, 2142, 1760 and 2285 feddan; namely, new Al-Atf, new Ash Shaykh Mas'ud, new Al-Bahnasa, new Al-Hema and new Abu Algod villages, respectively (Map 1).

Said (1993) mentioned that in the western side of the Nile valley, the middle Eocene formations are covered by Oligocene gravels and cobbles. The Eocene limestone may crop to the surface locally. The main geological deposits in the study area are Nile deposits, sand dunes, aeolian deposits, gravels and basalt, (Egyptian General Petroleum Corporation - Conco Coral Staff, 1987). According to Abu El-Izz (2000) the investigated area is built of recent alluvium sediments belong to Pleistocene, and Pliocene periods. The area is characterized by arid climate as the total rainfall is (4-7.8) mm/year. The dryness is prevailing most of the year and the wet periods are comparatively short. Based on the Egyptian Meteorological Authority data (2000-2009) and USDA Soil Survey Staff (2010), the soil temperature regime of the studied area is defined as *Thermic*, and the soil moisture regime as *Torric*. Ground water is considered the main source of irrigation water in the study area.

The availability of advanced technologies, for managing significant quantities of data, should help the planers and decision makers to organize the information, understand their spatial association, and provide a powerful means for analyzing and synthesizing the related information. Moreover, the launching of space-born satellite is powerful in gathering and managing information about the state of land using remote sensing (RS) and Geographic Information System (GIS). Applying the powerful capabilities of advanced RS and GIS techniques through integrating spatial data contribute in terrain analyzing, as well as generate a digital soil information layers. The aim of this study is to evaluate soils of some areas at the western desert fringes of El-Minia Governorate for producing digital land capability map as a base of defining priorities of agricultural utilization.



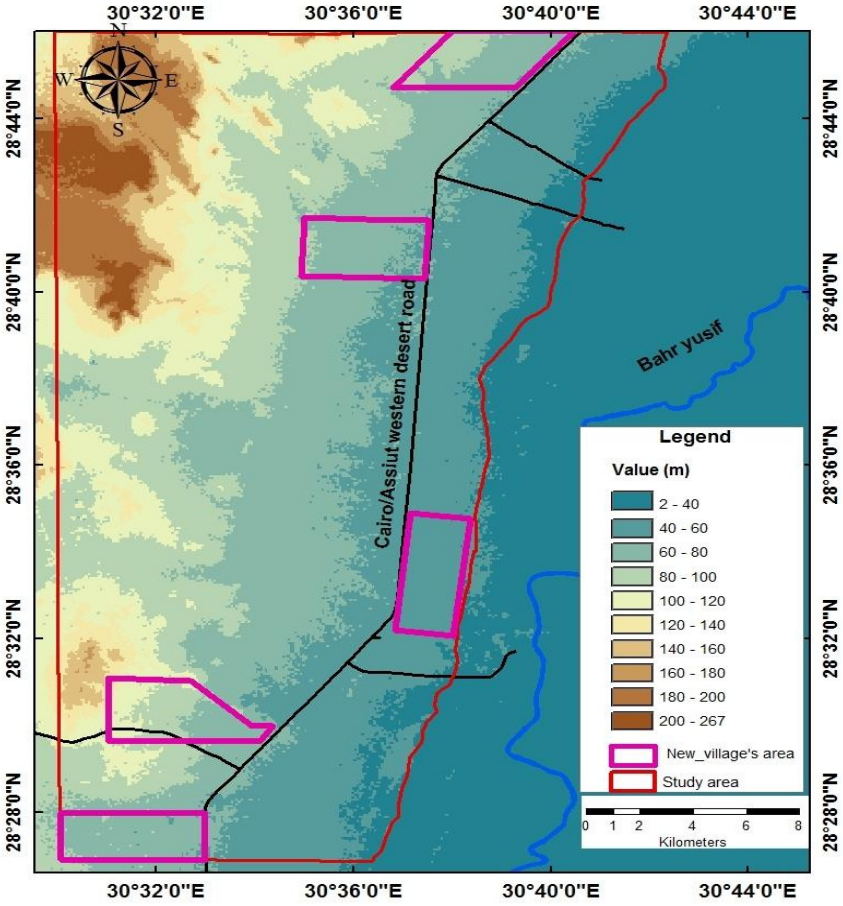
Map (1). Location of the studied area at the western desert fringe of El-Minia.

MATERIALS AND METHODS

A Landsat-8OLI image acquired in 2016 (path 176 / row 40) was employed in this study. It was processed using ERDAS Imagine 9.3 software (2010) with a generated Digital Elevation Model (DEM) based on vector contour lines (Map 2). DEM was successfully used to identify different landforms of the study area and to gain an appreciation of the landscape characteristics (slope gradient).

A semi-detailed soil survey (DRC Staff, 2016) was made throughout the investigated area, including five new village's areas of El-Minia Governorate western desert fringes. Soil survey was undertaken in order to identify and verify the major landform and to gain an appreciation of the broad soil patterns and landscape characteristics. The primary mapping units were verified based on the field interpretation and the information gained during the survey. A total of 90 soil profiles were spatially distributed over the area under consideration in addition to some auger observations were taken to represent the delineated mapping units and to fulfill the requirements of digital mapping (DRC Staff, 2016). A detailed morphological description was recorded on the basis of guidelines for soil description, FAO (1990). Seventeen soil profiles were selected in the current study to represent the spatial extend of different landforms.

The collected soil samples were subjected to some physical and chemical analyses using soil survey laboratory methods manual, USDA (2014). Soil classification was carried out according to the USDA Soil Taxonomy, USDA Soil Survey Staff (2010).



Map (2). Digital Elevation Model of the studied area.

A land capability evaluation was applied using CERVATANA model constituent of MicroLEIS DSS. This model was designed by De la Rosa *et. al.* (1992) and modified for computing purpose by De la Rosa *et al.* (2004). Following the generally accepted norms of land evaluation (Klingebiel and Montgmery, 1961; FAO, 1976; Dent and Young, 1981; ONERN, 1982; and Verheye, 1986), the CERVATANA model forecasts the general land use capability or suitability for a broad series of possible agricultural uses. That model works interactively, comparing the values of the characteristics of the land-unit to be evaluated with the generalization levels established for each Use Capability Class. The prediction of general land use capability is the result of a qualitative evaluation process or

overall interpretation of the following biophysical factors: relief, soil, climate, and current use or vegetation (Fig. 1).

Priorities of Agricultural Utilization Model (PAUM) was designed and processed using spatial modeling environment of Arc GIS software, ESRI (2010). Soil, geomorphologic, land capability and agricultural utilization priorities maps were spatially generated using Arc GIS software, ESRI (2010).

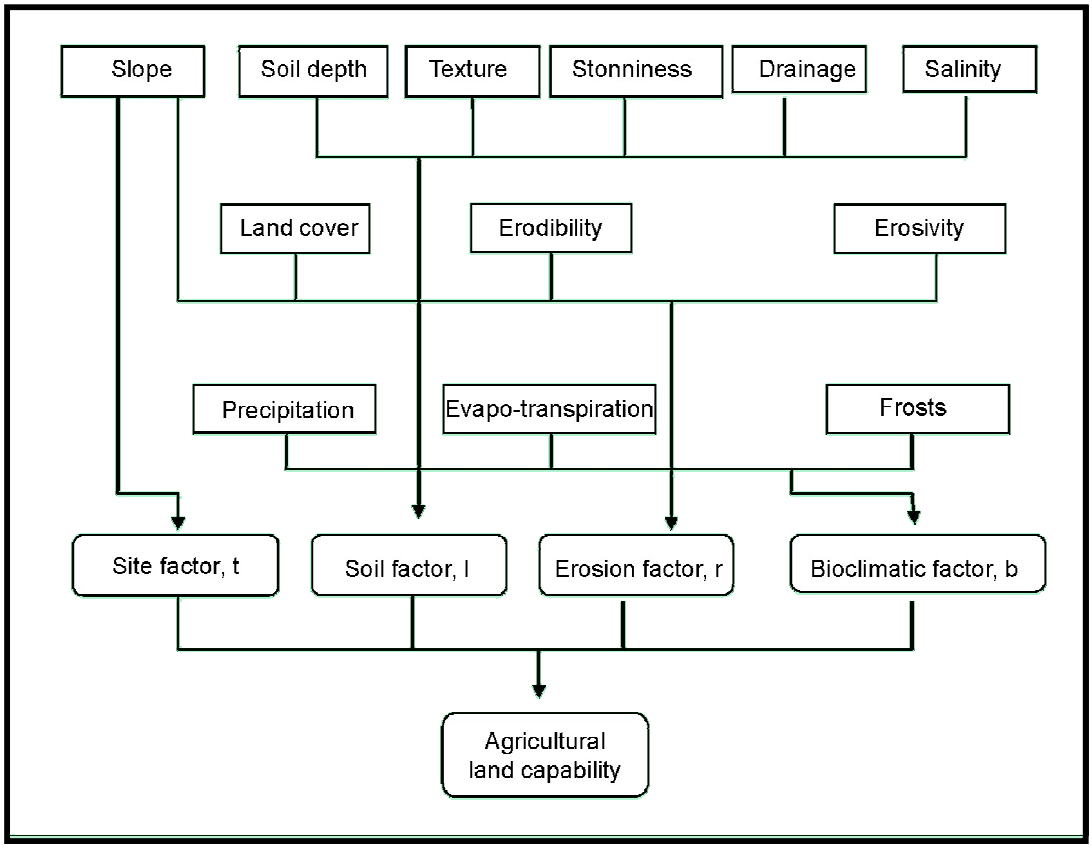


Fig.(1). Flowchart of data processing using CERVATANA model constituent of MicroLEIS DSS.

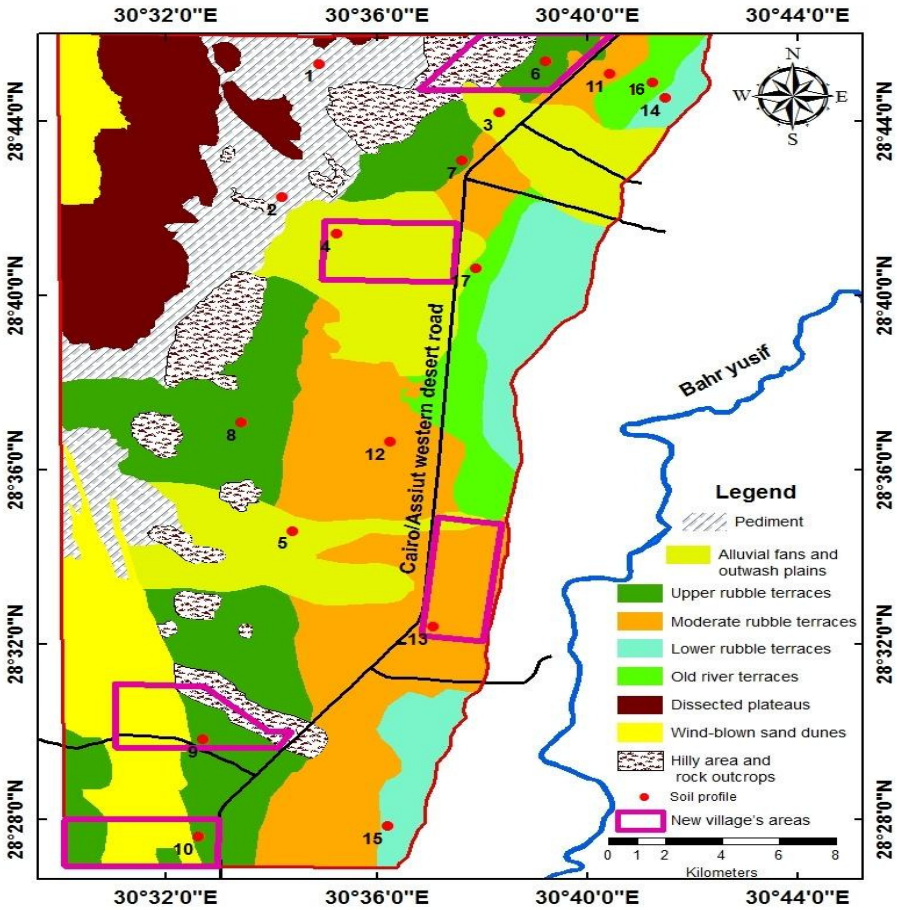
RESULTS AND DISCUSSION

A- Geomorphology of the investigated area

Based on the visual interpretation of merged DEM with OLI image together with knowledge driven from the geological map (Egyptian General Petroleum Corporation Conco Coral Staff, 1987), topography map, ground truth data and soil survey of the study area, the main landforms were delineated (Map 3). They could be recognized as 1-Dissected plateau 2-Pediment 3-Alluvial fans 4-Lower rubble terraces 5-Moderate rubble terraces 6-Upper rubble terraces 7-Old river terraces 8-

Sand dune 9-Hilly area and rock out crops. Landforms map was considered a Geo-database map over which the representative soil profiles were spatially distributed. Table 1 gives the proportions of each landform and associated soil profiles.

The area under investigation, part of El-Minia Governorate western desert fringes, consists largely of rubble and river terrace soils in addition to soils of alluvial fans and outwash plains. The rubble terrace soils dominate the area of desert fringe, having the same conspicuous sloping character as seen from the Nile valley. The rubble terrace soils are interrupted, and covered in three places by fan and outwash deposits. They are gently undulating at surface than those of river terrace present in the study, and sometimes have extremely gypsiferous profiles.



Map (3). Main landforms of the studied area.

Table (1). Main landforms and its areas in the study location.

Landform	Representative soil profile	Max. Elevation	Area feddan	(%)
Pediment	1 - 2	162	13094	10.5
Alluvial fans and outwash plains	3 - 4 - 5	95	19118	15.34
Upper rubble terraces	6 - 7 - 8 - 9 - 10	101	20652	16.56
Moderate rubble terraces	11 - 12 - 13	77	24405	19.57
Lower rubble terraces	14 - 15	49	8665	6.95
Old river terraces	16 - 17	58	5400	4.33
Dissected plateaus		267	12075	9.68
Wind-blown sand dunes		260	11974	9.6
Hilly areas and rock out crops.		96	9308	7.46
Total			**124691**	**100**

Soils of river terrace occurred generally in lower terrain with high gravel contents. Locally they may show strong gypsum accumulations in the profile or somewhat reddish subsoil colors due to ferric oxides. As a result of their higher altitude, the relief is somewhat more undulating to even sometimes rolling. Alluvial fan and outwash plain soils are generally of a deep slightly gravelly sandy nature. This may be attributed to the great run-off depositional regime from the pediment lands and/or from the northwestern soft middle Eocene rocks than that from the southwestern Oligocene cobble land.

The dissected limestone plateaus stand out locally at the western north part of the study area and occupy a large area with steep scarps. Most of the plateau area is occupied by exposed soft middle Eocene formations, except for some scattered portions are covered by sand dunes. Whole plateau formations, in particular the shales and shaly clays, appear to be very saline and gypsiferous. The characteristics of the dissected limestone plateaus are affecting the desert fringe soils. North of Maghagha, very few remnants of the Oligocene cobble formation are found (isolated hills and rock out crops).

Soils of the wind-blown sand dunes were formed over higher land at the western boundaries of the study area. They overlie either the middle Eocene or denuded Oligocene formations. These soils were originated from the soft middle Eocene sandstone, which is exposed to weathering south of El Fayum depression, carried by the prevailing northerly winds. They sometime form elongated seif – or sword-dunes (longitudinal shape) with sheets of sand in between.

B- Soils of the investigated area

The area under study has different morphological, physical and chemical characteristics according to studied soil profiles representing the different landforms. Tables 2 and 3 show values of soil attributes which could be classified according to Soil Taxonomy (USDA, Soil Survey Staff, 2010) and discussed as the following:

1- Soils of Pediments

Studied soils of this unit were formed at the down of a rock escarpment of the dissected limestone plateaus in the northwestern of the study area, dated back to middle Eocene age. They occupy an area of about 13094 feddan covering 10.5 % of the total area and represented by soil profiles No. 1 and 2. The surface is undulating, sloping towards the east, and covered with many fine gravels. Surface runoff and associated hazard of water erosion are slight due to dominant gentle slope. The data show that soils have shallow depth lays between 35 and 45cm due limitation by a lithic contact. Soil texture is sand throughout the different layers of representative soil profiles, and pH values indicate slightly alkaline condition. They are characterized by very slightly to slightly saline soils as electric conductivity values ranged between 2.9 and 6.9 dS/m. Meanwhile, soils of pediment possess relatively high content of $CaCO_3$. The soils of this unit are classified as *Lithic Torripsamments*.

2- Soils of alluvial fans and outwash plains

Soils of this unit cover an area of about 19118 feddan, representing 15.34 % of the total area and represented by soil profiles No. 3, 4, and 5. They are derived from the high-lying lands of the dissected limestone plateaus which located at west of the study area. The surface is almost flat, gently sloped towards east direction, and is covered with many fine gravels. The hazardous effect of water erosion is slight as surface runoff is very slow due to slight slope class. The soils are deep and characterized by coarse texture, excessively drainage, and slight to moderate alkalinity. Variable levels of salinity are noticeable depending on the site topography. Secondary formations of carbonates and gypsum in detectable amount were identified throughout the layers with no any characteristics of diagnostic horizons. With a few exceptions they are gravelly sand in deep layers. Based on analytical data and field studied soils of alluvial fans and outwash plains are classified as *Typic Torripsamments*.

3- Soils of Rubble terraces

The rubble terrace soils occupy most of the study area as they cover about 53722 feddan representing 43.08 % of the total area. They are developed from the pediment land and/or the soft middle Eocene rocks at west of the study area. Soils of rubble terraces are considered a transition zone between the eastern river terrace deposits and the western dissected limestone plateau. They are formed from sandy to gravelly sand soils. Surface is almost flat to gently undulate which minimize surface runoff with slight hazard of water erosion. They are divided into different subdivisions according to their physiographic position as follow:-

3.1- Soils of upper rubble terraces

The upper rubble terraces cover an area of 20652 feddan representing 16.56 % of the total studied terrain. Their formation may be affected by the adjacent rocky area, which rendered those terrace soils extremely gypsiferous. Soils of this landform were examined by soil profiles No. 6, 7, 8, 9, and 10. The surface is gently undulating and covered with gravels associated to desert varnish.

They are excessively drained and characterized by deep gravelly sand profile. Soil reaction is slight tend to moderately alkaline range where pH values fluctuate between 7.4 and 8.2. Soils have wide range of salinity where EC values ranging between 6.24 and 54.47 dSm^{-1}. Relatively high content of total $CaCO_3$ occurred in accordance to the nature of parent material. Gypsum secondary formation was detected in some profile horizons in which the characteristics of diagnostic horizon are recorded. Hence, soils are classified as *Typic Haplogypsids*.

3.2- Soils of moderate rubble terraces

Soils of this unit occupy the largest extent of the rubble terraces. They cover an area of 24405 feddan representing 19.57 % of the total area and studied through profiles No. 11, 12 and 13. Surface is almost flat to gently undulated and mostly covered with desert pavement of gravels. They are characterized by deep gravelly sand profile with excessively drainage. The soils are slightly to moderately alkaline, highly calcareous, and extremely saline. Characteristics criteria of calcic and salic horizons in some layers were identified; therefore, they are classified as *Calcic Haplosalids* and *Typic Haplocalcids*.

3.3- Soils of lower rubble terraces

The lower rubble terraces soils cover an area of 8665 feddan representing 6.95 % of the total area. The surface is almost flat and covered with rock grits with common fine gravels. They are represented by soil profiles No. 14 and 15. These soils are characterized by deep sand profile with excessively drainage status. Values of pH indicate neutral to slightly alkaline tendency, and soils concerning salinity are classified as slightly salt affected soils throughout representative profiles. Accumulation of lime secondary formation in some profile horizons was detected. Characteristics criteria of calcic diagnostic horizons were found; hence they are classified as *Typic Haplocalcids and Typic Torripsamments.*

4- Soils of old river terraces

This unit is the remnants of Nile deposits at different altitudes and occupying small and elongated portion in the eastern north part of the study area. Soils of this unit are mostly identical in origin and composition with Nile alluvium soils. They cover an area of about 5400 feddan representing 4.33 % of the total area, having an undulating surface covered by desert pavement, and a wide elevation range from 40 to 50 m above sea level. The hazard of water erosion is expected to be slight according to moderate surface. They are represented by soil profiles No. 16 and 17 which have deep drainable soil profile. Soils are very gravelly coarse sand in texture. pH values ranged from 7.4 to 7.8 indicating slightly alkalinity throughout the different layers of representative soil profiles. These soils are slightly to moderately saline where EC values ranging between 3.55 and 8.1 dS/m. Total carbonate content is moderate and ranging between 5.15 and 10 % due to the nature of parent material which consists essentially of Nile alluvium sediments, while gypsum content is null. They are placed as *Typic Torriorthents*.

Table (2). Main morphological characteristics of representative soil profiles in the studied area.

Prf. No.	Lat. (N) Long. (E)	-Topography, -Slope, -Surface cover	-Erosion, -Drainage	Depth (cm)	Soil color	
					Dry	Moist
Pediment						
1	28°45'18.53" 30°34'56.16"	-Undulating, -Sloping, -Many fine gravels with ripple mark	-Moderate, -Poorly	0-20	10YR 6/4	10YR 5/4
				20-35	10YR 6/4	5YR 5/4
2	28°42'15.41" 30°34'13.82"			0-25	10YR 6/6	10YR 5/8
				25-45	10YR 6/6	10YR 5/8
Alluvial fans and outwash plains						
3	28°44'12.07" 30°38'21.02"	-Almost flat, -Nearly level, -Many fine gravels	-Slight, -Excess.	0-20	10YR 7/6	10YR 6/6
				20-80	10YR 7/6	10YR 6/6
				80-150	10YR 7/6	10YR 6/6
4	28°41'24.97" 30°35'15.45"			0-30	10YR 8/4	10YR 7/4
				30-80	10YR 7/6	10YR 6/6
				80-150	10YR 7/6	10YR 6/6
5	28°34'36.32" 30°34'25.52"			0-40	10YR 8/4	10YR 7/4
				40-100	10YR 7/6	10YR 6/6
				100-150	10YR 7/6	10YR 6/6
Upper rubble terraces						
6	28°45'21.33" 30°39'14.66"	-Gently undulating, -Gently sloping, -Gravels with desert varnish	-Slight, -Excess.	0-25	10YR 7/6	10YR 6/6
				25-50	10YR 7/6	10YR 6/6
				50-80	10YR 7/6	10YR 6/6
				80-110	10YR 6/6	10YR 5/8
7	28°43'04.89" 30°37'39.39"			0-35	10YR 7/6	10YR 6/6
				35-90	10YR 7/6	10YR 6/6
				90-110	10YR 7/6	10YR 6/6
				110-150	10YR 7/6	10YR 6/6
8	28°37'05.60" 30°33'27.77"			0-40	10YR 6/6	10YR 5/6
				40-95	10YR 5/8	10YR 4/6
				95-150	10YR 5/8	10YR 4/6
9	28°29'49.85" 30°32'44.08"			0-30	10YR 7/6	10YR 6/6
				30-110	10YR 6/8	10YR 5/8
10	28°27'35.90" 30°32'38.43"			0-40	10YR 7/6	10YR 6/6
				40-100	10YR 7/4	10YR 6/6
				100-150	10YR 7/4	10YR 6/6
Moderate rubble terraces						
11	30°32'05.27" 30°40'26.77"	-Almost flat to gently undulating, -Nearly level to gently sloping, -Desert pavement of gravels	-Slight, -Excess.	0-20	10YR 7/6	10YR 6/6
				20-55	10YR 7/6	10YR 6/6
				55-100	7.5YR 6/6	7.5YR 5/6
				100-150	7.5YR 6/6	7.5YR 5/6
12	28°36'39.02" 30°36'16.95"			0-50	10YR 8/4	10YR 7/4
				50-100	10YR 8/4	10YR 7/4
				100-150	10YR 7/6	10YR 6/6
13	28°32'24.56" 30°37'06.07"			0-30	10YR 7/6	10YR 6/6
				30-90	7.5YR 6/6	7.5YR 5/6
				90-150	7.5YR 6/6	7.5YR 5/6

Table (2). Continued.

Profile No.	Lat. (N) Long. (E)	-Topography, -Slope, -Surface cover	-Erosion, -Drainage	Depth (cm)	Soil color	
					Dry	Moist
Lower rubble terraces						
14	28°44'31.55" 30°41'30.10"	-Almost flat, -Nearly level, -Grit with common fine gravels	-Slight, -Excess.	0-40	10YR 5/8	10YR 4/6
				40-60	10YR 5/8	10YR 4/6
				60-85	10YR 5/8	10YR 4/6
				85-120	10YR 6/4	10YR 5/4
15	28°27'51.00" 30°36'14.28"			0-50	10YR 7/6	10YR 5/8
				50-100	10YR 6/6	10YR 5/8
				100-150	10YR 6/6	10YR 5/8
Old river terrace						
16	28°44'53.09" 30°41'16.56"	-Undulating -Sloping -Desert pavement	-Moderate, -Excess.	0-50	10YR 7/6	10YR 6/6
				50-100	10YR 7/6	10YR 6/6
				100-150	10YR 5/8	10YR 4/6
17	28°40'36.69" 30°37'55.12"			0-40	10YR 6/4	10YR 5/4
				40-90	10YR 5/8	10YR 4/6
				90-130	7.5YR 5/8	7.5YR 4/6
				130-150	10YR 7/6	10YR 6/6

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

Profile No.	Depth (cm)	Gravel (%)	Texture class	pH	EC dS/m	$CaCO_3$ %	Gypsum %
1	0-20	6.67	S	7.6	6.91	12.8	nil
	20-35	1.79	S	7.8	4.21	9.9	nil
2	0-25	6.12	S	7.6	3.54	16.5	nil
	25-45	6.09	S	7.4	2.97	18	nil
3	0-20	7	S	7.5	4.78	20.2	15.5
	20-80	12.05	LS	7.8	11.08	12.3	10.98
	80-150	18.33	GrLS	7.5	5.34	19	12.48
4	0-30	6.67	S	7.8	14.04	8	22.5
	30-80	8.33	LS	8	9.91	6.9	21.9
	80-150	10.53	LS	8	8.91	7.7	20
5	0-40	8.11	LS	8	9.42	10.2	13.99
	40-100	9.26	S	8	8.00	16	13.82
	100-150	16.29	GrS	7.6	8.50	22.7	10.98
6	0-25	8	S	7.7	15.52	12.2	9.16
	25-50	20.5	GrS	7.8	26.53	10.1	18.94
	50-80	26.6	GrS	7.9	9.77	9.9	21.53
	80-110	36.36	GrS	7.9	7.04	11.9	9.69

Table (3). Continued.

Profile No.	Depth (cm)	Gravel (%)	Texture class	pH	EC dS/m	$CaCO_3$ %	Gypsum %
7	0-35	20.2	GrLS	7.6	9.70	15.6	5.5
	35-90	1.41	LS	8.2	14.06	11.4	11.21
	90-110	34.48	GrS	7.8	9.53	14.3	11.2
	110-150	1.32	LS	7.8	7.42	12.3	3.11
8	0-40	7.41	S	7.6	8.41	7.5	2.19
	40-95	17.2	GrS	7.5	28.67	5.7	19.37
	95-150	19.05	GrS	7.4	27.45	6.1	9.47
9	0-30	16.4	GrLS	7.6	18.53	18.8	0.2
	30-110	26.67	GrS	7.4	54.47	67.4	6.1
10	0-40	25	GrS	7.7	20.92	11.1	2
	40-100	19.2	GrS	7.7	11.34	21.9	9.26
	100-150	8.33	S	7.8	6.24	49.5	4.5
11	0-20	18.18	GrS	7.7	13.31	8	16.79
	20-55	35.45	GrS	7.8	9.39	10.8	17.87
	55-100	18	GrS	7.8	33.18	22.3	8.61
	100-150	16.6	GrS	7.8	10.79	15.6	6.45
12	0-50	15	S	7.4	12.66	19.5	10.11
	50-100	16	GrLS	7.6	23.78	18.1	8.62
	100-150	18	GrLS	7.5	34.28	13	15.92
13	0-30	10.53	S	7.7	7.62	14.1	9.5
	30-90	16	GrS	7.6	7.60	23.2	10.33
	90-150	20	GrS	7.4	31.50	17.1	8.2
14	0-40	9.38	LS	7.4	6.49	10.11	1
	40-60	7.78	S	7.3	4.56	16	2.1
	60-85	4.76	S	7.3	4.69	8.8	2
	85-120	35	GrS	7.6	2.72	10.4	0.5
15	0-50	1.04	LS	7.7	5.74	6.7	0.2
	50-100	1.1	S	7.3	6.80	13.3	0.5
	100-150	5.41	S	7.4	3.40	6.6	2
16	0-50	39.29	VGrS	7.4	4.14	5.15	nil
	50-100	40.1	VGrS	7.6	8.10	9.15	nil
	100-150	43.33	VGrS	7.6	7.63	7.7	nil
17	0-40	38.33	VGrS	7.5	3.55	10.1	nil
	40-90	39.86	VGrS	7.8	6.20	7.6	nil
	90-130	70.71	VGrS	7.7	5.50	6.12	nil
	130-150	80.21	VGrS	7.4	7.85	10	nil

S = Sand LS = Loamy Sand GrS = gravelly Sand GrLS = gravelly Loamy Sand VGrS = very gravelly Sand

In general, four soil mapping units could be distinguished in accordance to variations in profile depth and gravel content (Map 4). These are (1) deep coarse-textured unit (15.33%), (2) deep gravelly coarse-textured unit (43.1 %), (3) deep very gravelly coarse-textured unit (4.33 %), and (4) shallow coarse-textured unit (10.5%) .

Agricultural land capability using MicroLEIS

Results of the agricultural land capability evaluation generated by CERVATANA model constituent of MicroLEIS DSS are presented in Table 4 and Map 5. They include land capability classes and associated limitations of the studied soils representing different landforms.

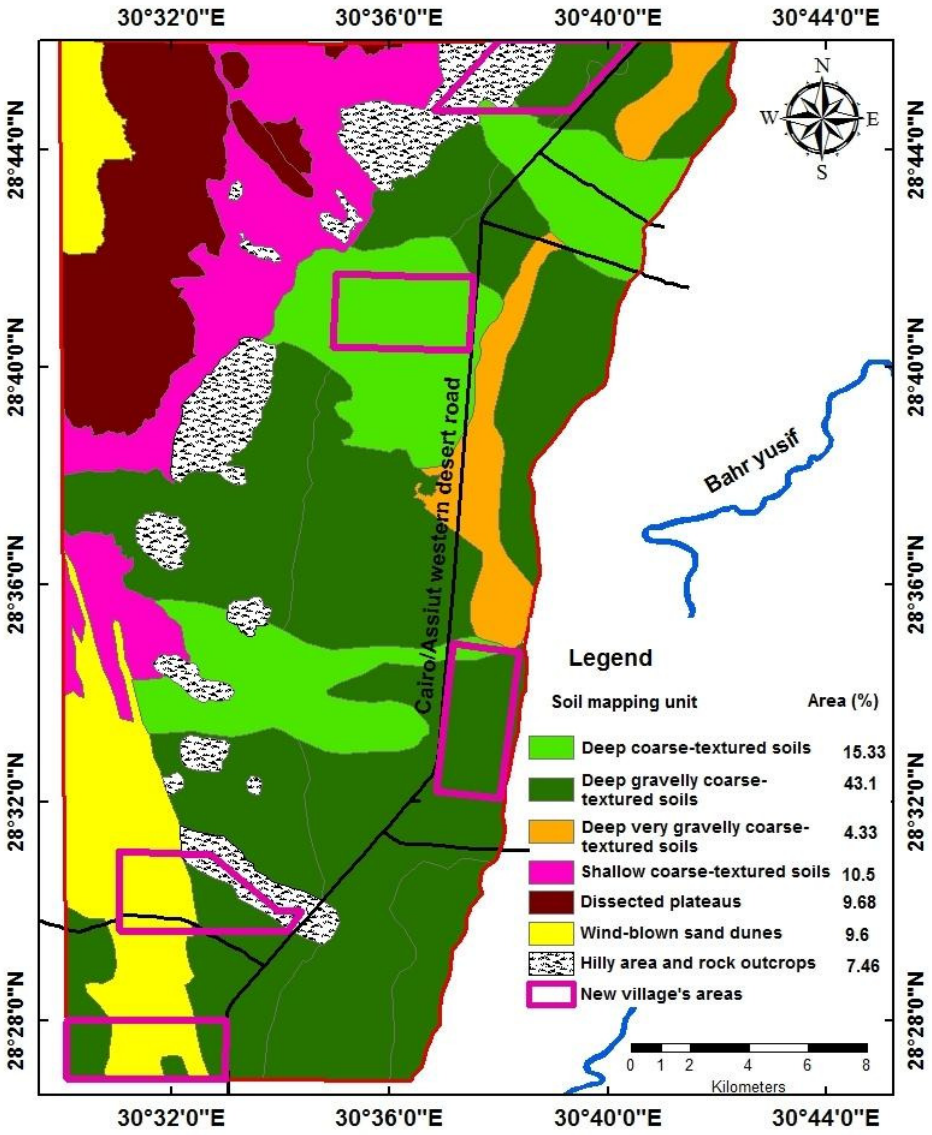
Two land capability classes were recognized, "Moderate Capability, S3" and "Non-Productive, N". Lands of moderate capability have two subclasses abbreviated as "S3 l" referring to moderate capability with slight constrain severity, and "S3 lr" including soils of moderate capability affected by sever soil constrains and erosion risk. S3 l subclass include soils of alluvial fans and outwash plains, lower rubble terraces, and partially old river terraces, which have moderate limitation regarding soil factor. Meanwhile S3 lr subclass has considerable limitations linked to topographic (slope), edaphic (shallow profile, poorly drainage, and/or high gravel content), or climatic factors. They include soils of pediment and partially old river terraces. These substantially reduce the range of possible crops and the productive capability. Management techniques are more difficult to be applied due to higher costs. Intensive practices are necessary - and sometimes special conservation practices to maintain a continued productivity. Non-productive land (N l) includes soils of upper and moderate rubble terraces. They do not provide the ecological conditions necessary for agricultural crops, therefore they are recommended for pasture or forestry land utilization types. They may need very different management and conservation practices to overcome its topographic (slope), edaphic (high salinity and gravels), or climatic deficiencies.

D- Priorities of agricultural utilization

To define the best agricultural utilization at El-Minia desert fringe, a Priorities of Agricultural Utilization Model (PAUM) was designed and processed using the GIS spatial modeling environment. The most effective factors included in that model to determine priorities of agricultural utilization under the studied area conditions could be concluded as geomorphological units, soil units, capability classes, slope gradient, water availability and quality and roads network.

Four steps were incorporated to process data and information using PAUM, these are:

1- Data input,
2- Extract and classify new information in accordance to common scales, where the higher values were given to the more capable location for agricultural use,
3- Weighting the classified data according to a percentage of their influence in the process.
4- Combining the data using conditional statements and data filtering to produce a graded map of agricultural use priority.



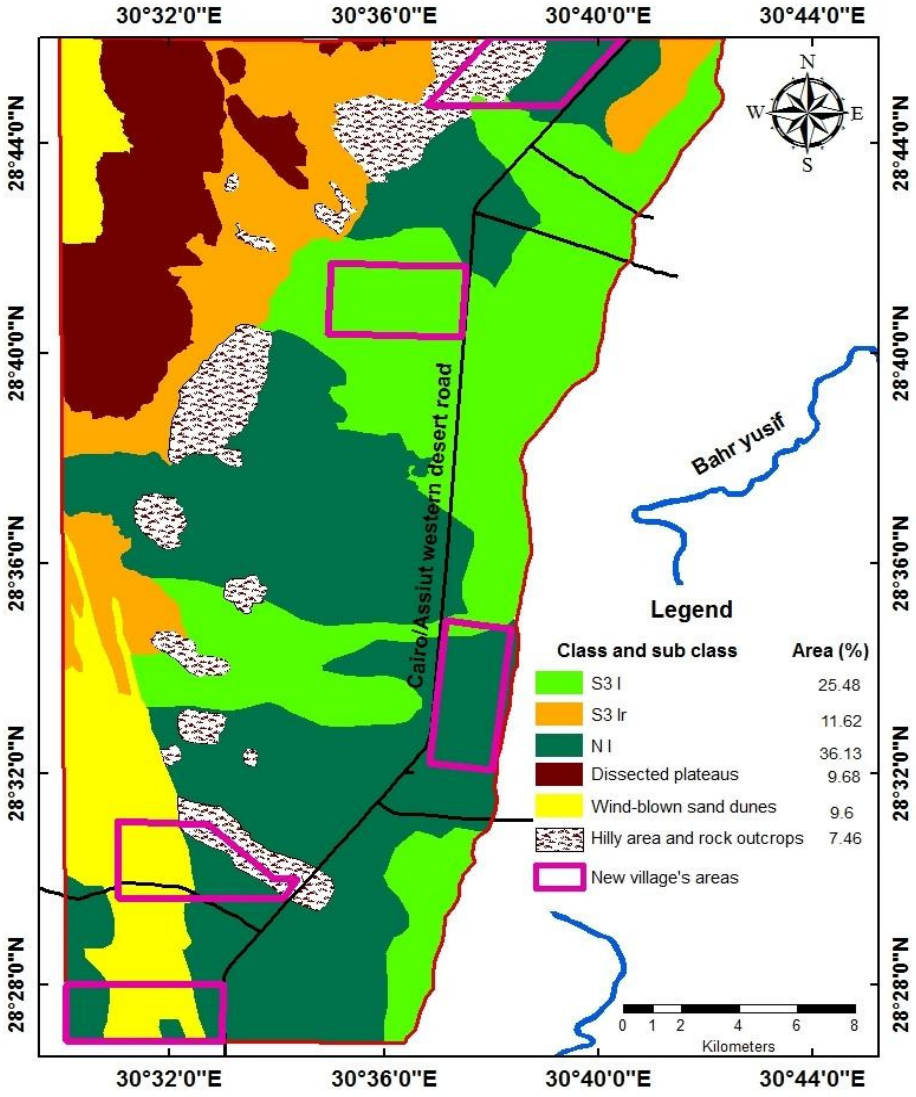
Map (4). Soil mapping units of the studied area.

PAUM resulted in four grades or categories of the agricultural utilization priorities at El-Minia desert fringe shown in Map 6. The first priority extent over 25.84 % of the total area and belongs mainly to soils of alluvial fans and outwash plains, lower rubble terraces, and partially old river terraces, while the second priority cover 11.62 % of the whole area representing soils of pediment and partially old river terraces. The third priority occupies 45.40 % of the area and includes soils of upper and moderate rubble terraces in addition to sand dune. Unsuitable soils represent the fourth priority which extends over 17.14 % of the entire terrain including dissected plateaus and hilly areas.

Table (4). Land capability classes in accordance to processed land characteristics in the study area.

Prf. No.	Slope	Depth cm	Text. class	Gr. %	EC dS/m	Drainage	Soil erosion	Vegetation	Erosiv.	Water deff.	Frost	class
Pediment												
1	Sloping	35	S	6.7	6.9	Poorly	Moderate	Nil	Slight	Low	Slight	**S3 Ir**
2		45	S	6.1	3.5	Poorly	Moderate	Nil	Slight	Low	Slight	**S3 Ir**
Alluvial fans and outwash plains												
3	Nearly level	150	S	14.0	7.1	Excessively	Slight	Moderate	Slight	Low	Slight	**S3 I**
4		150	S	10.0	9.8	Excessively	Slight	Moderate	Slight	Low	Slight	**S3 I**
5		150	LS	15.0	12.0	Excessively	Slight	Moderate	Slight	Low	Slight	**S3 I**
Upper rubble terraces												
6	Gently sloping	110	GrS	25.0	20.0	Excessively	Slight	Moderate	Slight	Low	Slight	**N I**
7		150	GrLS	25.0	13.0	Excessively	Slight	Nil	Slight	Low	Slight	**N I**
8		150	GrS	20.0	14.0	Excessively	Slight	Nil	Slight	Low	Slight	**N I**
9		110	GrLS	20.0	18.5	Excessively	Slight	High	Slight	Low	Slight	**N I**
10		150	GrS	25.0	14.0	Excessively	Slight	High	Slight	Low	Slight	**N I**
Moderate rubble terraces												
11	Nearly level to gently sloping	150	GrS	25.0	20.0	Excessively	Slight	Nil	Slight	Low	Slight	**N I**
12		150	GrS	20.0	20.0	Excessively	Slight	High	Slight	Low	Slight	**N I**
13		150	GrS	25.0	19.0	Excessively	Slight	High	Slight	Low	Slight	**N I**
Lower rubble terraces												
14	Nearly level	120	LS	10.0	6.5	Excessively	Slight	High	Slight	Low	Slight	**S3 I**
15		150	S	5.0	5.7	Excessively	Slight	High	Slight	Low	Slight	**S3 I**
Old river terrace												
16	Sloping	150	VGrS	50.0	5.4	Excessively	Moderate	Nil	Slight	Low	Slight	**S3 Ir**
17		150	VGrS	45.0	5.0	Excessively	Moderate	High	Slight	Low	Slight	**S3 I**

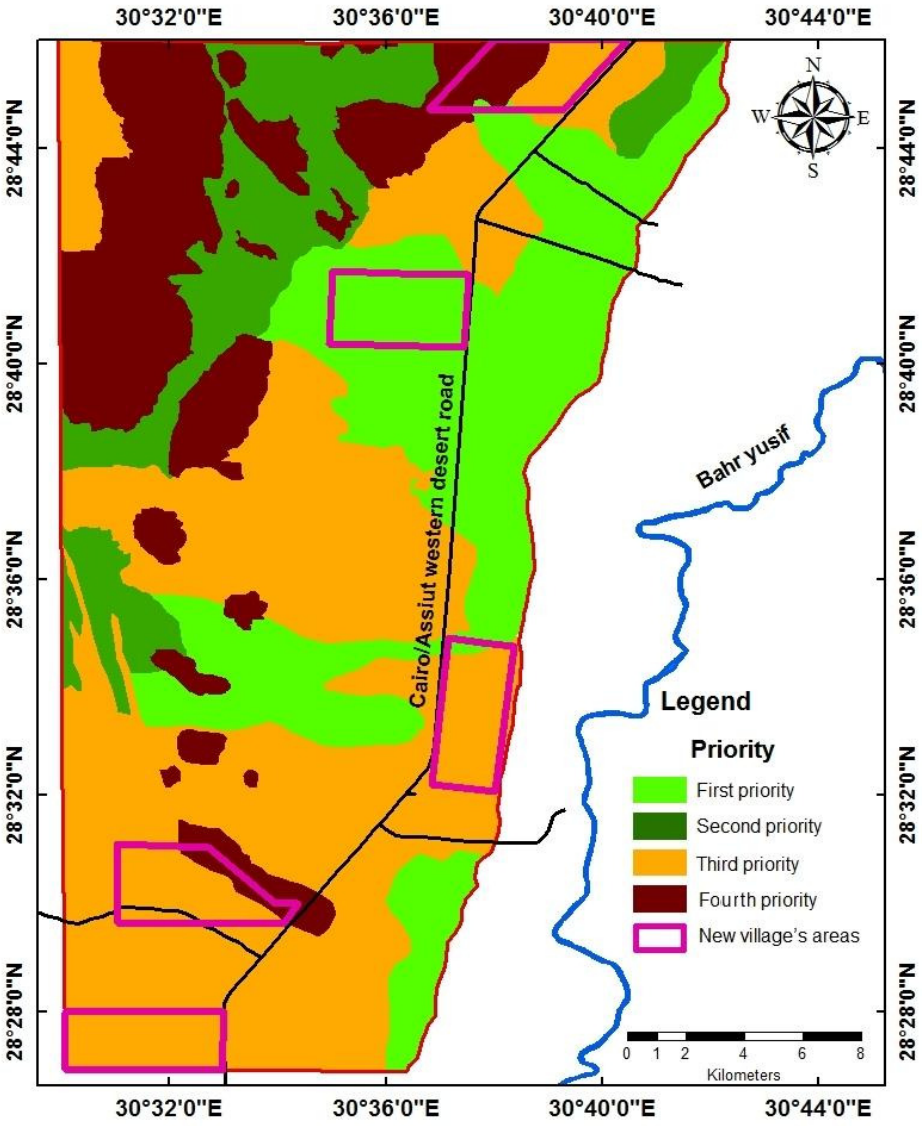
Text. = Texture Gr. = Gravel Erosiv. = Erosivity deff. = deficiency S = Sand LS = Loamy Sand GrS = Gravelly Sand
GrLS = Gravelly Loamy Sand VGrS = Very Gravelly Sand



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

In conclusion, soils of the immediate western desert fringe of El-Minia are affected by the western rocky areas, which rendered those terrace soils to contain relatively high content of carbonate and gypsum. Only new AshShaykh Mas'ud village belongs to the first priority for agricultural utilization, while, the rest villages under investigation classified as third priority. This may be present an important query around the selection of these new villages locations. Therefore, the study is considered of vital importance for decision makers and for the management of natural resources in this desert fringe of El-Minia. Such investigation is aggressively needed before the planning stage of the national schemes of agrarian

extension. On the other hand, integrating MicroLEIS Decision Support System DSS with spatial analyst in a GIS framework for mapping and analysis allows the use of spatial techniques to expand land evaluation results through geo-referenced map units.



Map (6). Land priority of agricultural utilization at the studied area.

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الملخص العربى

أولويات الاستغلال الزراعى لبعض المناطق الجديدة بالظهير الصحراوى لمحافظة المنيا – مصر

طاهر مصطفى حامد يوسف و محمد عزت عبد الهادى خليفة و أحمد سيد أحمد

قسم البيدولوجى – شعبة مصادر المياه والأراضى الصحراوية – مركز بحوث الصحراء

نظرا لتآكل الرقعة الزراعية بشكل مستمر فإن الضرورة تحتم سرعة البحث عن مساحات أرضية جديدة بالأقاليم الصحراوية تكون مناسبة لتنفيذ مشروعات التنمية الزراعية المتواصلة بها. لذا تهدف هذه الدراسة إلى تحديد أولويات الإستخدام الزراعى لبعض أراضى الظهير الصحراوى الغربى لمحافظة المنيا، حيث أختيرت منطقة الدراسة بين خطى طول ٠٠" ٣٠' ٣٠° و ٠٠" ٤٥' ٣٠° ودائرتى عرض ٥٦" ٢٦' ٢٨° و ٠١" ٤٦' ٢٨° ، لتغطى مساحة ١٢٤٦٩١ فدان. وتشتمل المنطقة المستهدفة بالدراسة على عدد ٥ قرى جديدة بالظهير الصحراوى الغربى لمحافظة المنيا وهى العطف، الشيخ مسعود، البهنسا، الهمة، وأبو الجود. تم حصر أراضى المنطقة بإستخدام ٩٠ قطاع أرضى ممثل للأشكال الأرضية السائدة بها، وتم تجميع عينات التربة منها لإجراء التحليلات المعملية اللازمة لتقدير صفات وخصائص التربة، وأختير منها ١٧ قطاع تربة ممثل بالدراسة الحالية. وبناءا على الدراسة الحقلية والتحليلات المعملية وتحليل المرئية الفضائية Landsat 8 OLI مع التحليل الطبوغرافى للنموذج الرقمى للإرتفاعات بإستخدام GIS، أمكن تمييز عدد (٩) أشكال أرضية بالخريطة الجيومورفولوجية للمنطقة هى السهل التحاتى – المراوح الرسوبية – المصاطب المجواه العليا والوسطى والدنيا – المصاطب النهرية القديمة – الهضبة الجيرية المقسمة – الكثبان الرملية – التلال الصخرية. كما أمكن تقسيم تربة هذه الأشكال الأرضية لعدد (٦) تحت مجموعة عظمى طبقا للتصنيف الأمريكى الحديث هى *Lithic Torripsamments – Typic Torripsamments – Typic Torriorthents – Typic Haplocalcids – Calcic Haplosalids – Haplogypsids*، مع تمييز عدد من الآفاق التشخيصية التحت سطحية التى تميز رتبة الأراضى الجافة Aridisols ببعض القطاعات مثل آفاق Salic – Gypsic – Calcic

كذلك تم تقييم القدرة الإنتاجية للأراضى بإستخدام نموذج CERVATANA لبرنامج MicroLEIS حيث وجد أن التربة تتبع قسمين من أقسام القدرة الإنتاجية وهما "متوسطة – S3" و "وغير منتجة – N" على إمتداد ٣٧.١ و٣٦.١٣ % من إجمالى المساحة على الترتيب، واللذان أمكن تقسيمهما لثلاث تحت أقسام هى S3 l ، S3 lr ، N l، تبعا لنوع وشدة المحدات الأرضية السائدة. وحددت الدراسة أنواع ومواقع المحدات الأرضية ببعض المساحات بالمنطقة

والتى تركزت فى وعورة السطح وشدة الميول – ضحالة قطاع التربة – سوء الصرف – إرتفاع الملوحة – إرتفاع نسبة الحصى – زيادة مخاطر التعرية. تم تصميم نموذج أولويات الإستغلال الزراعى PAUM لتقييم أولويات الإنتفاع الأرضى حيث حددت الدراسة أربعة درجات لأولوية الإستخدام الزراعى بالمنطقة. الأولوية الأولى إمتدت على ٢٥.٨٤ % من إجمالى مساحة المنطقة وكانت لأراضى المراوح الرسوبية والمصاطب المقسمة الدنيا وبعض أراضى المصاطب النهرية القديمة. أدرجت أراضى قرية الشيخ مسعود الجديدة فقط ضمن الأولوية الأولى للإنتفاع الزراعى بينما صنفت بقية القرى ضمن أراضى الأولوية الثالثة، مما يطرح تساؤلا حول الأسس الفنية التى أعتمد عليها فى إختيار المواقع الحالية للقرى الجديدة بالظهير الصحراوى الغربى لمحافظة المنيا. وفى العموم قدمت الدراسة دلائل كمية قد تكون من الأهمية بمكان لمتخذ القرار الزراعى فى إدارة الموارد الطبيعية بإقليم الظهير الصحراوى لمحافظة المنيا كنموذج لمحافظات صعيد مصر.

Effect of Some Macro Elements and Bio Fertilization on The Growth, Yield and Chemical Composition of Coriander Plant (*Coriandrum sativum* L.)

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ABSTRACT: Coriander (*Coriandrum sativum,* L.) is an important medicinal herbs worldaride. The objective of this study was to investigate the effect of mineral and bio fertilization on vegetative growth, yield, and chemical composition including essential oil**;** as well as, major compounds of *Coriandrum sativum* L. Therefore, two filed experiments were conducted at the Experimental Farm of the Nubaria station-ELbeharia**,** Egypt during 2013/2014 and 2014/2015 growing seasons. The experimental design was split plot design with three replicates. Mineral fertilizer levels (control, 50% NPK, 75% NPK and 100% NPK) occupied the main plots. The sub plot was assigned to five bio-fertilizer treatments, i.e.,uninoculation, phosphorein, cerealine, potassomage and mixed bio-fertilizer). Theresultsobtained could be summarized as follows: (1) the addition of mineral fertilizer at rate of 100% resulted in a significant increment in vegetative growth,yield and chemical composition of coriander plants during both seasons, (2) the application of 100%NPK with mixture of biofertilizers (phosphorein +cerealine + potasisomage) was the best combination to obtain the highest mean values of plant height, number of branches/plant, fresh and dry weights of herb/plant, number of umbels/plant, 100-seed weight and seed yield/fed, as well as, oil %, but major compounds resulted fromcombination of 75 % NPK with potassomage and mix of biofertilizers for the coriander were tested in this study. However, of traits under study increased significantly, due to inoculation treatments over the uninoculation (control) one and the mixture of biofertilizers was the best treatment. This investigation suggests the need for more studies concerning the effect of NPK fertilizer rates and biofertilizers on coriander plants under different environments using different types of soil in order to reach the optimum combination to achieve the best yield.
Keywords: Mineral fertilizers, biofertilization, coriander major compounds.

INTRODUCTION

Coriandrum sativum L. (coriander)Fam.Apiaceae is an important fresh culinary herb in the United States, widely used in Mexican, African and Asian cuisines (Cantwell and Reid, 1993). It is used as a spice in a wide variety of foods. The pungent leaves are called "cilantro" a basic ingredient in Latin American and Asian cooking. The leaves (cilantro) have a bold taste, combining a strong sage flavor with sharp-citrus noted. The roots are similar with an added nutty flavor and are used fresh only. The seeds of coriander have a taste of citrus and are used in medicinal house hold cosmetics and fragrance (Rashed, 2002).

Fertilization is one of the most important factors limiting the productivity of plants. The intensive use of expensive mineral fertilizers results in environmental pollution problems. Further, chemical fertilizers at extremely high rates to a long period decreased the potential activity of microflora and the stability of soil organic matter (Hussien, 1995).Also, bio-fertilization is an important factor being used to produce products without some mineral fertilizer that cause environmental pollution problems. Hence, the attention has been focused on the recreates of biofertilizers to safe alternative specific chemical fertilizers. Biofertilizers play a vital role for increasing the number of

microorganisms and accelerate certain microbial process in the rhizosphere of inoculated soil of plants (Kandeel *et al.,* 2001;Rashed, 2002; Mohamed and Abdu, 2004). This research, however, is an attempt to find out the best fertilization treatments (mineral NPK and biofertilizer on the vegetative growth, yield and chemical composition of corianderplants (*Coriandrum sativum* L.).

MATERIALS AND METHODS

Two filed experiments were carried out at the Experimental Farm of the Nubaria station, El-beharia, Egypt during both seasons of2013/2014 and 2014/2015, to study the effect of NPK, biofertilizer and their interaction on the growth,yield, chemical composition of coriander plants(*Coriandrum sativum* L.). The experimental design followed in this work was a split plot design with three replicates.where as the chemical fertilizers were arranged as maim plots and biofertilizers were arranged as sub plots. The replicate contain 20 treatments. The coriander seeds were sown on November 11th and 12thduring both growing seasons. Each sub plot in both experimental seasons was 3.5 meters long and 3 meter wide (10.5 m^2 i.e. 1/400 feddan) contained 10 rows 25 cm apart between plants. The applied chemical fertilizer were ammonium sulphate (20.5% N), calcium superphosphate (15.5%P_2O_5) and potassium sulphate (48% K_2O) at the rates of (100, 100 and 50 kg/fed), respectively which are the recommended dose. The used biofertilization of bacteria was phosphorein (*Bacillus megatherium* phosphorus dissoliving bacteria P. D.B.), potassiomage biofertilizer contains of *Bacillus* mucilaginousas a potassium dissolving bacteria (KDB) or potassium solubilizing bacteria (KSB) and cerealine (*Azosprillum lipoferum* and *Azotobacter chroococcum*) which supplied by Natioal Research Center. The inoculation with phosphorein, potassiomage and cerealine were performed by coating coriander seed with each product individually using a sticking substance (Arbic gum at 5%) just before sowing. The recommended dose of NPK was divided into two equal parts, the first one was applied one month after sowing and the second one was applied before the first irrigation. The tested treatments were conducted as follows:

A) NPK fertilizer (Main plot)
- Control (without fertilization)
- 50% NPK
- 75% NPK
- 100% NPK

B) Biofertilization (sub plot)
- Uninoculation (control)
- Phosphorein
- Cerealine
- Potassiomage
- Mixture (phosphorein + cerealine + potassiomage)

The physical and chemical characteristics of the experimental soil are given in Table (1) .The soil was analyzed according to the methods described by Page *et al.* (1982). At harvest dates on April 8th and 10thduring the two seasons, guarded plants were randomly taken from each plot and the following characteristics were recorded:

1. Plant height (cm)
2. Number of branches
3. Fresh and dry weight (g)/plant
4. Number of umbles/plant
5. 100-seed weight (g)
6. Seed yield (g)/plant
7. Seed yield (ton/fed)
8. Total chlorophyll (mg/g fresh weight)was determined in fresh leaves, samples of the fifth leaf from top at harvesting using the methods by Moran (1982).
9. The N, P and K contents were determined in the leaves which were driedat 70℃ for 48hr., and ground leaves (0.5 g) were digested with sulphuric acid and hydrogen peroxide H_2SO_4. H_2O_2 according to the method of Lowther (1980) and the following determination were carried out in the digested solution to determine the following:

- Nitrogen content (N%)
  Nitrogen was determined in the digested plant material colorimetrically by Nessler`smethod(Chapman and Pratt, 1978).

- Phosphorus content (P %)
  Phosphorus was determined by the Vanadomolyate yellow methodas given by Jackson (1973) and the intensity of color developed was read by spectrophotometer at 405nm.

- Potassium content (K %)
  Potassium was determined according to the method described by Jackson (1973) using Beckman Flame photometer.

- Essential oil percentage was determined in the air-dried seeds according to British Pharmacopocia (1963) by water distillation 40 g of herb for 1.5-2 hour, in order to extract the essential oil.

- The percentage of major compounds (linolool, α- 2-deenol, α-pinene,camphor and geraniol) were estimated by measuring the peak area of the different compounds of the chromatogram according to Heftman (1967) and Gunther and Joseph (1978).

The obtained data were analyzed statistically for ANOVA and L.S.D. values were calculated to least differences between the studied treatments according to Gomez and Gomez (1984).

Table (1). Physical and chemical analysis of the used soil before planting (average of 2013/2014 and 2014/2015seasons.

Parameter	Sample	Unit
Mechanical Analysis		
Sand	67	%
Silt	16	%
Clay	17	%
Textural class	Sandy loam	
pH (1:1)	7.55	-
EC(1:1, water extract)	3.3	dS/m
OM	0.32	%
Soluble cations		
Ca^{2+}	9.52	meq/l
Mg^{2+}	8.16	meq/l
Na^{+}	11.76	meq/l
K^{+}	1.28	meq/l
Soluble anions		
$HCO3^{-}$	2.7	meq/l
Cl^{-}	7.5	meq/l
SO_4^{2-}	11.73	meq/l
Available nutrients		
Nitrogen (N)	267.7	mg/kg
Phosphorus (P)	41.00	mg/kg
Potassium (K)	300.0	mg/kg

RESULTS AND DISCUSSION

A) Growth parameters and yield

Data in Tables (2 and 3) revealed that the fertilization treatment of 100 % NPK gave, significantly, the highest plant height, number of braches/plant, fresh and dry weight (g)/plant, number of umbles, 100-seed weight, seed yield (g)/plant and seed yield (ton)/fed, while, the least growth parameters and yield was obtained from the control treatment during both seasons. It could be concluded that, the role of available mineral nutrition as essential elements in building coriander umbles due to the positive effect of NPK in increasing the vegetative growth photosynthetic, as well as, the increasing seed yield (ton)/fed. These results coincided with those obtained by El-Mahrouk (2000) on *Swietteina mahogany* seedling, reported that 120+ 240 + 120 kg NPK/fed and 24 l/day; gave the highest significant plant growth, also, Reshad (2002)recorded similar trendon coriander, too.

The obtained results given in Tables (2 and 3)decleared that biofertilizers treatments exhibited a significant effect on all estimated traits during both seasons. Inoculation of mixture biofertilizer (phosphorein + cerealine + potassiomage) significantly increased growth parameters and yield. This finding could explain this positive effect of this mixture on growth characters and some yield in response to the phosphate potassium solubilizing bacteria and N-fixing

bacteria (cerealine) where this mixture may increase the synthesis of endogenous phytohormones i.e. indol acetic acid (IAA), gibberelline (GAS) and cytokinene(CKs) which play an important role in formation of a big active shoot and root systems which allow more nutrition uptake which reflect positively on both systems. The previous results agree, more or less, with the findings of Gad (2001) on *Aneithum graveolens*, Rashed (2002) on coriander, Abdel Latif (2002) on C*ariumcarvi* and Kandee l*et al.* (2001) and Mohamed and Abdu (2004) on *Foeniculumvulgare.*

Tables(4 and 5) declared that the interaction between NPK fertilizer and biofertilization was significant on all growth parameters and yield. The superiority effect of applying 100% NPK plus interaction mixture of bio-fertilizerswas noticeable to plant height, number of braches/plant, fresh and dry weight,s (g)/plant, number of umbles, 100-seed weight, seed yield (g)/plant and seed yield (ton)/fed.

Table (2).Plant height, number of branches, fresh and dry weight,sas affected by some macroelement,sand bio-fertilization during 2013 /2014 and2014 / 2015 seasons.

Treatments	Plant height (cm)		Number of branches/plant		Fresh weight/plant(g)		Dry weight/plant (g)	
	2014	2015	2014	2015	2014	2015	2014	2015
A) NPKfertilizer								
Control	86.32d	92.33c	7.30c	7.97c	354.50d	385.42c	69.65d	79.43d
50% NPK	104.93c	112.75b	10.80b	12.00b	536.37c	681.41a	103.38c	119.60c
75% NPK	111.84b	119.79a	11.57a	12.87c	609.83b	657.7b	120.39b	131.18b
100% NPK	113.47a	121.28a	11.93a	13.20a	634.51a	681.83a	128.06a	138.14a
L.S.D.(0.05)	**1.10**	**1.05**	**0.50**	**0.60**	**10.70**	**12.30**	**2.90**	**3.20**
B) Bio-fertilization								
Uninoculation	96.26d	104.07d	8.13d	9.25d	400.27d	448.25e	83.44e	94.13d
Phosphorein	103.32c	110.25c	9.12c	10.79c	516.59c	584.19c	108.40c	118.63c
Cerealine	106.43b	114.61b	11.13b	12.33b	560.57b	605.58b	113.77b	123.88b
Potassmage	105.95b	113.74b	9.25c	10.38c	527.16c	567.80d	104.88d	114.88c
Mixed	108.80a	117.38a	13.58a	14.92	627.80a	675.79a	124.77a	134.78a
L.S.D.(0.05)	**1.20**	**1.30**	**0.70**	**0.85**	**11.20**	**12.60**	**3.10**	**4.60**
Interactions								
Ax B	*	*	*	*	*	*	*	*

Means of each factor designated by the same letter not significantly different at 5% using least Significant difference (L.S.D.)
*: Significant at 0.05 and 0.01 level of probability.

Table (3).Number of umbles, 100-seed weight, seed yield plant and seed yield fed as affected by some macroelement,s and bio-fertilization during 2013 /2014 and 2014 / 2015 seasons.

Treatments	Number of umblers/plant		100-seed weight (g)		Seed yield (g)/plant		Seed yield (ton)/fed	
	2014	2015	2014	2015	2014	2015	2014	2015
A) NPKfertilizer								
Control	104.43d	114.94d	1.45c	1.46c	73.40c	79.71d	0.880d	0.955d
50% NPK	157.07c	172.59c	1.55b	1.57b	82.51b	88.50c	0.967c	1.062c
75% NPK	175.97b	191.84b	1.58b	1.61b	89.66a	94.30b	1.064b	1.135b
100% NPK	180.05a	197.83a	1.62a	1.66a	90.37b	96.54a	1.085a	1.158a
L.S.D.(0.05)	**2.75**	**4.20**	**0.03**	**0.04**	**1.05**	**1.10**	**0.018**	**0.020**
B) Bio-fertilization								
Uninoculation	133.23e	134.79d	1.49d	1.51d	79.51e	85.11e	0.925e	1.021e
Phosphorein	144.59c	158.39c	1.52c	1.55c	80.58d	86.70d	0.967d	1.040d
Cerealine	164.66b	180.82b	1.56b	1.58bc	83.66c	89.07c	1.004c	1.071c
Potassmage	138.39d	153.57c	1.58ab	1.61ab	86.84b	91.88b	1.042b	1.102b
Mixed	201.16a	218.97a	1.60a	1.63a	88.12a	96.07a	1.057a	1.151a
L.S.D.(0.05)	**5.50**	**5.70**	**0.02**	**0.03**	**0.92**	**1.05**	**0.012**	**0.018**
Interactions								
Ax B	*	*	*	*	*	*	*	*

Means of each factor designated by the same letter not significantly different at 5% using least Significant difference (L.S.D.)
*: Significant at 0.05 and 0.01 level of probability.

Table (4). Interaction between NPK fertilizer and biofertilization on fresh and dry weights/plant during 2013 /2014 and 2014 /2015 seasons.

Treatments		Fresh weight (g)		Dry weight (g)	
NPK fertilizer	**Bio-fertilization**	**2014**	**2015**	**2014**	**2015**
Control	Uninoculation	311.20	343.44	57.87	67.33
	Phosphorein	354.47	381..64	71.17	81.50
	Cerealine	362.10	393.05	73.00	83.00
	Potassmage	339.47	366.90	67.40	76.60
	Mixed	405.33	439.06	78.83	88.70
50% NPK	Uninoculation	354.40	392.02	79.57	89.60
	Phosphorein	352.53	597.07	113.43	123.40
	Cerealine	568.13	615.64	116.00	127.00
	Potassmage	562.40	606.23	111.23	122.20
	Mixed	644.37	697.57	126.67	136.70
75% NPK	Uninoculation	473.87	513.23	95.17	105.20
	Phosphorein	614.93	644.44	119.83	129.90
	Cerealine	653.87	706.18	133.40	143.50
	Potassmage	592.67	636.50	116.10	126.40
	Mixed	708.80	768.13	140.47	150.60
100% NPK	Uninoculation	501.60	544.31	101.13	111.40
	Phosphorein	644.27	693.60	129.17	139.20
	Cerealine	658.14	707.46	132.67	142.70
	Potassmage	614.13	661.55	124.20	154.30
	Mixed	754.40	798.39	153.10	163.10
L.S.D.(0.05)		**11.80**	**12.20**	**3.70**	**4.90**

Table (5). Interaction between NPK fertilizer and biofertilization on 100-seed weight and seed yield during 2013/2014 and2014 / 2015 seasons.

Treatments		100-seed weight (g)		Seed yield (g)/plant	
NPK fertilizer	**Bio-fertilization**	**2013/2014**	**2014/2015**	**2013/2014**	**2014/2015**
Control	Uninoculation	1.40	1.42	70.31	75.73
	Phosphorein	1.44	1.45	70.55	77.03
	Cerealine	1.47	1.47	75.12	80.43
	Potassmage	1.47	1.48	76.88	82.07
	Mixed	1.48	1.50	73.83	83.30
50% NPK	Uninoculation	1.50	1.50	76.47	83.44
	Phosphorein	1.51	1.53	77.84	83.98
	Cerealine	1.57	1.58	80.39	86.84
	Potassmage	1.59	1.61	87.33	91.74
	Mixed	1.56	1.63	90.51	96.48
75% NPK	Uninoculation	1.51	1.5	84.62	89.39
	Phosphorein	1.55	1.58	85.63	91.44
	Cerealine	1.58	1.63	88.04	93.76
	Potassmage	1.60	1.65	91.18	96.56
	Mixed	1.65	1.66	92.83	100.35
100% NPK	Uninoculation	1.55	1.59	86.63	91.89
	Phosphorein	1.58	1.62	88.01	94.33
	Cerealine	1.60	1.65	91.10	95.23
	Potassmage	1.66	1.69	91.83	97.14
	Mixed	1.70	1.73	94.30	104.10
L.S.D.(0.05)		**0.03**	**0.04**	**1.30**	**1.45**

B) Total chlorophyll and Chemical composition

Data in Table (6) showed the effect of NPKfertilizer and biofertilization on total chlorophyll, N%, P% and K% in the leaves during the bothseasons.As for the effect of NPK fertilization obtained data showed that the treatment of 100 % NPK, gavethe highest total chlorophyll (1.864 and 1.378 (mg/g F.W.)N (2.29 and 2.33%), P (0.599 and 1.592%) andK(5.19 and 5.69%),for the both seasons respectively while theleasttotal chlorophyll, and N, P and K% were obtained from the control treatment during bothseasons. Results in Table (6) declared that thetotal chlorophylland chemical compositionincreased due to using all different commercial bio-fertilizers when compared to the uninoculation (control) treatment with significant differences in the most traits during both season. However, the highest mean values of chemical composition during both seasons were observed due to inoculation by the mixture biofertilizer. On the other hand, bio-fertilizers treatment resulted in the highest values of all studied parameters in comparison to the other treatments during both seasons. Hence, it could be concluded that these findings may be taken place due to that the active role of phosphorus, potassium dissolving bacteria and N-fixation (cerealine) and increasing the endogenous phytohormones as reported earlier which play an important rolesin life cycles of both shoot and root systems.

These obtained results are in compatible with those obtained by Kandeel *et al.* (2001) on *Foeniculum vulgare* and Osman (2000) on coriander. The interaction between NPKf ertilizer and biofertilization was significant on alltraits during both seasons (Table 7), whereas, theapplication of 100 % NPK and mixturebiofertilization on root zone of plant as result of adding fertilization treatments reflected positively on nutrients uptake by plants and confirm the previous vegetative growth. Similar results, more or less, were obtained by Aly (1994) on saponaria. Also, Jacoub (1999) on *Ocimum basilicum*, found that as all NPK rates increased; chemical compositionin the leaves and stem increased.

Table (6).Total chl. and N, P and K% as affected by some macroelements and bio-fertilization during during 2013/2014 and 2014 / 2015 seasons.

Treatments	Total chlorophyll (mg/g)		N%		P%		K%	
	2014	2015	2014	2015	2014	2015	2014	2015
A) NPKfertilizer								
Control	0.875d	0.884d	1.16d	1.21d	0.334d	0.352d	2.36d	3.05d
50% NPK	1.069c	1.079c	1.47c	1.49c	0.478c	0.465c	3.53c	3.91c
75% NPK	1.195b	1.207b	1.83b	1.88b	0.537b	0.531b	4.35b	4.81b
100% NPK	1.364a	1.378a	2.29a	2.33a	0.599a	0.592a	5.19a	5.69a
L.S.D.(0.05)	**0.080**	**0.087**	**0.20**	**0.25**	**0.055**	**0.057**	**0.45**	**0.40**
B) Bio-fertilization								
Uninoculation	1.017d	1.026d	1.44d	1.49d	0.402d	0.335d	3.52d	3.85c
Phosphorein	1.106c	1.117c	1.67c	1.69c	0.508b	0.542b	3.74cd	4.13b
Cerealine	1.176b	1.188b	1.80b	1.83b	0.485c	0.501b	3.99b	4.28b
Potassmage	1.076c	1.086c	1.67c	1.70c	0.445c	0.451c	4.29a	4.71a
Mixed	1.256a	1.267a	1.89a	1.92a	0.582a	0.583a	4.35a	4.84a
L.S.D.(0.05)	**0.075**	**0.072**	**0.07**	**0.07**	**0.060**	**0.065**	**0.22**	**0.19**
Interactions								
Ax B	*	*	*	*	*	*	*	*

Means of each factor designated by the same letter not significantly different at 5% using least Significant difference (L.S.D.)
*: Significant at 0.05 and 0.01 level of probability.

Table (7).Total chl. and N, P, and K% as effected by Interaction between NPK fertilizer and bio-fertilizer sources during 2013 / 2014 and 2014 /2015 seasons.

Treatments		Total Chlorophyll (mg/g F.W.)		N (%)		P (%)		K (%)	
NPK fertilizer	Bio-fertilization	2013/2014	2014/2015	2013/2014	2014/2015	2013/2014	2014/2015	2013/2014	2014/2015
Control	Uninoculation	0.765	0.772	1.00	1.08	0.247	0.267	2.30	2.50
	Phosphorein	0.852	0.861	1.14	1.16	0.354	0.401	2.59	2.94
	Cerealine	0.903	0.912	1.23	1.28	0.350	0.344	2.81	3.09
	Potassmage	0.827	0.837	1.21	1.21	0.317	0.340	3.00	3.30
	Mixed	1.028	1.034	1.24	1.29	0.400	0.407	3.10	3.40
50% NPK	Uninoculation	0.962	0..972	1.29	1.22	0.384	0.307	3.17	3.49
	Phosphorein	1.069	1.076	1.44	1.47	0.504	0.534	3.23	3.57
	Cerealine	1.134	1.147	1.54	1.57	0.477	0.490	3.36	3.68
	Potassmage	1.035	1.046	1.50	1.53	0.447	0.440	3.92	4.34
	Mixed	1.140	1.152	1.60	1.64	0.574	0.551	3.99	4.48
75% NPK	Uninoculation	1.108	1.118	1.56	1.62	0.480	0.354	3.82	4.18
	Phosphorein	1.183	1.197	1.81	1.85	0.544	0.587	4.09	4.48
	Cerealine	1.263	1.276	1.93	1.98	0.520	0.540	4.18	4.59
	Potassmage	1.153	1.161	1.72	1.80	0.494	0.474	4.81	5.35
	Mixed	1.266	1.282	2.12	2.18	0.644	0.647	4.83	5.42
100% NPK	Uninoculation	1.231	1.242	1.92	2.00	0.497	0.410	4.79	5.23
	Phosphorein	1.319	1.332	2.27	2.29	0.627	0.644	5.01	5.53
	Cerealine	1.401	1.417	2.46	2.48	0.590	0.627	5.27	5.74
	Potassmage	1.287	1.298	2.23	2.27	0.520	0.550	5.39	5.86
	Mixed	1.587	1.599	2.56	2.58	0.707	0.727	5.47	6.07
L.S.D.(0.05)		**0.084**	**0.090**	**0.29**	**0.30**	**0.064**	**0.068**	**0.48**	**0.43**

C) Major components percentage of essential oil

The effect of NPK fertilization treatments and biofertilization on essential oil of major components (Linalool, α-2-deenol, α- Pinene, Camphor and Geraniol) percentages are shown in Table (8). The recorded results indicated that using application 75 % NPKfertilization treatments had thehighest values for the studiedmajor components percentage of coriander oil in the sameTable. The interaction with potassiomage and mixture biofertilizer, brought about gave the highest percentage of major components in 2014 / 2015season.Similarresults were reported by Darzi *et al.* (2011) on anisum and Khalil (2008) on Foeniculum vulgare.

The highest values were produced by applied at 75 % NPK with inoculation of potassmage and mixed biofertilizer (Table8).

Table (8). Major components percentage as affected by mineral and bio-fertilization during 2014 /2015 seasons.

Treatments	Linalool%	α-2-deenol%	α-Pinene%	Camphor%	Geraniol%
A) NPK fertilizer					
Control	47.08d	13.47d	432c	5.19c	1.95
50% NPK	48.31b	15.00b	4.53b	5.54b	2.34
75% NPK	48.38a	15.10a	4.61a	5.87a	2.70
100% NPK	48.01e	14.89c	4.59a	5.88a	2.53
L.S.D.(0.05)	**0.05**	**0.06**	**0.04**	**0.06**	**0.06**
B) Bio-fertilization					
Uninoculation	47.95d	14.58b	4.49c	5.46d	2.20
Phosphorein	48.06c	14.56b	4.50bc	5.57c	2.35b
Cerealine	48.11bc	14.64a	4.52ab	5.64b	2.38
Potassmage	48.32a	14.65a	4.53a	5.69ab	2.50a
Mixed	48.14b	14.67a	4.54a	5.74a	2.49a
L.S.D.(0.05)	**0.06**	**0.05**	**0.02**	**0.05**	**0.04**
Interactions					
Ax B	*	*	*	*	*

Means of each factor designated by the same letter not significantly different at 5% using least Significant difference (L.S.D.)

*: Significant at 0.05 and 0.01 level of probability.

Table (9). Interaction between mineral fertilizer and bio-fertilization on major components percentage in 2014 / 2015 seasons.

NPK fertilizer	Bio-fertilization	Linolool	α-2-deenol	α-Pinene	camphor	Geraniol
Control	Uninoculation	47.08	13.46	4.30	5.02	1.85
	Phosphorein	47.11	13.47	4.30	5.11	1.94
	Cerealine	47.30	13.47	4.33	5.23	1.96
	Potassmage	47.20	13.48	4.34	5.31	2.01
	Mixed	47.50	13.47	4.33	5.30	2.00
50% NPK	Uninoculation	48.31	14.82	4.48	5.38	1.98
	Phosphorein	48.42	14.91	4.49	5.51	2.31
	Cerealine	48.48	15.02	4.53	5.51	2.38
	Potassmage	48.91	15.08	4.56	5.59	2.52
	Mixed	48.75	15.18	4.61	5.62	2.52
75% NPK	Uninoculation	48.38	15.11	4.59	5.63	2.45
	Phosphorein	48.41	15.03	4.61	5.73	2.60
	Cerealine	48.51	15.15	4.61	5.92	2.63
	Potassmage	48.83	15.11	4.63	5.95	2.91
	Mixed	48.61	15.11	4.62	6.14	2.89
100% NPK	Uninoculation	48.01	14.91	4.59	5.81	2.51
	Phosphorein	48.31	14.82	4.59	5.92	2.53
	Cerealine	48.32	14.89	4.60	5.91	2.53
	Potassmage	48.31	14.91	4.60	5.90	2.54
	Mixed	48.31	14.92	4.59	5.88	2.56
L.S.D.(0.05)		**0.05**	**0.06**	**0.04**	**0.05**	**0.05**

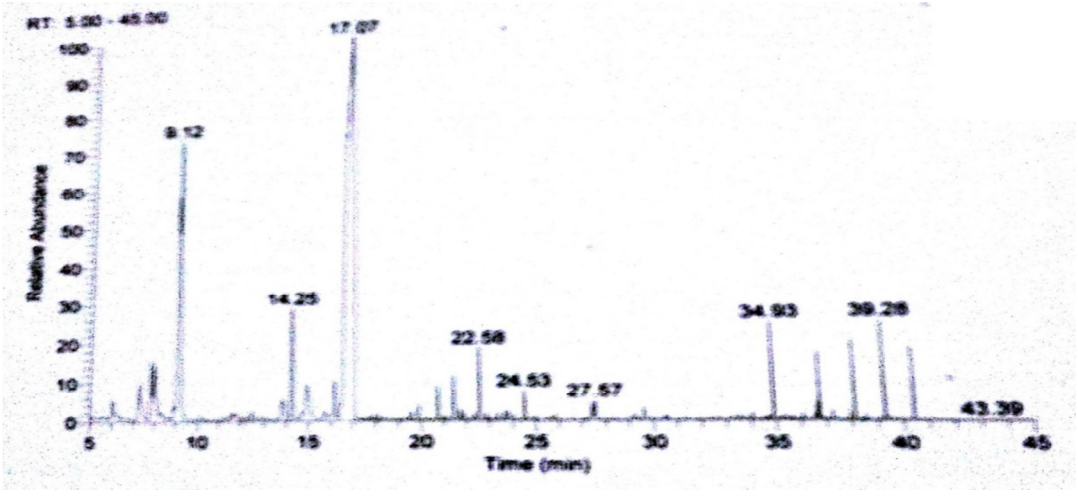

Fig (1). Typical chromatogram of Coriander oil

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الملخص العربي

تأثير التسميد ببعض العناصر الكبري والتسميد الحيوي علي النمو والمحصول والمحتوي الكيماوي لنبات الكزبرة

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**قسم بحوث النباتات الطبية والعطرية – مركز البحوث الزراعية – شعبة إنتاج وتكنولوجيا النباتات الطبية والعطرية

أجريت هذة الدراسة بمزرعة محطة النوبارية بالبحيرة– مصر خلال موسمي النمو ٢٠١٣/٢٠١٤، ٢٠١٤/ ٢٠١٥. وكان الهدف من هذه الدراسة هو دراسة تأثير التسميد المعدني والحيوي علي النمو الخضري والإنتاج والمكون الكيماوي والزيوت الفعالة وكذلك المكونات الرئيسية لنمو النبات ولذلك أقيمت تجربتان حقليتان لدراسة تأثير التسميد المعدني والحيوي علي النمو الخضري، المحصول، المكونات الكيميائية شاملة محتوي الزيت بالإضافة الي محتوي المكونات الفعالة للزيت لنبات الكزبرة. حيث صممت التجربة بتصميم القطع المنشقة مرة واحدة مع ثلاث مكررات. وكان التسميد المعدني (كنترول، ٥٠% ن فو بو، ٧٥%ن فو بو، ١٠٠%ن فو بو) كقطع رئيسية، أما القطع الشقية فوزعت بخمس معاملات تسميد حيوي (بدون تلقيح، فوسفورين، سيريالين، بوتاسيوماج، خليط الأسمدة الحيوية) .

ويمكن تلخيص أهم النتائج المتحصل عليها فيما يلي:

١. كان لإضافة التسميد المعدني عند ١٠٠% ن فو بو تأثيراً معنوياً علي صفات النمو الخضري، المحصول، المكونات الكيميائية مقارنة بالكنترول لنباتات الكزبرة في كلا الموسمين.

٢. كان أفضل تداخل بين إضافة١٠٠% ن فو بومع خليط الأسمدة الحيوية (فوسفورين، سيريالين، بوتاسيوماج) حيث أعطي أعلي متوسط قيم لإرتفاع النبات، عدد الأفرع/نبات، الوزن الطازج والجاف للعشب/نبات، عدد النورات/نبات، وزن ١٠٠ بذرة، محصول البذور/فدان إلي النسبة المئوية للزيت ولكن محتوي مكونات الزيت أنتجت من التداخل بين ٧٥% ن فو بو مع البوتاسيوماج وخليط من الأسمدة الحيوية لنبات الكزبرة ومع هذا فإن

الصفات تحت الدراسة زادت معنوياً عند معاملات التلقيح مقارنة بدون تلقيح (الكنترول) حيث أن خليط الأسمدة الحيوية كان أفضل معاملة .

٣. هذه الدراسة تقترح مزيد من الدراسة لتأثير معدلات التسميد المعدني والحيوي علي نبات الكزبرة تحت مختلف البيئات وبإستخدام أنواع مختلفة من الأراضي للحصول علي أقصي تداخل لأفضل إنتاج .

Improving some Wheat Cultivars Productivity Using Hypertonic and Humic Acid in Saline Soils

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ABSTRACT: In order to improve productivity of three wheat cultivars as affected by soil salinity conditions by using nano- technological compound (Hypertonic) and humic acid, two field experiments were conducted at the Abess Region, Alexandria Governorate, Egypt, during 2014/2015 and 2015/2016 growing seasons, in split plot design in three replications. The main plots included four salinity alleviated compounds namely; Hpertonic (nano-compound), Humic acid (HA), Hypertonic + HA, and control treatments, while three wheat cultivars (Sakha 93, Sids 12 and Giza 168) was allocated in the sub plot. The results revealed that significant increase was recorded on plant height (cm), spike number/m^2, spikelets number/spike, grains number/spike, 1000- kernel weight, grain, straw, and biological yields (tons/ha.) as well as harvest index % by using Hypertonic + humic acid in both growing seasons. Sids cultivar recorded the highest mean values for the previous mentioned characters under study. Sowing Sids 12 cultivar under the application of nano-compound and humic acid recorded the highest mean values of yield and its components as compared with Sakha 93 and Giza 168 cultivars under Alexandria conditions.
Key words: *wheat, cultivars, productivity, humic acid, nano-compound, salinity, hypertonic*

INTRODUCTION

Wheat (*Triticum aestivum,* L.) is the most widely grown crop in the world with its unique protein characteristics that serves as an important source of food and energy (Abedi *et al*., 2010). Mature wheat grains contain 8–14% protein, which are divided into two major categories: prolamins including gliadins and glutenins and non-prolamins consisting of water-soluble albumins and salt-soluble globulins (Singh and Skerritt, 2001).

Introduction of the first generation of technology to agriculture resulted in the green revolution and changed the traditional agriculture to modern intensive agriculture. Today, nanotechnology as a novel technology has solved many problems in different fields of science and industry and has found its position and functions in agriculture. Nanotechnology has various functions in all stages from production, processing, storage, packing and transportation of agricultural products (Scott and Chen, 2003).

The use of nano- compounds leads to reduce the toxicity of the soil and increased efficiency of the elements to at least reach the negative effects caused by the consumption of excessive consumption of fertilizers and reduce the frequency of application of fertilizers (Naderi and Danesh Shahraki, 2011).

The mechanism of humic acid activity in promoting plant growth is not completely known, but several explanations have been proposed by some

researchers such as increasing cell membrane permeability, oxygen uptake, respiration and photosynthesis, phosphate uptake, and root cell elongation (Türkmen *et al.,* 2004), Moreover addition of HA to soil increases the rate of absorption of ions on root surfaces and their penetration into the cells of the plant tissue. Humic acid (HA) application positively affected the plant parameters of plants grown in salinity condition (Türkmen *et al.,* 2005). It also increases both mater and fertilizer retention and stimulate beneficial microbial activity.

Humic acid is an important constituent of soil organic matter which enhances the growth and yield of crops and improves soil physical and chemical characteristics, such as aeration, permeability, water holding capacity, aggregation, availability and transportation of ions through pH buffering (Khan *et al.,* 2012).

This investigation aims to improve some wheat cultivars productivity using nano- technology compound (hypertonic) and humic acid in salt- affected soils.

MATERIALS AND METHODS

Two field experiments were conducted at the Experimental Station Farm of the Faculty of Agriculture (Saba Basha), Alexandria University, Egypt, during 2014/2015 and 2015/2016 growing seasons, to investigate the effect of nanocompound and humic acid on some wheat cultivars under salinity conditions.

A split- plot design with three replicates was used. N and humic acid (HA) application) i.e. Hypertonic (Nano), Humic acid, Hypertonic + humic acid, and control treatment were arranged in main plots. Wheat cultivars (Sakha 93, Sids 12, and Giza 168) were allocated in sub-plots.

The size of each plot was 10.5 m^2 (3.5 x 3.0 m) surrounded by ditches to avoid water movement into adjacent plots.

Humic acid (Table 1) was applied with sowing at rate of 5 kg/fed. While Nano- compound (Hypertonic which structured from 10% Ca, 15 % carbocyclic acids, 10 % Seaweed extract and 5 % Biosac) was applied at rate of 5.00 L/fed., with each irrigation every 25 days.

Table (1). Humic acid analysis

Product analysis	
Product name	Techno Potas- Humic acid
Formula (W/W)	12% K_2O – HA 75 %
Potassium K_2O (on dry basis)	12 % (W/W)
Humic acid (on dry basis)	75 % (W/W)
Moisture	15 (Max.)
P^H (1% solution)	9 -10 (Max.)
Water solubility	95 % (Min.)

The sowing method was broadcasting in both seasons. Sowing dates were 21th and 28th November in both seasons 2014/2015 and 2015/2016, respectively, while, seeding rate was 70 - 80 kg grains/fed., according to wheat cultivar. First irrigation was applied 25 days after sowing and then plants were irrigated every 25 days till the dough stage.

Nitrogen fertilizer at rate of 75 kg N/fed. In the form of urea (46.50 %N), was added in three doses. The first dose (20 kg N/fed.) was added at sowing time, the second dose (35 kg N/fed.) was added with the first irrigation (25 days after sowing) and the third dose (20 kg N/fed.) was added (25 days after the first irrigation). Calcium Super phosphate fertilizer (15.5 % P_2O_5) was applied before sowing at rate of 100 kg/fed., (the recommended dose). Potassium fertilizer was applied before sowing (during seedbed preparation) at rate of 50 kg/fed., in the form of potassium sulphate (48 % K_2O) (the recommended dose).

The preceding crop was maize (*Zea mays* L.) in both cropping seasons. Soil samples of the experimental sites were taken at the depth of (0-30 cm). Physical and chemical analysis were done according to Chapman and Pratt (1978) are presented in Table (2)

Table (2). Some Physical and chemical properties of the experimental soil in 2014 / 2015 and 2015/2016 seasons.

Soil properties	Season	
	2014/2015	2015/2016
A) Mechanical analysis		
Clay %	38	37
Sand %	32	33
Silt %	30	30
Soil texture	Clay loam soil	
B) Chemical properties		
P^H (1 : 1)	8.20	8.31
EC (dS/m)	3.80	3.70
1) Soluble cations (1:2) (cmol/kg soil)		
K^+	1.52	1.54
Ca^{++}	9.4	8.7
Mg^{++}	18.3	18.5
Na^{++}	13.50	13.8
2) Soluble anions (1 : 2) (cmol/kg soil)		
$CO_3^{--} + HCO_3^-$	2.90	2.80
Cl^-	20.4	19.80
SO_4^{--}	12.50	12.60
Calcium carbonate (%)	6.50	7.00
Total nitrogen (%)	1.00	0.91
Available phosphorus (mg/kg)	3.70	3.55
Organic matter (%)	1.41	1.40

Plant height (cm), yield and its components were characterized as spike length (cm), spike number/m^2, spikelets number /spike, grains number /spike, 1000-grains weight (g), grain yield, straw yield, biological yield (kg/fed) and harvest index (%).

All data collected were subjected to analysis of variance according to Gomez and Gomez (1984). All statistical analysis was performed using analysis of variance technique by means of CoStat computer software package (CoStat, Ver. 6.311., 2005).

RESULTS AND DISCUSSION

Data presented in Table (3) reveal the effect of nano- compounds (hypertonic) and humic acid (HA) application on plant height (cm), spikes number/m^2, spikelets number/spike, grains number/spike and 1000- kernel weight (gm) of Sakha 93, Sids 12 and Giza 168 wheat cultivars under salinity soil conditions in 2014/2015 and 2015/2016 seasons. Whereas nano- compounds (hypertonic) and humic acid, significantly, affected on these attributes during both cropping seasons. Whereas, the highest mean values of those characters were recorded with Hypertonic + humic acid as compared with other treatments in both seasons. The increase in these characters may be due to the role of hypertonic and humic acid decreasing salinity effect on wheat plants. These results are in agreement with those obtained by Tahir *et al.* (2009); Saruhan *et al.* (2011); Harsini *et al.* (2014); Akhtar *et al*. (2015) who concluded that humic acid and nano-compound increased growth and yield and its components.

Significant, differences among wheat cultivars for plant height (cm), spikes number/m^2, spikelets number/spike, grains number/spike and 1000- kernel weight (gm) are shown in Table (3) during the two cropping seasons. The cultivar “Sids 12” recorded the highest mean values of above mentioned attributes, while “Giza 168” cultivar gave the lowest ones during the two growing seasons. These differences between wheat cultivars are mainly due to genetic differences between the three cultivars. Hafez (2007); Majer *et al.* (2008); Abo-Marzoka (2009); Jatoi *et al.* (2011); Raza *et al.* (2012); Al-Temimi *et al.* (2013) who found high significant differences between the wheat cultivars under their studies for plant height.

Salinity alleviated compounds interact, significantly, with wheat cultivars for plant height (cm), spikes number/m^2, spikelets number/spike, grains number/spike and 1000- kernel weight (g) in both cropping seasons Table (3). Likewise, “Sids 12” cultivar treated with hypertonic + humic acid gave the highest values of these traits. Meanwhile the lowest ones were recorded by the untreated “Giza 168” cultivar (without hypertonic or humic acid) in the first and the second season, respectively.

Table (3). Average of plant attributes for three wheat cultivars (C) as affected by hypertonic, humic acid (S) and their interaction during 2014/2015 and 2015/2016 seasons

Attributes	Salinity alleviated compounds (S)	Season 2014/2015							Season 2015/2016						
		Sakha 93	Sids 12	Giza 168	Average (S)	L.S.D (S) at 0.05	L.S.D (C) at 0.05	L.S.D (CxS) at 0.05	Sakha 93	Sids 12	Giza 168	Average (S)	L.S.D (S) at 0.05	L.S.D (C) at 0.05	L.S.D (CxS) at 0.05
Plant height (cm)	Hypertonic(Nano)	99.23	108.20	88.33	98.59b	3.53	3.78	7.55	97.93	107.67	87.13	97.58b	2.47	3.70	7.39
	Humic	93.67	106.67	92.67	97.67b				88.63	108.57	91.23	96.14b			
	Hypertonic +humic	110.00	119.60	104.00	111.20a				108.70	118.90	103.47	110.36a			
	Control	98.83	111.17	84.33	98.11b				96.40	109.97	83.47	96.61b			
Average (C)		100.43b	111.41a	92.33c					97.92b	111.28a	91.33c				
Spikes number /m^2	Hypertonic(Nano)	211.67	245.00	204.00	220.22ab	43.85	30.10	60.21	213.50	253.33	215.33	227.39ab	40.10	29.51	59.01
	Humic	245.00	270.33	219.33	244.89ab				260.50	285.83	234.83	260.39a			
	Hypertonic +humic	231.67	281.33	266.00	259.67a				243.00	280.67	264.00	262.56a			
	Control	152.33	243.00	210.33	201.89b				153.17	260.00	217.17	210.11b			
Average (C)		210.17b	259.92a	224.92b					217.54b	269.96a	232.83b				
Spikelets number/spike	Hypertonic(Nano)	17.67	20.67	18.37	18.90bc	1.23	1.06	2.12	16.00	18.67	17.20	17.29c	0.741	1.08	2.15
	Humic	17.17	22.83	17.67	19.22b				17.37	22.33	16.33	18.68b			
	Hypertonic +humic	20.83	22.13	22.83	21.93a				20.33	22.33	21.83	21.50a			
	Control	17.50	19.53	16.67	17.90c				16.17	18.50	15.33	16.67c			
Average (C)		18.29b	21.29a	18.89b					17.47b	20.46a	17.67b				
Grains number/spike	Hypertonic(Nano)	47.17	55.00	48.50	50.22c	2.06	1.41	2.82	47.17	55.00	48.50	50.22c	2.06	1.41	2.82
	Humic	52.53	65.67	48.17	55.46b				52.53	65.67	48.17	55.46b			
	Hypertonic +humic	56.00	70.33	53.00	59.78a				56.00	70.33	53.00	59.78a			
	Control	47.27	52.37	43.67	47.77d				47.27	52.37	43.67	47.77d			
Average (C)		50.74b	60.84a	48.34c					50.74b	60.84a	48.34c				
1000- kernel weight (g)	Hypertonic(Nano)	46.20	50.17	42.83	46.40c	1.280	1.284	2.56	47.67	53.37	44.83	48.62c	1.81	1.34	2.67
	Humic	46.90	53.50	48.57	49.66b				48.33	56.00	48.27	50.87b			
	Hypertonic +humic	48.43	59.00	52.87	53.43a				50.53	61.67	54.20	55.47a			
	Control	38.43	48.00	38.33	41.59d				38.00	44.67	38.93	40.53d			
Average (C)		44.99b	52.67a	45.65b					46.13b	53.93a	46.56b				

-Mean values in the same column/row marked with the same letters are not significantly different at 0.05 level of probability.

The obtained data in Table (4) indicate the effect of nano- compounds (hypertonic) and humic acid (HA) application on grain, straw, and biological yields, and harvest index (H.I. %) of Sakha 93, Sids 12 and Giza 168 wheat cultivars under salinity soil conditions in 2014/2015 and 2015/2016 seasons. Whereas salinity alleviated compounds (nano- compounds (hypertonic) and humic acid), significantly, affected on these characters in both cropping seasons. Whereas, the highest mean values of these character were recorded with the hypertonic + humic as compared with other treatments in both seasons. The increase in these characters may be due to the role of hypertonic and humic acid in decreasing salinity effect on wheat plants. These results are in harmony with those obtained by Saruhan *et al.* (2011); El-Bassiouny *et al*. (2014); Akhtar *et al*. (2015); Vafa *et al.* (2015) who reported that humic acid and nano- compound increased growth and yield and its components.

Significant, differences among wheat cultivars for grain, straw, and biological yields, and harvest index (H.I. %) are shown in Table (3) during the two cropping seasons. The cultivar “Sids 12” recorded the highest mean values of above mentioned attributes, while “Giza 168” cultivar gave the lowest ones during the two growing seasons. These differences between wheat are mainly due to genetic differences between the three cultivars. El-Esh (2007); Ganbalani *et al*., (2009); Buhedma (2011); Raza *et al.* (2012); Al-Temimi *et al.* (2013); Bakry *et al.* (2013) found high significant differences between the wheat cultivars under their studies for yield and its components.

Salinity alleviated compounds interact, significantly, with wheat cultivars for grain, straw, biological yields, and harvest index (H.I. %) in both cropping seasons Table (4). Likewise, “Sids 12” cultivar treated with hypertonic + humic acid achieved the highest mean values of these traits. Meanwhile the lowest ones were recorded by the untreated “Giza 168” cultivar (without hypertonic or humic acid) in the first and the second season, respectively.

Table (4). Average of plant attributes for three wheat cultivars (C) as affected by hypertonic, humic acid a(S) nd their interaction during 2014/2015 and 2015/2016 seasons

Attributes	Salinity alleviated compounds (S)	Season 2014/2015							Season 2015/2016						
		Sakha 93	Sids 12	Giza 168	Average (S)	L.S.D. (S) at 0.05	L.S.D. (C) at 0.05	L.S.D. (C x S) at 0.05	Sakha 93	Sids 12	Giza 168	Average (S)	L.S.D. (S) at 0.05	L.S.D. (C) at 0.05	L.S.D. (C x S) at 0.05
Grain yield (kg/fed.)	Hypertonic (Nano)	1975.00	2487.04	1591.00	2017.68c	84.79	60.01	120.02	1980.00	2320.00	1656.00	1985.33b	83.75	110.57	221.14
	Humic	1949.67	2495.33	1966.89	2137.30b				1878.00	2141.67	1944.80	1988.16b			
	Hypertonic+humic	2357.27	3085.27	1955.13	2465.89a				2658.67	3226.60	1914.50	2599.92a			
	Control	1624.23	1986.53	1299.17	1636.64d				1662.23	1862.67	1316.50	1613.80c			
Average (C)		1976.54b	2513.54a	1703.05c					2044.73b	2387.74a	1707.95c				
Straw yield (kg/fed.)	Hypertonic (Nano)	2424.47	2767.49	1835.63	2342.53c	114.27	202.43	404.86	2851.83	2959.63	1900.50	2570.65b	164.68	95.56	191.13
	Humic	2421.00	2714.87	2340.87	2492.25b				2435.33	3214.67	2452.60	2700.87b			
	Hypertonic+humic	2846.67	3247.10	2206.13	2766.63a				2933.53	3839.13	2559.33	3110.66a			
	Control	2133.00	3220.53	1543.63	2299.05c				2196.60	3284.13	1679.22	2386.65c			
Average (C)		2456.29b	2987.50a	1981.57c					2604.32b	3324.39a	2147.91c				
Biological yield	Hypertonic(Nano)	4399.47	5254.53	3426.63	4360.21c	114.21	236.12	472.23	4831.83	5279.63	3556.50	4555.99b	189.83	128.58	257.16
	Humic	4370.67	5210.20	4307.76	4629.54b				4313.33	5356.34	4397.40	4689.02b			
	Hypertonic+humic	5203.94	6332.37	4161.26	5232.52a				5592.20	7065.73	4473.83	5710.59a			
	Control	3757.23	5207.06	2842.80	3935.70d				3858.83	5146.80	2995.72	4000.45c			
Average (C)		4432.83b	5501.04a	3684.61c					4649.05b	5712.13a	3855.86c				
Harvest index(H.I. %)	Hypertonic(Nano)	44.89	47.33	46.43	46.22a	1.80	1.92	3.85	40.98	43.94	46.56	43.83ab	1.73	1.69	3.38
	Humic	44.61	47.89	45.66	46.05a				43.54	39.98	44.23	42.58bc			
	Hypertonic+humic	45.30	48.72	46.98	47.00a				47.54	45.67	42.79	45.33a			
	Control	43.23	38.15	45.70	42.36b				43.08	36.19	43.95	41.07c			
Average (C)		44.51a	45.52a	46.19a					43.78a	41.45b	44.38a				

-Mean values in the same column/row marked with the same letters are not significantly different at 0.05 level of probability.

CONCLUSION

From the above results of this two growing seasons field's study, it was concluded that nano compound and humic acid increased yield and its components of wheat crop by decreasing the effect of salinity and Sids 12 cultivar gave more response with this treatment under study conditions at Abess Region, Alexandria governorate, Egypt.

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الملخص العربي

تحسين انتاجية بعض أصناف القمح بإستخدام الهيبرتونيك وحامض الهيوميك فى الأراضى الملحية

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أجريت تجربتان حقليتان بالمزرعة البحثية بكلية الزارعة سابا باشا بمنطقة أبيس جامعة الإسكندرية خلال الموسمين ٢٠١٤/٢٠١٥ و2015/2016،وذلك لتحسين أنتاجية ثلاثة أصناف من القمح بإستخدام مركب الهيبرتونيك المصنع بتكنولوجيا النانو ، حامض الهيوميك تحت ظروف التربة المتأثرة بالملوحة. تم توزيع المعاملات في تصميم القطع المنشقة مرة واحدة في ثلاث مكررات ، حيث وزعت أربع معاملات (الهيبرتونيك ، حامض الهيوميك ، الهيبرتونيك + الهيوميك اسيد ، المقارنة) على القطع الرئيسية ، ووزعت الثلاثة أصناف من القمح (سخا ٩٣ ، سدس ١٢ ، جيزة ١٦٨) فى القطع تحت الرئيسية.

ويمكن تلخيص أهم النتائج فيما يلي:

- تفوق صنف القمح سدس ١٢ على سخا ٩٣ ، وجيزة ١٦٨ معنوياً في أرتفاع النبات وعدد السنابل/م^{٢} ، عدد السنيبلات/سنبلة ، عدد الحبوب/سنبلة ، وزن ١٠٠٠ حبة ، محصول الحبوب ، القش والبيولوجى ودليل الحصاد في الموسمين. حيث أعطى سدس ١٢ أعلى متوسطات قيم لهذه الصفات فى حين أن صنف جيزة ١٦٨ اعطى أقل القيم فى موسمى الدراسة.
- معاملة نباتات القمح بمركب النانو تكنولوجى (الهيبرتونيك) وحامض الهيوميك حقق أعلى قيم للصفات تحت الدراسة ، بينما معاملة المقارنة (بدون مركب او حامض هيوميك) أعطت أقل قيم بالنسبة لارتفاع النبات والمحصول ومكوناته في موسمي الزراعة.

- كان التداخل بين عاملى الدارسة معنوياً فى معظم الصفات المدروسة خلال موسمى الزراعة حيث أعطت المعاملة بمركب الهيبرتونيك + حامض الهيوميك لصنف سدس ١٢ أعلى متوسطات قيم لأرتفاع النباتات ومحصول الحبوب ومكوناته ودليل الحصاد مقارنة بالمعاملات الأخرى خلال موسمى الدراسة. ومن الناحية الأخرى كانت أقل القيم لمعاملة المقارنة مع صنف جيزة ١٦٨ خلال الموسمين.

التوصية:

يوصى البحث بزراعة صنف سدس ١٢ ومعاملته بمركب الهيبرتونيك + حامض الهيوميك وتحسين صفات التربة عن طريق تقليل تأثير الملوحة لزيادة أنتاجية محصول القمح تحت ظروف منطقة ابيس ، الأسكندرية.

Effects of Dried Onion and Ascorbic Acid on Performance, Immune Response and Serum Blood Lipid Profiles of Growing Rabbits

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ABSTRACT: Thirty-six growing V-line rabbits of both sexes, 5 weeks old, with initial weights of 791.7 ± 14.1 g were used for the study through summer season from June to September(2104). The rabbits were randomly allocated to four treatments groups of 9 rabbits each. Each treatment was further sub-divided into 3 replicate of ٣ rabbits. Group one fed control diet free of feed additives and served as a control group. Group 2 and 3 supplemented with 400 and 800 mg dried onion / kg diet, respectively. Group 4 received control diet, but drinking water supplemented with 200 mg vitamin C / l water. Results showed that at 15 weeks of age the live body weight was significantly (P ≤ 0.05) increased by the addition of ascorbic acid and dried onion at different inclusion rate. A significant decrease in feed consumption was recorded in the group received diet supplemented with 800 mg onion / kg diet in comparison with the control group. Significant (P ≤ 0.05) improvement in feed conversion ratio was observed in dried onion or ascorbic acid groups in comparison with the control. Hematological parameters were insignificantly affected by treatments. Dried onion and ascorbic acid failed to induce any significant impact on sheep red blood cells(SRBCs) in comparison with the control group. All feed additives significantly (P ≤ 0.01) reduced serum total lipids, triglycerides, total cholesterol and low density lipoprotein, however, they had insignificant effect on high density lipoprotein concentration in comparison with the control group. Malondialdehyde as an indicator of lipid peroxidation was significantly decreased in all treatments, however, only the group received 400 mg onion in their diet recorded significant (P ≤ 0.05) increase in total antioxidant capacity in comparison with the control group. In conclusion, rabbit dietary supplementation with ascorbic acid or dried onion could have beneficial effects on performance under summer environment without any side effects.

Key words: Rabbits, dried onion, ascorbic acid, performance, immunity and blood lipid profile

INTRODUCTION

The sub-therapeutic uses of antibiotics to enhance growth and prevent the infectious intestinal diseases have led to a problem of drug residues in final animal products and emerge of new antibiotic-resistance bacteria (Frankic *et al.,* 2009). In Egypt, the routine use of antibiotics in animal and poultry diets have been banned in November 2006 and thus, some endeavors are made to develop new in-feed antibiotics substitutes for reducing and treating infectious diseases in rabbit and poultry industry. Attempts to use the natural materials such as herb and botanicals could be widely accepted as feed additives to improve the efficiency of feed utilization and animal productive performance (Zeweil *et al.,* 2013). Ascorbic acid is one of the most widely studied vitamins used to alleviate heat stress in rabbits. Amakye-Anim *et al.* (2000) and El-Ghaffar *et al.* (2000) showed that, ascorbic acid has a role in lowering viral pathogenic actions and in protecting animals from heat

stress as well as in the enhancement of the immune system of infected rabbits. Ascorbic acid is not considered a required dietary nutrient, but under certain adverse environmental conditions, the metabolic need for this vitamin may exceed the inherent biosynthetic ability of ascorbic acid (Abou-Ashour *et al.,* 2004). However, many additives are recently added to rabbit feed or water as a way to help alleviate adverse effect during summer months and to enhance productive performance and immune response of rabbits. Onion bulbs have numerous organic sulphur compounds, flavonoids and phenolic acids with proven antibacterial, antioxidant and hypolipidemic efficacy (Melvin *et al.,* 2009; Srinivasan *et al.,* 2004). The results of Goodarzi *et al.* (2013) showed the beneficial influence of onion extract on the growth performance in meat-type broiler chickens. Vidyavati *et al.* (2010) suggested that the serum cholesterol was significantly decreased by dietary dehydrated onion in experimentally hypercholesterolemic rats. The aim of the present study is to determine the effects of dried onion and ascorbic acid as feed additives on growth performance, blood hematology, immune response and serum blood lipid profiles of growing rabbits through summer season from June to September.

MATERIALS AND METHODS

Thirty-six growing V-line rabbits of both sexes, 5 weeks old, with initial weights of 791.7 ± 14.1 g were used for the study. The rabbits were randomly allocated to four treatments groups of 9 rabbits each. Each treatment was further sub-divided into 3 replicate of ٣ rabbits. Rabbits were housed in wire floor batteries of 45 x 36 x 36 cm and were offered diets for duration of the feeding trial until reaching 15 weeks of age. All animals were kept under similar hygienic conditions. Rabbits were housed in well ventilated block building. Fresh air circulated in the house using exhaust fans. The rabbits were kept within a cycle of 16 h light and 8 h dark. Four pelleted diets were prepared. Group one fed control diet free of feed additives and served as a control group. Group 2 and 3 supplemented with 400 and 800 mg dried onion / kg diet, respectively (American garden product - New York 11783 USA). Group 4 received control diet, but drinking water supplemented with 200 mg vitamin C /L (Fisher chemical -analytical reagent Grande). Fresh water was automatically available at all times through stainless steel nipples for each cage. The experimental diets were offered to rabbits *ad libitum*. The formula of basal experimental diet is presented in Table (1) that formulated to cover the requirements of rabbits according to NRC (1977).

Individual body weight and feed consumption were recorded weekly. Body weight gain and feed conversion ratio were also calculated. The incidence of dangerous diseases was largely avoided and rabbits have never been treated with any kind of systematic vaccination or medication. At the end of the feeding trial, 3 rabbits were selected from each treatment group randomly, starved of food but not water for 12 hours and slaughtered for carcass analysis. Before slaughtering, 6 ml

of blood sample was taken from the ear vein with a sterile syringe. 3 ml of the blood was put into a bijon bottle containing ethylene diamine tetracetic acid (EDTA) as an

Table (1). Composition and chemical analyses of the basal experimental diet.

Ingredients	%
Yellow corn	19.0
Wheat bran	11.0
Barley	17.2
Berseem hay	33.0
Soybean meal (44%)	15.0
Molasses	3.0
Di-calcium phosphate	1.0
L-lysine	0.1
DI-Methionine	0.1
Premix	0.3
Salt	0.3
Total	**100**
Chemical analyses:	
Dry matter (DM), %	91.36
Crude protein(DM), %	17.24
Ether extract(DM), %	3.26
Crude fiber(DM), %	12.58
Nitrogen free extract(DM), %	50.47
Ash(DM), %	7.57
Organic matter (OM), %	92.42

[1]Vit+Min mixture provides per kilogram contains: Vit A 6000 IU; Vit D_3 450 IU; Vit E 40 mg; Vit K_3 1 mg; Vit B_1 1 mg; Vit B_2 3 mg; Vit B_3 180 mg; Vit B_6 39 mg; Vit B_{12} 2.5 mg; Pantothenic acid 10 mg; biotin 10 mg; folic acid 2.5 mg; choline chloride 1200 mg; Manganese 15 mg; Zinc 35 mg; Iron 38 mg; Copper 5 mg; Selenium 0.1 mg; Iodine 0.2 mg; Selenium 0.05 mg. [2]Analyzed values according to AOAC (2006).

Anticoagulant for haematological assay. The remaining 3ml of the blood sample was put into a sterile vacutainer tube without an anticoagulant for serum biochemical analysis. The haematological assay was carried out to determine erythrocyte indices such as packed cell volume (PCV), and haemoglobin (Hb) values. Red blood cell (RBC) counts were counted on an AO Bright line hemocytometer using a light microscope at 400X magnification after diluting blood samples 200 times with a physiological saline (0.9% NaCl solution) before counting (Natt and Herrick, 1952). White blood cell (WBC) were counted on an AO Bright line hemocytometer using a light microscopeat 100X magnification after diluting blood samples 20 times with a diluting fluid (1% acetic acid solution with a little of Leishman's stain) before counting (Hepler, 1966). Total lipids, triglycerides, cholesterol, low density lipoprotein (LDL) and high density lipoprotein (HDL),

concentrations in serum were estimated using commercial kits (Bio Merieux, France) accordingto the procedure outlined by the manufacturer. Three rabbits of each treatment were immunized with 0.1 ml of a 2.5% Sheep Red Blood Cells (SRBC) via the marginal ear vein at 15 days after starting the dietary treatment supplementation, to measure Antibody titer against Sheep Red Blood Cells. The dosage of SRBC for inoculation was pre-determined by a separate trial. Antiserum to SRBC was collected 7, 14 and 21 days post challenge. One ml of blood was refrigerated to allow red blood cells to settle. If sedimentation was not complete, samples were centrifuged for 1 to 2 min at 3000 rpm to separate serum and erythrocytes, and the supernatant was collected. Briefly, 96-well plates were first filled with 25 µl of physiological saline solution in each well. Then 25 µl of antiserum was pipetted into the first well in duplicates after which 25 µl from the first well was pipetted into the second well, and so forth using an automatic pipette. Finally, a 0.75% of SRBC solution was added to each well. Plates were incubated at 37 ^{o} C for 3 hours and then examined visually for agglutination Wegmann and Smithies. (1966). The agglutination titer was expressed as the $\log^2$ of the reciprocal of the highest serum dilution giving complete agglutination (Nelson *et al.,* 1995). The results were expressed as the mean ± SEM. All data were analyzed using one way analysis of variance (ANOVA) using SPSS 11.0 statistical software (SPSS, Inc., Chicago, Il, 2001). Significant differences between means were detected using new Duncan multiple range test (Duncan, 1955).

RESULTS AND DISCUSSIONS

The impact of dietary treatments on growth performance indices is presented in Table 2. At 15 weeks of age the live body weight was increased by the addition of ascorbic acid and dried onion at different inclusion rats. The obtained results and recorded observation clearly focused in group received ration supplemented with 400 and 800 mg onion / kg diet. Results showed that diets containing 400 and 800 mg onion / kg diet resulted in numerical increase in weight gain and significant ($P \leq 0.05$) increase in daily weight gain through the experimental period from 5-15 weeks of age. Goodarzi *et al.*(2013) reported that dietary supplementation of 30 g/kg onion bulb increased final body weight of broilers at 42nd day of age compared to the other treatments ($P \leq 0.05$) fed 15 mg Virginiamycin / kg or dietary supplementation of 10 g onion bulb/kg diet. The above results may be explained due to their contents of sulphur components that are considered as active antimicrobial agents. Similar to our results also was obtained by Aji*et al.* (2011)reported an enhancement in body weight of broilers received diets containing fresh onion bulbs as compared with birds fed basal diet. Concerning ascorbic acid, Al-Shanty (2003) showed that adding ascorbic acid (1.0 g/L water) significantly improved averages of daily gain when compared with the control group. Selim*et al.* (2004) cleared that rabbits had access to extra levels of ascorbic acid beyond recommendation level achieved ($P \leq 0.01$) better live weight gain compared to the control group. More recently, Selim *et al.* (2008) found that

diet treated with 200 ppm of ascorbic acid recorded significantly (P ≤ 0.01) the highest weight gain (1312 g vs. 943 g in control group).

A significant (P ≤ 0.05) decrease in feed intake in the group received diet supplemented with 800 mg onion / kg diet in comparison with the control group through the experimental period, however, insignificant effect on feed intake was observed due to addition of 400 mg onion or ascorbic acid. This result agrees partially with that obtained by Ibrahim *et al.* (2004)

Table (2). Effect of dried onion and ascorbic acid on rabbit's performance

Characteristics	Control	Onion (mg/kg diet)		Ascorbic acid 200 mg/l
		400	800	
Initial body weight, g	687.8 ± 89.1	665.56±100.1	683.9±112.90	687.8±84.6
Final body weight, g	2373.9b±78.6	2418.9a±92.6	2484.4a±100.3	2399.4a±113.6
Daily weight gain, g	22.8±1.0^{b}	25.1±2.0 ^{a}	25.7±2.2 ^{a}	24.5±2.0 ^{ab}
Daily feed onsumption,g	74.68±1.11^{ab}	75.86±3.47 ^{a}	66.86±5.16 ^{c}	70.62±6.52 ^{bc}
Feed conversion ratio	3.83±0.20 ^{a}	3.54±0.30 ^{b}	3.24±0.29 ^{c}	3.58±0.36 ^{ab}

Different letters (a-c) within a raw denote significant differences between treatments (P ≤ 0.05)

Who reported a significant decrease in feed consumption and the largest reduction of feed consumption in broiler ducks were observed when received 3% garlic (5.2%) and 1% onion + 3% garlic (4.6%) but cumulative feed consumption at week 0-10th lower than the same at 0-12th week. Goodarzi *et al.* (2013) reported that birds fed 30 g onion/kg in the diet had the highest (P ≤ 0.05) feed intake than the other treatments fed 15 mg Virginiamycin/kg or dietary supplementation of 10 g onion bulb/kg diet. Birds fed 10 g onion bulb/kg diet was significantly equal to the group fed the control diet. Aji *et al.* (2011) reported an enhancement in average feed intake of broilers offered diets containing fresh onion bulbs in comparison with broilers fed basal diet. Sallam *et al.* (2005) indicated that the treatment with ascorbic acid (40 mg/kg body weight) resulted in non-significant increase in feed intake and drinking water comparing with those of control group. Moreover, Selim *et al.* (2004) reported that the treated with ascorbic acid (300 mg/kg diet) did not significantly affect feed intake.

In contrast, Shehata (2005) reported that ascorbic acid supplementation caused significant increase in feed intake. In addition, Yassein *et al.* (2008) showed that the water supplementing with ascorbic acid at 1 g/L increased daily feed consumption when compared with those of control group of NZW rabbits does.

The observed results showing that supplementation of dried onion or ascorbic acid improve (P ≤ 0.05) the feed conversion ratio in comparison with the control group. The groups fed 400 and 800 mg onion /kg showed better feed

conversion ratio (3.54 and 3.24) vs. control group (3.83). The same results were obtained by Ibrahim *et al.* (2004) on broiler dusks and they attributed the improvement in feed conversion ratio to the reduction of small intestine thickness since the nutrient absorption is more efficient through thinner intestinal wall that reflected on the improvement of absorption which translated to improvement in feed conversion ratio.

Similar to our results Aji *et al.*(2011) reported an enhancement in feed conversion ratio of broilers offered diets containing fresh onion bulbs in comparison with broilers fed basal diet. On the other hand, El Nawawy (1991) found that feed conversion ratio was nearly identical when compared Hubbard broiler chicken control with those fed garlic, onion or garlic plus onion. Using ascorbic acid, Selim *et al.* (2004) reported that rabbits had access to extra levels of ascorbic acid beyond recommendation level achieved better performance in feed conversion ratio compared to the control group. In addition, Selim*et al.* (2008) cleared that the treated with 200 ppm of ascorbic acid recorded significantly the best feed conversion ratio (2.68 vs. 3.68 in control group).

Results presented in Table 3 indicated that hematological parameters of the rabbits showed insignificant effect on hematocrit, RBCs, WBCs, and Hb of rabbits given different levels of onion or ascorbic acid in comparison with the control group. The percentage of lymphocytes, eosinophils, neutrophils and monocytes were not affected by different treatments also in comparison with the control group. The normal hematocrit indicates the absence of normocytic anemia.

The result is corroborated by the normal RBCs which further elucidated the absence of hemolytic anemia and depression of erythrogenesis. The normal hemoglobin concentration for all the experimental rabbits is probably an indication that onion or ascorbic acid at studied levels supported hemoglobin synthesis, which according to Sirosis (1995) is among other factors, primarily affected by protein intake. Njidda *et al.* (2006) reported that normal range of values for Hb indicated that the vital physiological relationship of hemoglobin with oxygen in the transport of gases (oxygen and carbon dioxide) to and from the tissues of the body has been maintained and was normal.

Table (3). Effect of dried onion and ascorbic acid on hematological parameters and sheep RBCs of growing rabbits at 15 weeks of age

Characteristics	Control	Onion (mg/kg diet)		Ascorbic acid 200 mg/l
		400	800	
Red blood cells (RBCs) 10^6	3.57±0.11	3.53±0.17	3.54±0.12	3.73±0.10
White blood cells(WBCs) 10^3	6.40±0.52^{ab}	7.36±0.73^{a}	5.56±1.59^{b}	6.07±0.30^{ab}
Hemoglobin (Hb)mg/dl	10.70±0.45^{ab}	10.53±0.45^{b}	10.50±0.30^{b}	11.46±0.50^{a}
PCV %	33.03±1.26	33.30±1.47	33.97±1.18	32.70±5.49
Eosinophil %	3.33±0.57	3.33±0.57	3.67±0.58	3.33±0.58
Neutrophils %	55.00±1.00^{ab}	52.67±2.08^{b}	55.00±1.00^{ab}	55.33±0.58^{a}
Lymphocytes %	39.67±1.52	40.00±1.73	38.67±2.08	37.66±2.52
Monocytes %	4.67±0.58	4.67±0.58	5.33±0.57	4.67±0.57
Sheep RBCs titer				
7 days	0.660 ±0.05	0.687±0.09	0.687±0.09	0.660±0.05
14 days	0.743±0.05	0.740±0.08	0.770±0.00	0.767±0.07
21 days	0.736±0.12	0.770±0.00	0.816±0.04	0.766±0.07

Different letters (a-c) within a raw denote significant differences between treatments (P ≤ 0.05)

Dried onion and ascorbic acid failed to induce any significant impact on SRBCs in comparison with the control group (Table 3). Results presented by Goodarzi*et al.* (2013) found that dietary supplementation of 10 and 30 g onion bulb/kg diet fiasco to induce any significant effect on antibody titers against NDV, although the weight of lymphoid organs was significantly (P ≤ 0.05) higher for birds fed diets supplemented with 30 g/kg Onion. In the present trial SRBCs measured, neither positive nor negative effect was affected. Since antimicrobial agents started to be used as growth promoters, researchers (Coates *et al.,* 1952; White hair and Thompson, 1956) working with broilers and swine respectively understood that the presence of an important health challenge in the field was essential to reveal the significant effects of these products. This was while the current trial was conducted in optimum conditions and no external challenges were impelled to the rabbits. On the other hand, Lee *et al.* (2014) suggested that an onion peel extract supplement at levels 4, 20, or100 mg/kg can improve the immune status of rats by increasing the number of immune-related cells and specific cytokine levels in comparison with the control group.

Results illustrated in Table 4 indicated that all feed additives used in the present study were significantly (P ≤ 0.01) reduced serum total lipids, triglycerides, total cholesterol and low density lipoprotein; however, they had insignificant effect on high density lipoprotein concentration in comparison with the control group. Generally, it was observed that 800 mg dried onion was more effective in decreasing serum total lipids, total cholesterol and low density lipoprotein,

however, ascorbic acid was more effective in decreasing serum triglycerides concentration in comparison with the other experimental groups.

Table (4). Effect of dried onion and ascorbic acid on serum lipid profile at 15 weeks of age

Characteristics	Control	Onion (mg/kg diet)		Ascorbic acid 200 mg/l
		400	800	
Total lipids, mg/dl	320.00±4.6[a]	310.67±12.5[a]	217.00±5.3[b]	230.00±4.0[b]
Triglycerides, mg/dl	80.87±2.4[a]	70.30±1.5[b]	71.20±0.9[b]	63.97±1.4[c]
Total cholesterol, mg/dl	112.33±1.5[a]	102.40±6.6[b]	61.90±0.8[d]	70.53±1.5[c]
High density lipoprotein,mg/dl	49.66±0.6	48.00±2.6	48.67±1.2	49.33±1.2
Low density lipoprotein, mg/dl	48.60±1.2[a]	38.23±6.7[b]	31.1±0.8[c]	38.40±2.4[b]
Total antioxidant capacity, mmol/l	0.90±0.10[b]	1.85±0.57[a]	1.20±0.26[b]	1.41±0.09[ab]
Malondialdehyde, nmol/ml	68.90±3.18[a]	46.07±4.49[b]	49.37±5.36[b]	45.07±4.41[b]

Different letters (a-c) within a raw denote significant differences between treatments (P ≤ 0.05)

Suresh and Srinivasan (1997) found that 3% onion powder reduced blood lipids, lipid peroxides and cholesterol. Goodarzi *et al.* (2013) reported that broilers receiving 30 g/kg onion had a significantly higher HDL and lower triglyceride concentrations compared to control group and dietary supplementation of 10 g onion bulb/kg diet. Also, An *et al.* (2015) stated that the concentrations of serum free cholesterol and triacylglycerol in broilers groups fed diet containing onion extract were significantly decreased compared with those of control or the group fed diet containing antibiotic (P ≤ 0.01).Chung *et al.* (2011) reported that onion peel extract supplementation to Sprague-Dawley male rats fed high fat diet significantly decreased serum level of LDL-cholesterol and increased HDL-cholesterol, while total cholesterol and triglyceride level were not affected. Hematological parameters were also not significantly affected by treatments. In contrast, Sklan *et al*. (1992) did not observe any effect of onion on hepatic cholesterol. The effects of onion have been ascribed to its sulfur containing principles which oxidize thiol compounds either present free or combined with a protein and NADPH which are necessary for lipid synthesis (Sebastian *et al*., 1979). The lipid lowering action of S-methyl cysteine sulfoxide (SMCS) isolated from *Allium cepa* was investigated in Sprague–Dawley rats fed on 1% cholesterol diet (Kumari and Augusti, 2007). Administration of SMCS at a dose of 200 mg/kg body weight for 45 days ameliorated the hyperlipidemic condition. The lipid profile in serum and tissues showed that concentrations of cholesterol, triglyceride and phospholipids were significantly reduced when compared to their untreated counterparts. The total lipoprotein lipase activity in the adipose tissue was decreased with also a decrease in the free fatty acid levels in serum and tissues. The activities of the lipogenic enzymes glucose 6-phosphate dehydrogenase and malic enzyme as also of 3-hydroxy-3-methyl-glutaryl-CoA reductase in the tissues remained low on treatment

indicating that SMCS did not favor lipogenesis and cholesterogenesis in the hyperlipidemic animals. The fecal excretion of bile acids and sterols was further increased upon treatment with SCMS.

Concerning ascorbic acid, Gad Alla *et al.* (2002) reported that cholesterol was significantly decreased with ascorbic acid addition as compared to the control group of bucks and does Bouscat rabbits. Also, Yousef *et al*. (2003) found that rabbits treated with ascorbic acid (20 mg/kg BW) showed a decrease in plasma cholesterol. However, Yousef (2004) suggested that ascorbic acid supplementation significantly decreased the level of total lipids and cholesterol. Similarly, Ibrahim (2005) found that vitamin C significantly decreased the cholesterol level by 4.7% compared to the control group. On the other hand, Salem *et al.* (2003) investigated the influence of ascorbic acid supplementation on some blood constituents of growing New Zealand White rabbits. They indicated that ascorbic acid supplementation did not effect on the serum cholesterol.

Malondialdehyde (MDA) as an indicator of lipid peroxidation was significantly decreased in all treatments in comparison with the control group (Table 4), while the results showed numerical increasein serum total antioxidant capacity (TAC) in the groups given 800 mg onion or 200 mg ascorbic acid. However, the group received 400 mg onion in their diet recorded significant ($P \leq 0.05$) increase in total antioxidant capacity in comparison with the control and 800 mg onion fed groups. It is reported that oral administration of fresh onion juice (3 cc/daily) for 4 weeks meaningfully decreased serum MDA levels, however, it increased TAC in Wistar rats (Khaki *et al*., 2012). The same reduction on MDA levels is demonstrated in male rats treated with onion (Ige and Akhigbe, 2012).The study of Prakash *et al.*(2007) showed that onion (Allium cepa) is a rich source of polyphenols with promising antioxidant and free radical scavenging potentials and has the ability to provide protection against DNA damage caused by reactive oxygen and reactive nitrogen species. Ogunlade *et al.* (2012) reported that under stress of alcohol administration in rabbits the results showed a statistically significant decrease in superoxide dismutase (SOD), catalse (CAT) and glutathione peroxidase (GPx) activity in liver compared to control animals, however, treatment with combined alcohol and Allium cepa (AC) significantly increased the liver SOD, CAT and GPx activity compared to animals that received alcohol alone. The authors also showed that alcohol significantly elevated the liver lipid peroxides expressed as MDA by about five folds as compared to the control value, however, co-administration of alcohol and Allium cepa (AC) exhibited a notable reduction in the liver MDA level compared to alcohol alone treated rabbits. Abdel-Salam *et al.* (2014) reported that the essential oils of red onion had the highest phenolic contents and antioxidant activity in contrast to garlic essential oils. In addition, Peluso *et al.* (2015) demonstrated that the onion peel ethanol extract have a strong antioxidant activity with quercetin and polyphenol proposed to be the major

components responsible for this effect suggesting the possibility that an onion peel supplement could improve the immune status.

In conclusion, rabbit dietary supplementation with ascorbic acid or dried onion could have beneficial effects on performance under summer environment without any side effects.

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الملخص العربي

تأثير البصل المجفف والأسكوربيك أسيد علي الأداء والمناعة ودهون الدم في الأرانب النامية

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أستخدم ٣٦ أرنب نامي عمر خمسة أسابيع من كلا الجنسين متوسط وزن ابتدائي ٧٩١.٧جم خلال فصل الصيف في الفترة من يونيو – سبتمبر .

تم توزيع الأرانب عشوائياً علي أربع معاملات بكل معاملة تسعة أرانب ، وكل معاملة تم توزيعها علي ثلاث مكررات بكل مكررة ثلاث أرانب .المجموعة الأولي تناولت عليقة خالية من أي اضافات واستخدمت كمجموعة شاهد ، المجموعة الثانية والثالثة أضيف للعليقة البصل المجفف بمعدل ٤٠٠ ،٨٠٠ ملجم /كجم عليقة علي التوالي ، والمجموعة الرابعة تناولت عليقة الشاهد ولكن أضيف الأسكوربيك أسيد بمعدل ٢٠٠ملجم / لتر ماء .

أوضحت النتائج : انه عند عمر ١٥ أسبوع توجد زيادة معنوية في وزن الجسم نتيجة لأضافة البصل المجفف بمستويات مختلفة وكذلك الأسكوربيك أسيد . لوحظ أنخفاض معنوي في استهلاك العليقة في المجموعة التي أضيف لها ٨٠٠ ملجم / كجم عليقة مقارنة بمجموعة الشاهد تلاحظ تحسن معنوي في الكفاءة التحويلية في جميع المعاملات التجريبية مقارنة بمجموعة الشاهد . لم تتأثر الصفات الهيماتولوجية بالمعاملات المختلفة كما لم تؤثر المعاملات علي الاستجابة المناعية لكريات الدم الحمراء للأغنام مقارنة بمجموعة الشاهد . جميع الاضافات المستخدمة أدت إلي انخفاض في الدهون الكلية ، الدهون الثلاثية ، الكوليسترول الكلي والكليسترول منخفض الكثافة في سيرم الدم بينما لم يكن لها أي تأثير معنوي علي الكوليسترول مرتفع الكثافة مقارنة بمجموعة الشاهد . المالوندهايد كدليل لأكسدة الدهون أنخفض معنوياً في جميع المعاملات بينما المجموعة التي تناولت البصل المجفف بمعدل ٤٠٠ملجم في العليقة أدت إلي زيادة في السعة الضد تأكسدية مقارنة بمجموعة الشاهد . والخلاصة وجد أن الأرانب المضاف لعليقتها الأسكوربيك أسيد والبصل المجفف لها تأثير مفيد علي أداء الأرانب خلال فصل الصيف بدون أي تأثيرات جانبية .

Evaluation of Some Onion Genotypes Under Calcareous Soil Conditions

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ABSTRACT: To evaluate fourteen local Egyptian genotypes of onion (*Allium cepa,* L.) under calcareous soils and drip irrigation for increasing economic income by through cultivation of the high yielding onion genotypes (cvs) and found the high quality cultivars in export characters. In this respect, two filed experiments were conducted at Experimental Farm of Nubaria Agricultural Research Station during 2014/2015 and 2015/2016 winter seasons in randomized complete block design (RCBD) with 5 replications. The obtained results cleared that there were a significant difference among the 14 onion genotypes in all studied characters. Whereas, the combined analysis of variance revealed significant differences among the fourteen genotypes for all studied characters. It can be concluded that Composite 16 large oblong genotype recoded the highest total and market yield of onion under calcareous soils under drip irrigation in Nubaria Region to increase economic income.

Key words: onion, genotypes, yield, quality, calcareous soil, drip irrigation, Nubaria.

INTRODUCTION

Onion (*Allium cepa,* L.) is the most important bulb crops and it is one of the most important vegetable crops grown in many parts of the world. It belongs to the family *Alliceae*, genus *Allium* that contains about 600 species. Onions have been valued for their medicinal qualities by many cultures around the globe. Numerous health benefits have been attributed to the onion, including prevention of cancer and cardiovascular disorders. It has a positive relationship between onion intake and risk for these common diseases. In Egypt, the total cultivated area of onion is 144.00 thousand feddans (FAO, 2012). The estimated productivity per feddan each of loaded and solo onions was 15.53 tons. The quantity exported annually from fresh onions about 202.1 thousand tons. In the world, the total cultivated area of onion is 3971000.51 ha, it produced 75.98 million tons by average of productivity per ha is 19.10 tons (FAO, 2012). Onions find widespread usage in both fresh green and dried forms. It is used as a flavor additive in a wide variety of food formulations such as comminuted meats, sauces, soups, salad dressings and pickle relishes (Kumar *et al*., 2006).

For many years, a program for improving the Delta genotypes was carried out at Onion Research Department. The workers succeed to obtain three new selections which have more uniform bulbs and better keeping quality. An increasing area is planted with onion in Nubaria region, appeared through the last few years some agricultural problems, especially, drought, salinity and diseases. Accordingly, it is essential to evaluate the performance of newly developed local lines and the introduce ones under Nubaria region conditions.

Onion cultivars are characterized by bulb skin, color, thickness, bulb pungency taste and bulb shape. Bulb shape can be globe, flattened globe, sometime with a flat to spindle or cylindrical. Onion cultivars differ in their quality characters. The quality characters of onion cultivars are described in several ways that include bulb doubling, the firmness of bulb, dry matter content, bulb pungency, flavor and its potential storage life. Also cultivars are characterized by inflorescence fertility, the flower number in umbel, the sepal and anther color, and the presence or absence of bulbils in the inflorescence. Hybrid varieties have replaced many of the standard open-pollinated cultivars. The hybrids are vigorous and uniform in bulb shape, size, and maturity and higher in yield (Swiader *et al*., 1992 and Brewster, 1990). Major factors that affect onion bulbs in storage include time of harvest, type of cultivar, pests and diseases, and atmospheric composition such as oxygen, carbon dioxide, temperature and relative humidity (Kader, 1992 and Thompson, 1992).

The combined analysis of variance revealed significant differences among the six genotypes for all studied characters except % of double bulbs. Giza 20, Red Giza and (Giza 20 x TEYG) genotypes had the highest values for plant height and no. of leaves/plant, while Comp. 13 Oblong gave the lowest ones. Comp. 13 Ob., was the earliest in bulb maturity, while Giza 20 and Red Giza were the latest ones. Giza 20, Red Giza, (Giza 20 x TEYG) and Group of Composites were the highest in total and marketable yield and average bulb weight Comp. 13 Ob., had the highest % of single bulbs 99.69 %, the lowest % of double bulbs and normal % of bolters (0.31 %) (Yaso, 2007). Giza 20 and Red Giza and (Giza 20 x TEYG) genotypes had the highest means for plant height and No. of leaves/plant, while Comp. 13 Oblong gave the lowest ones. Compo“13Ob” was the earliest in bulb maturity, while Giza 20 and Red Giza were the latest ones. Giza 20, Red Giza, (Giza 20 x TEYG) and Group of composites were the highest in total and marketable yield and average bulb weight (Yaso, 2007).

Lai *et al*. (1994) tested 60 onion cultivars and found that (Niz 1003 x PH 3325), Granex x PRR, Granex 429 and Henry’s. Special gave the highest marketable yields. However, Bettoni *et al*. (2012) reported that the cultivars Alfa Sao Francisco and Alfa Sao Francisco_RT produced higher values of dry mass and productivity in January. However, Kattak *et al*., 2013 inducted that heaviest individual bulb was produced by cultivar Swat-1 whereas the local cultivar gained weight. Cultivar Swat-1 produced heavy bulb at location-1 (Chokora) while bulb weight was recorded in location 2 (Chountra) by the same cultivar. The highest bulbs yield was recorded for cultivar Swat-1 at both locations, respectively, which was associated with the individual bulb weight and diameter gained by the same cultivar. The main objective of this study was to evaluate fourteen local Egyptian genotypes of onion (*Allium cepa* L.) under calcareous soils under drip irrigation to increase economic income through cultivation the high yielding onion genotypes and found the high quality varieties in export characters.

MATERIALS AND METHODS

Fourteen onion genotypes varied in their origin and characteristics were chosen from the onion germplasm collection at Onion Research Department, Field Crops Institute, Agricultural Research Center (ARC), Egypt. The genotypes were grown at the Experimental Farm of Nubaria Agricultural Research Station during 2014/2015 and 2015/2016 winter seasons. The tested genotypes were: (Composite 16 White, Composite 16 Large oblong, Composite 12, Composite 17, 1866- Behairy, New Valley, Giza Red Bulk, Nubaria DSR, Shandawil 1, Giza 6 Mohassan, Giza 20, Giza Red, 024-001-2014 and Yellow Creole).The soil of the experimental field was calcareous sandy loam in texture with pH 8.3 and 25% $CaCO_3$ content. Other soil properties are presented in Table (1) was described according to (Chapman and Partt, 1978).Seedlings of fourteen genotypes were transplanted to drip irrigation beds on December 5th and December 17th in 2014 and 2015 season, respectively. The experimental plot size was planted space at 10 cm in the bed, 80 cm in width and 7.2 m in length. Recommended doses of nitrogen, phosphorus and potassium fertilizers were added at the rate of 90 kg N, 45 kg P_2O_5 and 48 kg K_2O/fed. All other cultural practices for onion production in calcareous soil were followed. A randomized complete blocks design (RCBD) with five replicates was used.

Table (1). Physical and chemical properties of the experimental soil sites during the two cropping seasons 2015 and 2016.

Soil characteristics	2014/2015	2015/2016
Soil texture	**Sandy clay loam**	
Sand %	51.83	52.73
Silt %	25.64	22.46
Clay %	22.53	24.81
pH (1: 2.5 water suspension)	8.24	8.31
EC (dSm^{-1})	3.72	3.47
O.M. (%)	0.39	0.21
$CaCO_3$ (%)	22.74	26.32
Soluble cations (meq /L.)		
Ca^{++}	8.72	9.63
Mg^{++}	1.29	1.17
Na^{+}	23.83	21.11
K^{+}	3.16	2.79
Soluble anions (meq /L.)		
HCO_3^{-}	3.52	2.86
Cl^{-}	26.14	24.32
$SO4^{--}$	7.54	7.52
Available N(mg/kg)	19.40	20.60
Available P (mg/kg)	3.51	2.74
Available K (mg/kg)	159.00	137.00

The following data were recorded:

After 120 days from transplanting, 20 randomly selected plants were taken from each plot in both seasons to measure: Plant height (cm), number of green leaves/plant, total chlorophyll content (mg m^{-2}), plant fresh weight (g/plant), plant dry weight (g/plant), number of days to maturity, total yield (tons/fed.), marketable yield (tons/fed.), average bulb weight (g), bulb diameter (cm), percentage of single bulbs, percentage of double bulbs, percentage of bolters, bulb and total soluble solids (TSS).

Statistical analysis

All statistical analysis was performed using analysis of variance technique by means of CoStat computer software package (CoStat, Ver. 6.311., 2005). Recorded data of all studied characters were statistically analyzed according to the used design and the means were compared using LSD test (Duncan, 1955).. The analysis of variance was made separately for each season, then a combined analysis for the two seasons was calculated (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Highly significant differences occurred among seasons and combined analysis was carried out for plant height, number of leaves/plant, total chlorophyll, days to maturity, total yield, marketable yield, average of bulb weight, bulb diameter and % of bolters (Table 2). Whereas, the highest mean value for number of leaves/plant (7.50 leaves), total chlorophyll (66.30 mg/m^2), number of days to maturity (150.40 days), average bulb weight (67.44 g), total yield (17.88 tons/fed.), and marketable yield (17.03 tons/fed) were recorded for the first season 2014/2015. Meanwhile plant height (69.43 cm), bulb diameter (6.68 cm), and % of bolters (2.73 %) recorded the highest mean value in 2015/2016 season but there was no significant difference between the second season and the combined analysis in bulb diameter and % of bolters (Table 2).

However, the lowest values of plant height (63.17 cm), bulb diameter (6.11 cm), % of bolter (2.03 %) were obtained in the first season 2014/2015. In the otherwise, the lowest mean values of No. of leaves/plant (7.19 leaves), No. of days to maturity (144.61 days), average bulb weight (65.76 g), total yield (11.18 tons/fed) and marketable yield (10.54 tons/fed) in combined analysis. These results are in harmony with those obtained by Gamie and Yaso (2007), Yaso (2007), Bettoni *et al*. (2012) and Kattak *et al*. (2013) who revealed that there was a significant difference among seasons and location at different environmental conditions.

Genotypes responses differ under agro-ecological conditions and several genotypes of the same species behave different even grown under same environment. Bolting (formation of seed stalk followed by the initiation of flowering) is a highly undesirable character for bulb crop. Temperature and photoperiod are

considered to be the main factors for bolt initiation in onion (Diaz-Perez *et al.,* 2003) and different genotypes have different bolting percentage in a specific agro-climatic condition.

Also data in Table (2) indicated that there was no significant difference among seasons and combined data in these traits i.e. plant fresh weight, plant dry weight, % of single bulbs and % of double bulbs.

Figure (1) cleared that the highest and lowest mean values of the two seasons and combined analysis for all studied characters of onion genotypes.

Table (2). Average of growth and yield attributes for 14 onion genotypes evaluated under calcareous soils during seasons 2014/2015, 2015/2016 and combined data.

	Season			
Genotypes	**2014/2015**	**2015/2016**	**combined**	**LSD at 0.05**
Plant height (cm)	63.17c	69.43a	66.30b	1.14
No. of leaves/plant	7.50a	7.19b	7.35 ab	0.159
Total chlorophyll (mg/m^2)	66.30 a	62.85 b	52.52 c	0.219
Fresh weight/ plant (g)	182.35	171.01	176.68	n.s.
Dry weight/plant (g)	23.22	23.30	23.26	n.s.
Number of days to maturity	150.4a	144.61c	147.51b	1.96
Average bulb weight (g)	67.44a	65.76c	66.60b	0.133
Bulbs diameter (cm)	6.11b	6.68a	6.69a	0.022
Percentage of single bulbs	95.16	94.40	94.78	n.s.
Percentage of double bulbs	2.13	2.30	2.21	n.s.
Percentage of bolters	2.03b	2.73a	2.38ab	0.404
Total yield (tons/fed.)	17.88a	11.18c	14.53b	0.657
Marketable yield (tons/fed.)	17.03a	10.54c	13.79b	0.624

Means at the same row followed by the same letter are not significantly different according to L.S.D. at 0.05 value.
n.s. not significant difference at 0.05 level of probability.

Fig. (1). Growth and yield attributes for 14 onion genotypes as affected by two seasons 2014/2015, 2015/2016 and combined data.

The data in Tables (3 and 4) indicated that there was a significant difference among the 14 onion genotypes for all studied characters. Whereas, the combined analysis of variance revealed significant differences among the fourteen genotypes for all studied characters. Composite 16 White gave the highest mean value of number of leaves/plant (7.82) as compared with other genotypes in combined analysis. Composite 16 large oblong recorded the highest means values of total chlorophyll in leaves (59.65 mg/m^2), bulb diameter (6.99 cm) and total yield (17.73 tons/fed), marketable yield (16.98 tons/fed), and it was the earliest genotype (140.20 days) as in comparison with other genotypes during combined analysis. Nubaria Dsr had the highest mean value of % of double bulbs (6.60 %) as compared with other genotypes in combined data. Giza 6 Mohassan and Giza 20 had the highest mean values of plant height (69.44 cm and 68.85 cm) and fresh weight/plant (328.09 g/plant) and it was the latest in bulb maturity (155.10 and 155.80 days to maturity), respectively in comparison with others. But in dry weight Giza 20 gave the highest weight (33.43g/plant) followed by Giza Red (30.88 g/plant) and Shandawil (30.78 g/plant). Yellow Creole recoded the tallest plant (69.16 cm) after Giza 6 Mohassan (69.44 cm) and the % of bolter (4.78 %) as compared with others genotypes in combined data. Genotype (024.001.2014) had the heaviest average bulb weight (79.35 g) and the highest percentage of single bulbs (98.35 %) in comparison with others.

The cultivar Composite 16 Large oblong proved to be superior for marketable yield (ton/fed), total yield (tons/fed.), bulb diameter, total chlorophyll in leaves and number of leaves/plant, and it was the earliest as well as Giza 6 Mohassan and Giza 20 produced the highest values of plant height, number of leaves/plant, fresh weight, and dry weight compared to the other genotypes under this study conditions, and exhibited wide adaptability across different environments in two seasons under climate conditions in Nubaria region, Alexandria. This could be due to some differences in the temperature, rain fall pattern with higher amount of rain occurred during the growing seasons, which had positive effect on total yield and also on marketable yield and others characters.

Meanwhile, the lowest mean values of plant height (58.08 g) with 024.001.2014 genotype, No. of leaves/plant (6.85 and 6.88 leaves) with 1866-Behairy followed by New Valley respectively, total chlorophyll concentration in leaves (44.60 mg/m^2) with 1866- Behairy, the lowest fresh weight (83.72 and 104.28 g/plant) with Composite 12 and Composite 17, respectively, dry weight (13.54 g/plant) recorded by Composite 12, the lowest average bulb (52.15g) with New Valley, Bulbs diameter (5.73 cm) with 024.001.2014, Percentage of single bulbs (88.85 %) with Nubaria Dsr, Percentage of double bulbs (0.19 %) with New Valley, Percentage of bolters (0.35 %) with 024.001.2014, total yield (11.67 tons/fed), and the lowest Marketable yield (11.17 tons/fed), receptively. These results are in less/more agreement with those recorded by Lai *et al*. (1994), Gamie and Yaso (2007), Yaso (2007), Bettoni *et al*. (2012) and Kattak *et al*. (2013) who indicated that there were significant differences among onions genotypes.

Table (3). Average of growth and yield attributes for 14 onion genotypes evaluated under calcareous soils as combined analysis of two seasons.

Genotypes	Plant height (cm)	No. of leaves/plant	Total chlorophyll (mg/m^2)	Fresh weight (g/plant)	Dry weight (g/plant)	Number of days to maturity
Composite 16 White	61.25de	7.82 a	46.09de	99.69d	17.32cd	142.10de
Composite 16 Large oblong	64.94bcd	7.45abc	59.65a	107.67d	17.99bcd	140.20e
Composite 12	67.98abc	7.23bcd	50.65bcde	83.72d	13.54d	145.50cd
Composite 17	67.92abc	7.36bc	52.18bcd	104.28d	16.88cd	142.30de
1866- Behairy	67.00abc	6.85d	44.60e	112.60d	15.85cd	141.70de
New Valley	66.86abc	6.88 d	51.07bcd	137.64cd	22.69bc	151.90ab
Giza Red B	67.66abc	7.39abc	51.37bcd	218.75b	26.20ab	153.00ab
Nubaria Dsr	68.10ab	7.38abc	50.16bcde	191.95bc	19.68bcd	144.40de
Shandawil	64.30cd	7.39 abc	53.03bc	198.69bc	30.78a	143.50de
Giza 6 Mohassan	69.44a	7.48abc	51.48bcd	223.11b	26.21ab	155.10a
Giza 20	68.85a	7.51abc	51.64 bcd	328.09a	33.43a	155.80a
Giza Red	66.64abc	7.55ab	47.01cde	234.41b	30.88 a	154.10ab
024.001.2014	58.08e	7.51abc	54.23ab	194.71bc	22.47bc	149.80bc
Yellow Creole	69.16a	7.06cd	49.04bcde	238.22b	31.76 a	145.70cd
LSD at 0.05	3.73	0.454	6.24	75.120	7.779	4.67

Means at the same column followed by the same letter are not significantly different according to L.S.D. at 0.05 value.

Table (4). Average of yield attributes for 14 onion genotypes evaluated under calcareous soils as combined analysis of two seasons.

Genotypes	Average bulb weight (g)	Bulbs diameter (cm)	Percentage of single bulbs	Percentage of double bulbs	Percentage of bolters	Total yield (tons/fed.)	Marketable yield (tons/fed.)
Composite16 White	60.15defg	6.79abc	92.02e	2.49cde	4.63ab	14.47c	13.34bc
Composite16 Large oblong	69.70bc	6.99 a	95.41bcd	0.71f	3.88abc	17.73 a	16.98 a
Composite 12	59.95 efg	6.67abcd	97.25 ab	1.49def	1.63ef	14.63bc	13.94bc
Composite 17	56.10fg	6.92ab	96.31abc	1.71cdef	1.08efg	14.64bc	14.21bc
1866- Behairy	63.00cdef	6.37cde	96.02 abc	1.22ef	3.12cd	15.02bc	14.40b
New Valley	52.15 g	6.61abcd	95.53abcd	0.190 f	4.21abc	11.67e	11.17e
Giza Red B	68.95bcd	6.45 bcde	96.70abc	1.43def	0.92fg	14.86bc	14.36b
Nubaria Dsr	76.15ab	6.20 defg	88.85 f	6.60a	0.55fg	15.87b	14.15bc
Shandawil	59.95efg	6.39cde	93.83cde	2.73cde	3.56bc	12.36de	11.64de
Giza 6 Mohassan	71.50abc	6.26cdefg	95.54abcd	3.14c	1.15efg	14.05c	13.51bc
Giza 20	71.80abc	6.36 cdef	92.75de	5.01b	2.24de	14.82bc	13.86bc
Giza Red	68.05bcde	5.83 fg	96.32abc	2.90cd	1.23efg	15.35bc	14.69b
024.001.2014	79.35 a	5.73 g	98.35a	0.64f	0.35g	14.00c	13.89bc
Yellow Creole	76.25ab	6.02 efg	92.08e	0.80f	4.78a	13.94cd	12.91de
LSD at 0.05	8.864	0.529	2.92	1.52	1.20	1.62	1.38

Means at the same column followed by the same letter are not significantly different according to L.S.D. at 0.05 value.

CONCLUSION

Considering the obtained results, it can be concluded that Composite 16 large oblong genotype recoded the highest total and market yield of onion under drip irrigation in Nubaria Region, Alexandria, Egypt.

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الملخص العربى

تقييم بعض التراكيب الوراثية لمحصول البصل تحت ظروف الأراضى الجيرية

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أجريت تجربتان حقليتان بالمزرعة البحثية بمحطة بحوث النوبارية خلال موسمى الزراعة ٢٠١٤/٢٠١٥ و٢٠١٥/٢٠١٦ فى تصميم القطاعات العشوائية الكاملة فى ٥ مكررات لتقييم ١٤ تركيب وراثي من البصل المصري تحت ظروف التربة الجيرية ونظام الري بالتنقيط لزيادة الدخل عن طريق زيادة محصول الفدان واستخدام الأصناف عالية الجودة التصديرية . وكانت أهم الصفات المدروسة :

١- التقديرات الفسيولوجية: عدد الأوراق/نبات – ارتفاع النبات (سم) – الوزن الجاف(جم)/نبات – الوزن الرطب (جم)/نبات – تركيز الكلورفيل الكلي فى الأوراق.

٢- صفات المحصول (فترة النضج – المحصول الكلى/فدان – المحصول المسوق/فدان – قطر البصيلة (سم) – متوسط وزن البصلة (جم) – نسبة البصل المفرد – نسبة البصل المزدوج – نسبة التزهير المبكر.

ولخصت النتائج فيمايلى:

- يوجد أختلافات معنوية بين موسمين الزراعة وتحليل التباين المجمع للموسمين.
- يوجد اختلافات معنوية بين الـ ١٤ تركيب وراثية من البصل المصري فى معظم الصفات الفسيولوجية والمحصولية خلال التحليل التباين المجمع.
- التركيب الوراثى Composite 16 Large Oblong للبصل المصري سجل أعلى القيم فى الصفات الأتية (تركيز الكلورفيل فى الأوراق – قطر البصيلة – والمحصول الكلى (طن/فدان) – ومحصول التسويق (طن/فدان) – كما أن

هذا التركيب الوراثى أعطى أقل عدد أيام للنضج (كصنف مبكر) مقارنة بباقى التراكيب الوراثية تحت الدراسة وفى حين ان بعضها اعطت قيم عالية فى بعض الصفات الهامة تحت الدراسة.

التوصية:

- يوصى البحث بزراعة التركيب الوراثى Composite Large Oblong تحت ظروف الأراضى الجيرية ونظام الري بالتنقيط فى منطقة النوبارية ولا سيما الظروف المثالية ، كما يمكن الأستفادة من باقى التراكيب الوراثية فى برامج التربية لزيادة محصول الفدان من البصل وجودته وبالتالى زيادة الدخل القومى عن طريق تصديره .

Effect of Organic Amendments, Nitrogenous Fertilization and Spray of Micronutrients on Barley

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ABSTRACT : This study was carried out at the Experimental Farm of the Faculty of Agriculture (Saba- Basha), Alexandria University, Egypt, during 2013/2014 and 2014/2015 seasons to study the impact of three humic acid rates (0, 7 and 14 kg/ha), three nitrogen fertilizer levels (0, 84 and 168 kg/ha) and number of foliar micronutrients application (without, one spray and two sprays) on plant growth, yield and yield components and grain quality of six rows barley (*Hordium vilugare,* L. cv. Giza 123). Split- split plot design with three replications was used. The three humic acid rates were randomly distributed on main plot, while three nitrogen fertilizer levels were allocated in sub-plots meanwhile the three spray treatments of micronutrients were occupied the sub-sub plots. The obtained results indicated that a significant effect due to the favorable effect of the highest levels of the three studied factors, i.e., 14 kg/ha of humic acid, 168 kg N/ha and two micronutrients foliar application on barley plant growth, yield and its attributes and grain chemical contents.
Key word: barley, humic acid, nitrogenous fertilization, micronutrients, yield components

INTRODUCTION

Barley (*Hordeum vulgare* L.) is the major cereal in many dry areas of the world as food and vital for the livelihoods of many farmers. In Egypt, barley had tolerance characteristics to salt and drought stresses to be qualified to grown in wide areas, especially in the north coast region as well as in the new cultivated area. Barley is an annual cereal crop and grown in environments ranging from the desert of the Middle East to the high elevation of Himalayas (Hayes *et al*., 2003).

Humic acid (HA) is a complex molecule of polymeric organic acid of aromatic structure substituted by carboxyl, phenolic, hydroxyl and alkyl groups linked together through ether linkage (Sutton and Sposito, 2005). Humic acid might benefit plant growth by chelating unavailable nutrients and buffering pH (Julie and Bugbee, 2006). It contains 51-57% organic C, 4-6% N and 0.2-1% P, that may stimulate microbial activity, soil enzymatic activities thereby improve physicochemical and biological environment of soil which enhances plant growth (Zancani *et al.,* 2009).

N is an essential element limiting plant growth in many ecosystems; efficient use of N is believed to contribute to the fitness of the plant. Moreover, the N availability and internal distribution plays a critical role in the regulation of various growth-related and morphogenetic aspects of crop development that are usually attributed to hormonal factors (Hikosaka, 2004). N is the key element in achieving consistently high yields in cereals, where it is a constituent of many fundamental cell components such as nucleic acids, amino acids, enzymes, and photosynthetic pigments. The rate of uptake and partition of N is largely determined by supply and demand during various growth stages of plant. Soil N supply, for example, must be high at tillering, stem elongation, booting, heading and grain filling requiring a greater amount of the development

and growth of its reproductive organs and for an enhanced and high accumulation of proteins in the kernel. N is considered one of the most important factors affecting crop morphology (Amanullah *et al*., 2008).

Foliar application of microelements is more beneficial than soil application. Since application rates are lesser as compared to soil application, same application could be obtained easily and crop reacts to nutrient application immediately (Zayed *et al*., 2011). The use of micronutrients in soil nutrition is the pillars of agriculture in developed countries. Proper plant nutrition is one of the most important factors in improving the quality and quantity of plants product. Zinc is required in small but critical concentrations to allow several key plant physiological pathways to function normally (Mousavi *et al.,* 2011 and Yosefi *et al.,* 2011). Micronutrients like Fe, Mn and Zn have important roles in plant growth and yield of aromatic and medicinal plants (Abd El-Wahab, 2008). Fe is critical for chlorophyll formation and photosynthesis, and is important in the enzyme systems and respiration of plants; manganese is involved in the enzyme systems related to carbohydrate and nitrogen fixation in legumes; while zinc is essential for sugar regulation and enzymes that control plant growth (Havlin *et al*., 1999). Zn is main element for crop production and optimal size of fruit, also it required in the carbonic enzyme which present in all photosynthetic tissues, and chlorophyll biosynthesis (Mousavi, 2011and Xi-Wen *et al.,* 2011). El-Ghamry *et al*. (2009) indicated that mixture of foliar application (B, Mo, and Zn) gave the highest quantitative yield characteristics of wheat.

Foliar application of Zn and Mn significantly increased yield and yield components as well as chemical composition of barley grains over spray with tape water, when applied single or in combination. Zn application produced the tallest plants and spikes and number of grains/spike. The mixed Zn + Mn recorded the highest values for most of studied yield characteristics. Best results of chemical parameters of barley grains were achieved by foliar application with micronutrients with superiority to combined treatment (Gobarah *et al.,* 2015).

This investigation was carried out to fulfill the information about the impact of humic acid rates, foliar application with micronutrients and nitrogenous fertilization level on yield, yield components and grain chemical composition of barely cv. Giza 123 under Abees Region, Alexandria condition.

MATERIALS AND METHODS

Two field experiments were conducted at Agricultural Research Farm, Faculty of Agriculture (Saba- Basha), Alexandria University, Abees Region, Alexandria Governorate, Egypt during 2013/2014 and 2014/2015 seasons to study the effect of humic acid and nitrogen fertilizer levels besides foliar spray of micronutrients times on growth, yield, yield components and grain quality of six rows barley (*Hordeum vulgare*, L.) cv., Giza 123.Physical and chemical analysis soil characters of surface layer (0 to 30 cm) depth of the experimental sites

were determined before sowing in two growing seasons according to Chapman and Pratt (1978) and illustrated in Table (1).

Experimental design was carried out in a split-split plot design in three replicates. The studied factors were three humic acid rates (control (0), 7 and 14 kg/ ha) allocated in main plot, while, three nitrogen fertilizer levels (0, 84 and 168 kg /ha) as urea (46% N) in sub-plot and times of foliar spry of micronutrients (0, one spray and two times spray) in sub-sub plot. Sub- sub plot area was 4 m long and 3 m width (12 m^2) containing 10 rows; the distance between rows was 30 cm.

Humic acid as a powder was added during the soil preparation, while nitrogen fertilizer as urea (46%N) was applied into two equal doses, the first dose was added after 25 days from sowing date and the second dose was applied after 25 days from the first dose. However, Keltone (Mix-G-EDTA) (3% Zn, 4.5 % Fe, 3% Mn, 0.4% Cu, 3% B, 0.2% Mo and 8% EDTA) as source of micronutrients was added as foliar spray after 50 and 65 days from sowing at the rate of 1g/L as mentioned before.

Maize (*Zea may*, L.) was the preceding summer crop in the two seasons. Sowing date was 4th of December in both cropping seasons with seeding rate of 70 kg grains/fed of barley (*Hordeum vulgare*, L.) cultivar Giza 123.After sowing, irrigation applied every 25 days till dough ripe stage.

Table (1). Some physical and chemical properties of the soil in 2014and 2015 seasons

	Season	
	2013/2014	**2014/2015**
A) Mechanical analysis		
Clay %	38	37
Sand %	32	33
Silt %	30	30
Soil texture	Clay loam soil	
B) Chemical properties		
$_P$H (1 : 1)	8.20	8.31
EC (dS/m)	3.80	3.70
1) Soluble cations (1:2) (cmol/kg soil)		
K^+	1.52	1.54
Ca^{++}	9.4	8.7
Mg^{++}	18.3	18.5
Na^+	13.50	13.8
2) Soluble anions (1:2) (cmol/kg soil)		
$CO_3^{--} + HCO_3^-$	2.90	2.80
Cl^-	20.4	19.80
SO_4^{--}	12.50	12.60
Calcium carbonate (%)	6.50	7.00
Total nitrogen %	1.00	0.91
Available phosphorus (mg/kg)	3.70	3.55
Organic matter (%)	1.41	1.40

Plant height (cm), spike length (cm), number of spikes/m^2, number of spikelets/spike, number of grains/spike, 1000- grain weight (g), grain yield (tons/ha), straw yield (tons/ha), biological yield (tons/ha), harvest index (%), protein content and NPK, Fe, Zn, Mn, Cu content in grain of barley were studied in both growing seasons.

K percentage was determined in the dry grains. Their dry weights were determined following drying in a drying chamber to a constant weight at 75^{o}C for 72 hours according to Tandon (1995). After dryness, the plant samples were milled and stored for analysis as reported. However, 0.5 g of the grains powder was wet-digested with $H_2SO_4 – H_2O_2$ mixture according (Lowther, 1980) and the following determinations were carried out in the digested solution to determine using the atomic absorption spectrophotometer (Jackson, 1967).

Phosphorus was determined by the Vanadomolyate yellow method as given by Jackson (1973) and the intensity of colour developed was read in spectrophotometer at 405nm. Potassium was determined according to the described by method Jackson (1973) using Beckman Flame photometer.

Protein percentage was determined by estimating the total nitrogen in the grains and multiplied by 6.25 to obtain the percentage according of grain protein percentage to AOAC (1990).

Statistical analysis:

All the data collected were subjected to statistical analysis of variance as described by Gomez and Gomez (1984). The treatment means were compared using L.S.D. test at 0.05 level of significant by CoStat computer software package (Co Stat, Ver. 6.311., 2005).

RESULTS AND DISCUSSIONS

The obtained results recorded in Tables (2 and 3) revealed that plant height (cm), spike length (cm), number of spikes/m^2, number of spikelets/spike, number of grains/spike, 1000- grain weight (g), grain yield (tons/ha), straw yield (t/ha), biological yield (tons/ha) and harvest index (%) in both seasons significantly affected by the three studied factors i. e. humic acid rate, nitrogen fertilization levels and micronutrient foliar application.

With regard to humic acid effect, increasing humic acid application rate up to 14 kg/ha gradually and significantly increased the values of plant height, yield and its components (plant height (cm), spike length (cm), number of spikes/m^2, number of spikelets /spike, number of grains/spike, 1000- grain weight (g), seed yield/ plant (g), seed yield (t/ha), straw yield (t/ha), biological yield (t/ha) and harvest index (%) in both cropping seasons. These results, clearly show the importance of humic acid which may be due to the stimulatory effect of humic acid on cell division, elongation of internodes and increasing the activity of the intercalary meristem. These findings results are confirmed with

those obtained by Daur and Bakhashwain (2013), El-Bassiouny *et al*. (2014) and Wang *et al.* (2016).

As for nitrogen fertilization, the same trend was observed, where the highest nitrogen level (168 kg N/ha) produced the highest mean values of plant height, yield and its components during the two seasons. This may be due to the provision of nutrients at latter stages which might have enhanced accumulation of assimilate of the grains and thus resulting in hover grain of barley. Such findings are in agreements with those of Alazmani (2014) and Kouzegaran *et al.* (2015). Hikosaka, 2004 and Amanullah *et al. (*2008) reported the role of N for plants to make increasing growth and dry matter.

Additionally, two sprays of micronutrient foliar application showed the significantly effect on yield and its components in the two successive seasons (Tables 2 and 3). These results are in agreement with those achieved by Nadim *et al.* (2013) and Mekkei and El Haggan (2014) who revealed that there was the positive effect of micronutrient on these characters. Hemantaranjan and Gray (1994) revealed that using Zn led to increases in chlorophyll in leaves and indol acetic acid, so that photosynthesis will be improved and then dry mater will be increased.

The effect of the interaction between humic acid and nitrogen fertilizer on plant height (cm), spike length (cm), number of spikes/m^2, number of spikelets/spike, number of grains/spike, 1000- grain weight (g), seed yield/plant (g), seed yield (t/ha), straw yield (t/ha), biological yield (t/ha) and harvest index (%) were significant in both seasons.

With respect of nitrogen fertilization x micronutrients application effects on number of yield and its components, results presented in Tables (2 and 3) pointed out the highest values of that trait in the two studied seasons, respectively. With regard to humic acid rate x nitrogen fertilizer level x number micronutrients foliar application interactions effects on yield and its components, results in Tables (2 and 3) showed that the highest level of humic acid and nitrogen fertilizer combined with two times of foliar application micronutrients produced the highest mean value of yield and its components.

Table (2). Effect of humic acid rate, nitrogenous fertilization levels and micronutrient foliar applications on plant height, yield and its components for barley cv. Giza 123 during 2013/2014 and 2014/2015 seasons.

Treatments	Plant height (cm)		Spike length (cm)		Number of spikes/m^2		Number of spikelets /spike		Number of grains/spike	
	2013/2014	2014/2015	2013/2014	2014/2015	2013/2014	2014/2015	2013/2014	2014/2015	2013/2014	2014/2015
Humic acid rate (kg/ha)										
0	96.99c	96.96c	11.94c	11.98c	284.29c	288.96c	45.74c	45.11c	58.00b	59.39b
7	104.25b	103.95b	13.39b	13.39b	352.88b	371.44b	49.33b	50.70b	59.21b	60.44b
14	106.81a	109.81a	15.18a	15.26a	420.44a	431.88a	53.59a	54.77a	63.81a	63.08a
B) N fertilization level (kg N/ha)										
0	97.78c	98.91c	12.48c	12.79c	328.14c	331.81c	46.11c	46.29c	54.27c	55.04c
84	103.44b	104.65b	13.51b	13.37b	344.48b	359.00b	50.14b	51.22b	60.56b	60.59b
168	106.84a	107.17a	14.52a	14.47a	385.00a	401.48a	52.40a	53.07a	66.18a	62.29a
C) Micronutrient foliar application										
Without spray (control)	95.72c	97.64c	12.13c	12.38c	336.00c	343.33c	42.37c	43.88c	57.82b	58.80c
One spray	103.75b	104.12b	13.67b	13.53b	354.92b	366.66b	50.25b	50.62b	61.50a	60.87b
Two spray	108.57a	108.98a	14.72a	14.74a	366.70a	382.29a	56.03a	56.07a	61.68a	63.75a
Interactions										
A x B	*	*	*	*	*	*	*	ns	n.s.	n.s
A x C	*	*	*	*	*	*	*	ns	n.s.	ns
B x C	*	*	*	*	*	*	*	ns	*	*
Ax B x C	*	*	*	*	*	*	*	*	n.s	ns

- Means at the same column followed by the same letter are significantly different according to L.S.D. at 0.05 value.
- n.s. not significant difference at 0.05 level of probability.
- *: Significant at 0.05 level of probability.

Table (3). Effect of humic acid rate, nitrogenous fertilization levels and micronutrients foliar application on some yield characters of barley cv. Giza 123 during 2013/2014 and 2014/2015 seasons.

Treatments	1000-grain weight (g)		Grain yield (tons/ha)		Straw yield (tons/ha)		Biological yield (tons/ha)		Harvest index (%)	
	2013/2014	2013/2014	2013/2014	2013/2014	2013/2014	2013/2014	2013/2014	2013/2014	2013/2014	2013/2014
A) Humic acid rate (kg/ha)										
0	38.84c	39.63c	5.53c	7.28c	8.67b	11.23b	14.21b	18.52b	38.92a	39.31a
7	43.02b	44.03b	6.37b	7.35b	10.65a	11.61b	17.02a	18.97b	37.43b	38.75a
14	45.68a	46.52a	6.57a	7.48a	10.78a	12.36a	17.35a	19.84a	37.87b	37.70b
B) N fertilization level (kg N/ha)										
0	40.63c	41.31c	5.69c	7.05c	9.35b	11.53b	15.05c	18.58b	37.81b	37.94b
84	42.28b	43.55b	6.23b	7.49b	10.08a	11.75ab	16.31b	19.24a	38.20a	38.93a
168	44.62a	45.32a	6.55a	7.57a	10.67a	11.93a	17.23a	19.51a	38.02a	38.80a
C) Micronutrient foliar application										
Without spray (control)	39.60c	40.30c	5.75c	6.97c	10.16a	10.87c	15.91c	18.66c	36.14c	37.35c
One spray	42.37b	43.86b	6.19b	7.35b	9.99a	11.67b	16.18b	19.02b	38.26b	38.64b
Two spray	45.56a	46.02a	6.52a	7.78a	9.98a	12.66a	16.50a	19.64a	39.52a	39.61a
Interactions										
Ax B	*	*	*	*	ns	ns	ns	*	ns	*
AxC	ns	*	ns	*	ns	ns	ns	ns	ns	ns
BxC	*	*	ns	ns	ns	ns	ns	ns	ns	*
AxBx C	ns	*	ns	*	ns	ns	ns	*	ns	ns

- Means at the same column followed by the same letter are significantly different according to L.S.D. at 0.05 value.
- n.s. not significant difference at 0.05 level of probability.
- *: Significant at 0.05 level of probability

Chemical composition

Data recorded in Table (4) reveal that percentage of nitrogen, phosphorus, potassium, and protein content (%) in grains were significantly affected by adding humic acid rate, nitrogen fertilizer levels and micronutrients application. The highest means values of all chemical compositions character were obtained using (14 kg/ha humic acid, 168 kg N/ha and two foliar applications of micronutrients (Zn, Fe, Cu and Mn). Concerning the three studied factors, i.e., humic acid rate, nitrogen level and micronutrient foliar application effected nitrogen, phosphorus, potassium, and protein content (%) in barley grain. Results presented in Table (4) revealed that increasing the studied previous factors up to 14 kg/ha, 168 kg N/fed and two times of micronutrients application produced the highest percentage of all elements uptake, in 2013/2014 and 2014/2015 seasons. Conversely, growing barley without the three previous factors showed the lowest one in the first and the second seasons. These results agreed with those obtained by Moussavi-Nik *et al.* (2012), Leta *et al*. (2013), Mekkei and El-Haggan (2014).

With respect to humic acid rate x nitrogen level interaction effect on that trait, results in Table (4) showed that the highest mean values of that trait, resulted from 14 kg humic acid combined with 168 kg N/ha in the first and second seasons, respectively. On the other hand, barley plants treated with combination of 14 kg/ha of humic acid as soil application and micronutrients foliar applications two times produced significantly highest mean values of that trait, in the two successive seasons. Conversely, untreated plants with both factors showed the lowest one in 2013/2014 and 2014/2015 seasons, respectively, as presented in Table (4).

Table (4). Effect of humic acid rate, nitrogenous fertilization levels and micronutrient foliar application on chemical composition of barley grains cv. Giza 123 during 2013/2014 and 2014/2015 seasons.

Treatments	Protein content (%)		P (%)		K (%)	
	2013/2014	2013/2014	2013/2014	2013/2014	2013/2014	2013/2014
A) Humic acid rate (kg/ha)						
0	9.23c	9.29c	0.425c	0.436c	2.55c	2.56c
7	10.34b	10.57b	0.519b	0.533b	2.75b	2.77b
14	11.23a	11.22a	0.635a	0.649a	2.93a	3.18a
B) N fertilization level (kg/ha)						
0 (without N)	9.62c	9.82c	0.481c	0.492c	2.53c	2.60c
84	10.30b	10.45b	0.519b	0.536b	2.70b	2.81b
168	10.88a	10.81a	0.579a	0.591a	3.00a	3.10a
C) Micronutrient foliar application						
Without spray (control)	9.22c	9.43c	0.488c	0.492c	2.35c	2.34c
One spray	10.33b	10.41b	0.518b	0.540b	2.79b	2.92b
Two spray	11.24a	11.23a	0.573a	0.587a	3.10a	3.24a
Interaction						
Ax B	*	*	*	*	ns	*
AxC	*	*	*	*	*	*
BxC	*	*	*	*	ns	*
AxBx C	*	*	*	*	ns	*

- Means at the same column followed by the same letter are significantly different according to L.S.D. at 0.05 value.
- n.s. not significant difference at 0.05 level of probability.
- *: Significant at 0.05 level of probability.

CONCLUSION

It can be concluded that using 14 kg/ha from humic acid, 168 kg/ha of nitrogen fertilizer and foliar application of micronutrients recoded the highest yield of barley under Abees Region condition, Alexandria.

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الملخص العربي

تأثير إضافة المحسنات العضوية والتسميد النتروجيني والرش بالعناصر الصغري علي الشعير

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أجريت تجربتان حقليتان في مزرعة كلية الزراعة (سابا باشا) جامعة الأسكندرية خلال موسمي ٢٠١٣/٢٠١٤، ٢٠١٤/٢٠١٥ لدراسة تأثير معدلات حمض الهيوميك ومستويات السماد النيتروجيني وعدد مرات الرش بالعناصر الصغري علي النمو والمحصول ومكوناته والمحتوي الكيماوى للحبوب (الفوسفور والبوتاسيوم والحديد والزنك والمنجنيز والنحاس) والبروتين لصنف الشعير جيزة ١٢٣. استخدم تصميم القطع المنشقة مرتين ، حيث كانت الثلاث معاملات من الهيوميك (مقارنة ، ٧ ، ١٤ كجم/هكتار) فى القطع الرئيسية ، ووزعت الثلاث معاملات من معدلات السماد النتروجينى (مقارنة، ٨٤ ، ١٦٨ كجم/هكتار) بالقطع الشقية الأولى ، و معاملات الرش بالعناصر الصغرى الثلاثة (مقارنة ، رشة مرة واحدة ، رش مرتين) بالقطع الشقية الثانية فى ثلاثة مكررات . وكانت أهم الصفات المدروسة كما يلى (أرتفاع النبات ، طول السنبلة ، عدد السنابل/م^2، وزن ١٠٠٠ حبة ، عدد الحبوب/سنبلة ، محصول الحبوب (طن/هكتار) ، محصول القش (طن/هكتار) ، المحصول البيولوجي (طن/هكتار) ، ودليل الحصاد %) .

أوضحت النتائج مايلي:

١. أدي إستخدام ١٤ كجم/هكتار من حمض الهيوميك إلي الحصول علي أفضل القيم للصفات التي تم دراستها.
٢. أدي التسميد النيتروجيني بمعدل ١٦٨ كجم N/هكتار للحصول علي أفضل القيم للصفات المدروسة.
٣. أدي الرش مرتين بالعناصر الصغري للحصول علي أفضل القيم للصفات تحت الدراسة.

يمكن التوصية بإضافة حمض الهيوميك بمعدل ١٤ كجم/ هكتار من مع التسميد النيتروجيني بمعدل ١٦٨ كجم N/ هكتار والرش بالعناصر الصغري مرتين حيث أن هذه التوليفة ذات تأثير معنوي على النمو والمحصول ومكوناته ومحتوي حبوب الشعير جيزة ١٢٣ من البروتين والعناصر المعدنية تحت الظروف البيئية لمنطقة الدراسة.

Effect of Organic Selenium and Lycopene Addition of A Diet Enriched with Flaxseed Oil on Performance, Carcass, Blood Lipid Profile, Lipid Traits in The Muscle and Antioxidant Property of Rabbits

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ABSTRACT: The present study aimed to investigate the performance development, antioxidative status, immunological effects, muscle n-3 and n-6 fatty acids resulting from supplemented the flaxseed oil diets of growing V-line rabbits with lycopene and / or organic selenium during Egyptian summer season. Sixty growing V-line rabbits of both sexes, 5 weeks old, with initial weights of 781.0 ± 23.85 g were used for the study. The rabbits were randomly allocated to five treatments groups of 12 rabbits each. Each treatment was further sub-divided into 4 replicates of 3 rabbits. Group I – fed a pelleted basal diet with standard components (control group), group II – fed a pelleted diet with 2% flaxseed oil, group III – fed a pelleted diet with 2% flaxseed oil and 0.25 mg/kg diet organic selenium Sel-plex, group IV – fed a pelleted diet with 2% flaxseed oil and 110 mg lycopene/ kg diet , group VI – fed a pelleted diet with 2% flaxseed oil plus 0.25 mg/kg diet organic selenium Sel-plex® and 110 mg lycopene/ kg diet. The results showed that different experimental treatments had insignificant effect on growth performance and carcass traits. Serum total lipids, total cholesterol and low density lipoprotein significantly ($P \leq 0.05$) decreased due to different experimental diets, however, high density lipoprotein concentration and HDL/LDL ratio were significantly ($P \leq 0.05$) increased in comparison with the control group. Exposing growing rabbits to high temperature conditions during summer season resulted in significant decrease ($P \leq 0.001$) in serum total antioxidant capacity and elevated ($P \leq 0.05$) serum malondialdehyde (MDA) which was obtained in the control group, however, including flaxseed oil or flaxseed oil plus different feed additives used in the present study appeared to antagonize the effect of high temperature during summer. The n-3 fatty acids were significantly ($P \leq 0.05$) increased by feeding flaxseed oil, flaxseed oil plus organic selenium, flaxseed oil plus 110 mg lycopene and mix of flaxseed oil plus organic selenium and 110 mg lycopene treatments, while the n-6 fatty acids were increased significantly by feeding flaxseed oil plus organic selenium, flaxseed oil plus 110 mg lycopene and mix of flaxseed oil plus organic selenium and 110 mg lycopene treatment. In conclusion, the addition of flaxseed oil with organic selenium or lycopene could be recommendable to increase n-3 polyunsaturated fatty acids (PUFA) in rabbit meats, providing a healthier and functional rabbit meat to consumer.

INTRODUCTION

Flax is flowering plants native to the Mediterranean and to Central Asian areas but has been introduced to North America possibly as a weed in flax. It cultivated as an oilseed crop to produce vegetable oil and animal feed. The crop is now being researched due to its nutritional characteristics. It is seed has an oil content that about 40% on a dry matter basis (Budin *et al.,* 1995) Flaxseed oil is a rich source of the flowing unsaturated fatty acids: oleic 20%, linoleic 24% and linolenic acid 42% (Flachowsky *et al.,* 1998). And it has a relative low content of glucosinolates (Schuster and Friedt, 1998), but, PUFA-enriched meat could be more susceptible to oxidation especially heat stress. Tomatoes and related tomato products are the major source of lycopene in the human diet. Marković *et al.* (2006)

reported that lycopene is an acyclic carotenoid and contains 11 conjugated double bonds. In nature, most carotenoids originally occur in the all-trans forms. Lycopene, with its acyclic structure, large array of conjugated double bonds, and extreme hydrophobicity, exhibits many unique and distinct biological properties. Lycopene provided strong protection against singlet oxygen-induced cell damage with the use of an *in vitro* studies. Lycopene is extraordinarily efficient in the control of degenerative diseases; it is a preventive against cardiovascular diseases and cancer of the prostate gland, digestive tract, skin, pancreas and uterine uvula. Lycopene also blocks the biosynthesis of cholesterol. Lycopene is a potent antioxidant that provides protection against cellular damage caused by reactive oxygen species. Lycopene has an effective free radical scavenging activity, and this action could be beneficial to rabbits and poultry because harmful free radicals are formed under the stress, fast growth, high reproduction rates and intensive metabolism conditions of poultry farming. Lycopene may play an important role in the antioxidant defense system (Ševčíková *et al.,* 2008). Several studies confirmed many positive effects of organic selenium including immune response, lipid peroxidation, and antioxodative properties. The importance of selenium in animal nutrition lies in the fact that both first and second levels of antioxidant defense in the cell (detoxification of hydroperoxides) rely on the activity of glutathione peroxidase (GSH-Px), which in turn depends on adequate selenium status in the cell (Surai, 2000a,b). Indeed, a combination of dietary selenium supplementation with high vitamin E levels has been shown to further increase GSH-Px activity (Surai, 2000c). In particular, GSH-Px is involved in cellular antioxidant protection, and it has been suggested that GSH-Px works in synergy with vitamin E, because GSH-Px continues the work of vitamin E by detoxifying hydroperoxides (Allan *et al*., 1999). This study was conducted to investigate the performance development, muscle n-3 and n-6 fatty acids, antioxidative status and immunological effects resulting from supplemented the flaxseed oil diets of growing V-line rabbits with lycopene and / or organic selenium (Sel-plex®).

MATERIALS AND METHODS

Sixty growing V-line rabbits of both sexes, 5 weeks old, with initial weights of 781.0 ± 23.85 g were used for the study during summer season (June- mid of August 2015). The rabbits were randomly allocated to five treatments groups of 12 rabbits each. Each treatment was further sub-divided into 4 replicates of 3 rabbits. Rabbits were housed in wire floor batteries of 45 x 36 x 36 cm and were offered diets for duration of the feeding trial until reaching 13 weeks of age. All rabbits were kept under similar hygienic conditions. Rabbits were housed in well ventilated block building. Fresh air circulated in the house using exhaust fans. The rabbits were kept within a cycle of 16 h light and 8 h dark. Five pelleted diets were prepared. Group I – fed a pelleted basal diet with standard components (control group), group II – fed a pelleted diet with 2% flaxseed oil, group III – fed a pelleted diet with 2% flaxseed oil and 0.25 mg/kg diet organic selenium Sel-plex, group IV – fed a pelleted diet with 2% flaxseed oil and 110 mg lycopene/ kg diet , group VI – fed a pelleted diet with 2% flaxseed oil plus 0.25 mg/kg diet organic selenium Sel-

plex® and 110 mg lycopene/ kg diet. The experimental diets were feed for 8 weeks. Flaxseed oil was purchased from local company, (Alexandria company for extracted oils, Alexandria Governorate, Egypt), lycopene was purchased from Roche, Levent-Istanbul and Sel-plex®: a product produced by ALLTECH® (selenomethionine). Some modifications were done in the composition of the basal diets to make the five experimental diets isonitrogenous and isoenergetic containing approximately 17.0 % CP and 2542 Kcal/kg DE (Table. 1). Each group of rabbits was fed one of five experimental diets. Fresh water was automatically available at all times through stainless steel nipples for each cage. The experimental diets were offered to rabbits *ad libitum*.

Individual body weight and feed consumption were recorded weekly. Daily body weight gain and feed conversion ratio were also calculated. The incidence of dangerous diseases was largely avoided and rabbits have never been treated with any kind of systematic vaccination or medication. At the end of the feeding trial, 3 rabbits were selected from each treatment group randomly, starved of food but not water for 12 hours and slaughtered for carcass analysis. Before slaughtering, 6 ml of blood sample was taken from the ear vein with a sterile syringe. 3 ml of the blood was put into a bijon bottle containing ethylene diamine tetracetic acid (EDTA) as an anticoagulant for hematological assay. The remaining 3ml of the blood sample was put into a sterile vacutainer tube without an anticoagulant for serum biochemical analysis. The hematological assay was carried out to determine erythrocyte indices such as packed cell volume (PCV), and hemoglobin (Hb) values. Red blood cell (RBC) counts were counted on an AO Bright line hemocytometer using a light microscope at 400X magnification (Natt and Herrick, 1952). White blood cell (WBC) counts according to Hepler (1966). Total lipids, triglycerides, cholesterol, low density lipoprotein (LDL) and high density lipoprotein (HDL), concentrations in serum were estimated using commercial kits (Bio Merieux, France) according to the procedure outlined by the manufacturer. Three rabbits of each treatment were immunized with 0.1 ml of a 2.5% Sheep Red Blood Cells (SRBC) via the marginal ear vein at 15 days after starting the dietary treatment supplementation, to measure antibody titer against Sheep Red Blood Cells. The dosage of SRBC for inoculation was pre-determined by a separate trial. Antiserum to SRBC was collected 7, 14 and 21 days post challenge. One ml of blood was refrigerated to allow red blood cells to settle. If sedimentation was not complete, samples were centrifuged for 1 to 2 min at 3000 rpm to separate plasma and erythrocytes, and the supernatant was collected. Briefly, 96-well plates were first filled with 50µl of physiological saline solution in each well. Then 50 µl of antiserum was pipetted into the first well in duplicates after which 50µl from the first well was pipetted into the second well, and so forth using an automatic pipette. Finally, a 0.75% of SRBC solution was added to each well. Plates were incubated at 37 o C for 3 hours and then examined visually for agglutination Wegmann and Smithies (1966). The agglutination titer was expressed as the log2 of the reciprocal of the highest serum dilution giving complete agglutination (Nelson *et al.,* 1995). Fatty acids were extracted from hind leg muscle tissue of rabbit and analyzed by using gas chromatography (GLC) according to the method described by Radwan

(1978). Muscle cholesterol was determined by method of Richmond (1973), by using "Cholesterol CHOD-PAP Kits" which produced by Human, Germany. The results were expressed as the mean ± SEM. All data were analyzed using one way analysis of variance (ANOVA) using SPSS 11.0 statistical software (SPSS, Inc., Chicago, Il, 2001). Significant differences between means were detected using new Duncan multiple range test (Duncan, 1955).

Table (1). Composition and chemical analyses of control and the basal flaxseed oil experimental diets.

Ingredients	Control	Linseed oil 2%
Clover hay	28.00	28.00
Yellow corn	18.90	16.90
Wheat bran	11.00	11.00
Barley grain	17.30	17.30
Soybean meal (44%)	20.00	20.00
Molasses	3.00	3.00
Flaxseed oil	-	2.00
Limestone	1.00	1.00
Salt	0.30	0.30
DI- Methionine	0.10	0.10
L-Lysine	0.10	0.10
Vit, and min. mix.[1]	0.30	0.30
Total	100	100
Chemical analysis (%)		
Crude Protein	17.19	17.04
Crude Fiber	12.44	12.39
DE[3] (Kcal / kg) (calculated)	2542	2543

[1]Vit+Min mixture provides per kilogram contains: Vit A 6000 IU; Vit D_3 450 IU; Vit E 40 mg; Vit K_3 1 mg; Vit B_1 1 mg; Vit B_2 3 mg; Vit B_3 180 mg; Vit B_6 39 mg; Vit B_{12} 2.5 mg; Pantothenic acid 10 mg; biotin 10 mg; folic acid 2.5 mg; choline chloride 1200 mg; Manganese 15 mg; Zinc 35 mg; Iron 38 mg; Copper 5 mg; Selenium 0.1 mg; Iodine 0.2 mg; Selenium 0.05 mg. [2]Analyzed values according to AOAC (1995). DE calculated according to Fekete and Gippert (1986) as: DE (kcal/kg DM) = 4253 - 32.6(Crude fibre % DM) - 144.4(ash% DM).

RESULTS AND DISCUSSION

The effects of flaxseed oil without or with organic selenium, lycopene and organic selenium plus lycopene on growth performance of growing rabbits are summarized in Table 2. The different experimental treatments had insignificant effect on daily body weight gain, feed intake and feed conversion ratio. However, it was observed numerical improvement in feed conversion ratio ranged from 11.4 to 16.7 % due different experimental treatments in comparison with the control one.

The best values of feed conversion ratio were recorded in the group given flaxseed oil with lycopene and the group given mix of flaxseed oil organic selenium with lycopene. These results were in agreement with those presented by Saleh *et al.* (2013) who showed that linseed oil has no significant effect on body weight, weight gain and feed intake of male growing New Zealand white rabbits, but feed intake was significantly reduced and feed conversion ratio was improved when linseed oil mixed with organic selenium. Furthermore, Trebušak *et al.* (2011) indicated that body weight gain was not influence when the rabbits fed on diets containing linseed oil, while feed intake was significantly reduced and feed conversion ratio improved. Jain *et al.* (1999) reported that live weight was not affected by lycopene supplementation in rat diets. In rabbits, treatment with lycopene and green tea extract did not negatively affect the performance characteristics of feed intake, body weight and feed conversion ratio (Tedesco *et al.,* 2005). However, the results presented by Farag (2014) were in disagreement with our results, since He reported that 100, 200 and 300 mg lycopene/ kg diet resulted in improving body weight gain and feed conversion ratio of growing chickens. Also, Zeweil *et al.* (2016) demonstrated that supplementation of 100 or 200 mg lycopene / kg diet improved daily body weight gain and feed conversion ratio of growing rabbits.

Table (2). Effects of flaxseed oil without or with organic selenium, lycopene and organic selenium plus lycopene on growth performance

Treatments	Initialbody weight (g)	Final body weight (g)	Daily weight gain (g)	Dailyfeed intake (g)	Feed conversion ratio(gfeed :g gain)
Control	785.1±12.9	2327.5±17.9	27.3±0.2	72.3±2.6	2.64±0.08
Flaxseedoil 2%	788.7±9.5	2377.5±19.8	28.1±0.2	65.96±3.3	2.34±0.11
Flaxseedoil 2%+Se(0.25mg/kg)	783.2±9.0	2365.6±17.8	28.1±0.3	64.84±1.9	2.30±0.07
Flaxseedoil 2%+Lyco(110 mg/kg)	779.2±12.7	2341.0±8.5	28.1±0.4	62.1±2.2	2.20±0.08
Flaxseedoil2%+Se(0.25mg/kg)+Lyco(110mg/kg)	780.0±14.9	2344.0±8.9	28.0±0.3	63.8±3.1	2.28±0.12

Results in table 3 for pre-slaughter weight and percentage of hot carcass and liver were insignificantly affected by different treatments in comparison with control. Different treatments significantly decrease the muscle total cholesterol but did not significantly effect on the abdominal fat weight, although it were lower in comparison with the control group. Salama (2011) reported that the linseed oil had insignificant effect on pre slaughter weight of rabbits at 13 weeks of age, however, the percentage of blood, dressing, heart and fur were significantly increased in comparison with control group. Abdulkareem (2011) found that addition of organic selenium at level 0.15 mg/kg diet resulted in significant ($p \leq 0.01$) increase in dressed carcass percentage and significant ($p \leq 0.01$) decrease in head percentage level of growing rabbits. Saleh *et al.* (2013**)** reported that carcass weight, dressing percentage and liver weight were increased; however, abdominal fat weight was decreased by dietary supplementation of linseed oil with organic selenium. Farag (2014) reported that the relative weight of carcass, gizzard, liver, spleen and tests

were insignificantly affected by supplementation of 100 or 200 mg lycopene / kg diet as compared with the control chickens. Also, Zeweil *et al.* (2016) found that 100 or 200 mg lycopene / kg of growing rabbit's diet had insignificant effect on all carcass traits.

Table (3). Effects of flaxseed oil without or with organic selenium, lycopene and organic selenium plus lycopene on carcass traits

Treatments	Pre-slaughter weight (g)	Hot carcass %	Liver %	Abdominal fat weight %	Muscle total cholesterol (mg/dl)
Control	2324.2±18.1	55.1±1.1	2.51±0.03	2.45±0.19	68.7±2.9[b]
Flaxseed oil 2%	2377.5±21.7	57.8±1.2	2.53±0.09	2.17±0.12	57.0±2.1[a]
Flaxseed oil 2%+Se(0.25mg/kg)	2363.3±7.4	56.7±0.6	2.53±0.03	1.91±0.14	54.0±2.1[a]
Flaxseed oil 2%+Lyco(110 mg/kg)	2341.0±13.8	57.6±1.8	2.53±0.05	2.16±0.22	54.7±2.6[a]
Flaxseed oil 2%+Se (0.25mg/kg)+Lyco(110 mg/kg)	2344.0±14.2	56.7±2.3	2.53±0.05	2.11±0.26	54.3±1.9[a]

Different letters (a-b) within a column denote significant differences between treatments ($P \leq 0.05$)

Results illustrated in Table 4 showed the effects of flaxseed oil without or with organic selenium, lycopene and organic selenium plus lycopene on n-3, n-6 and the ratio n-6/n-3 of the hind leg muscle fat. It was observed that the n-3 fatty acids were significantly ($P \leq 0.05$) increased by feeding flaxseed oil, flaxseed oil plus organic selenium, flaxseed oil plus 110 mg lycopene and mix of flaxseed oil plus organic selenium and 110 mg lycopene treatment, while the n-6 fatty acids were increased significantly by feeding flaxseed oil plus organic selenium, flaxseed oil plus 110 mg lycopene and mix of flaxseed oil plus organic selenium and 110 mg lycopene treatment.

These results suggest that the addition of flaxseed oil with organic selenium or lycopene could be recommendable to increase n-3 PUFA in rabbit meats, providing a healthier and functional rabbit meat to consumer. The best value was recorded in the group had flaxseed oil plus 110 mg lycopene. The change of lipid composition of animal feeds can have an impact on the nutritional value of the meat consumed by the humans (Bourre, 2005). Feeding rabbits with pellet containing sunflower or linseed oil rich in PUFAs considerably improves polyunsaturated/saturated ratio, increases the α-linolenic and linoleic level as well as increases the n-3/n-6 ratio, an useful indicator for comparing relative nutritional values (Piggot *et al.,* 1990), in the muscles (Zsédely *et al.,* 2006). Trebušak *et al.,* (2011) found that linoleic acid and α-linolenic acid were increased while; palmatic acid was decreased when the rabbits fed on diet content linseed oil and consecutively caused a significant decrease in the n-6/n-3 PUFA ratio. Similarly, Peiretti (2012) reported that feeding rabbits with flaxseed oil, unsaturated fatty acids were increased and saturated fatty acids were decreased.

Table (4). Effects of flaxseed oil without or with organic selenium, lycopene and organic selenium plus lycopene on composition of n-3, n-6 and the ratio n-6/n-3 of the muscle tissue lipids in the rabbit hind leg (g per 100 g of all acids determined)

Treatments	n-3 (mg/100g)	n-6 (mg/100g)	n-6/n-3
Control	1.30±0.17^{d}	8.27±0.23^{b}	6.65±1.10^{a}
Flaxseed oil 2%	3.57±0.32^{c}	8.18±0.29^{b}	2.32±0.14^{b}
Flaxseed oil 2% + Se (0.25mg/kg)	4.92±0.51^{b}	12.47±2.07^{a}	2.52±0.24^{a}
Flaxseed oil 2% +Lyco (110 mg/kg)	6.53±0.32^{a}	12.43±0.37^{a}	1.91±0.06^{b}
Flaxseed oil 2% + Se (0.25mg/kg)+Lyco(110 mg/kg)	5.93±0.47^{ab}	11.73±0.67^{a}	2.01±0.23^{b}

Different letters (a-d) within a column denote significant differences between treatments (P ≤ 0.05)

Results on hematological parameters of the rabbits in Table 5 showed a general significant (P ≤ 0.05) increase in PCV, except flaxseed oil treatment and numerical increase in RBCs, WBCs, and Hb of rabbits fed flaxseed oil or diets containing flaxseed oil and supplemented with selenium, lycopene or selenium plus lycopene. Platlets was not differ significantly due to different treatments. The general increase in PCV and RBC of rabbits indicates that these feed additives may contain blood forming factors that may have stimulated more blood production by the rabbits fed supplemented diets than those fed control diet through summer season. This also suggests that these additives may have helped in boosting the immune system of the rabbits. The RBC, PCV and Hb values were fall within the normal range of 3.7 - 8.0 10^{6} µ / l, 25 – 50% and 8.9 – 17.5 g/dl reported for healthy rabbits by Mitruka and Rawnsley (1977). The normal PCV indicates the absence of normocytic anemia which is reportedly characterized by normal MCV and MCH and only detected by a decreased number of RBCs or PCV (Coles, 1986). The result is corroborated by the normal RBCs which further elucidated the absence of hemolytic anemia and depression of erythrogenesis. The normal hemoglobin concentration for all the experimental rabbits is probably an indication that these feed additives supplement supported hemoglobin synthesis, which according to Sirosis (1995) is among other factors, primarily affected by protein intake. Njidda *et al.* (2006) reported that normal range of values for Hb indicated that the vital physiological relationship of hemoglobin with oxygen in the transport of gases (oxygen and carbon dioxide) to and from the tissues of the body has been maintained and was normal.

Antibody titters against SRBCs determined are shown in Table (6) as affected by flaxseed oil or the different feed additives in flaxseed oil diet in comparison with the control group free of flaxseed oil or feed additives. Different treatments did not increase antibody titters against SRBCs enough to find statistical significance, although it were higher in the most studied treatments compared with control group at 7, 14 and 21 days after vaccination.

Table (5). Effects of flaxseed oil without or with organic selenium, lycopene and organic selenium plus lycopene on blood hematology

Treatments	RBCs ($x10^6/mm^3$)	WBCs ($x10^3/mm^3$)	Hb mg/dl	PCV%	PLT
Control	4.50±0.30	6.34±0.09	11.48±0.74	36.65±0.75^{c}	229.00±3.79
Flaxseed oil 2%	5.55±0.20	7.20±0.51	12.45±0.78	39.73±0.25^{bc}	220.33±2.91
Flaxseed oil 2% + Se (0.25mg/kg)	5.32±0.34	6.70±0.78	11.95±0.49	41.75±0.91^{ab}	222.67±3.93
Flaxseed oil 2% +Lyco (110 mg/kg)	5.54±0.24	6.20±1.24	11.95±0.62	42.85±1.52^{ab}	219.25±1.70
Flaxseed oil 2% + Se (0.25mg/kg) + Lyco (110 mg/kg)	5.50±0.24	8.16±0.41	12.27±0.17	44.01±0.65^{a}	218.75±4.48

Different letters (a-c) within a column denote significant differences between treatments (P ≤ 0.05)

Table (6). Effects of flaxseed oil without or with organic selenium, lycopene and organic selenium plus lycopene on antibody titer (log2)

Treatments	14 days	21 days	28 days
Control	0.89±0.03	0.93±0.03	0.82±0.05
Flaxseed oil 2%	0.89±0.01	0.93±0.04	0.83±0.06
Flaxseed oil 2% + Se (0.25mg/kg)	0.91±0.03	0.94±0.05	0.87±0.04
Flaxseed oil 2% +Lyco (110 mg/kg)	0.94±0.03	0.94±0.04	0.86±0.06
Flaxseed oil 2% + Se (0.25mg/kg) + Lyco (110 mg/kg)	0.94±0.02	0.95±0.03	0.88±0.04

Results illustrated in Table 7 showed the effect of different treatments on blood serum lipid profile. It was observed that serum total lipids, total cholesterol and low density lipoprotein significantly (P ≤ 0.05) decreased due to different experimental diets in comparison with the control group, however, triglycerides numerically decreased due to different treatments. On the other hand, high density lipoprotein concentration and HDL/LDL ratio were significantly (P ≤ 0.05) increased by different experimental diets as compared with the control group. Salama (2011) found that plasma cholesterol and triglycerides levels were decreased significantly in rabbits fed 2% linseed oil followed by 2% linseed oil plus 0.5% green tea and 0.5% green tea diets relative to control diet. On the other hand, high density lipoprotein cholesterol (HDL-chol) were significantly (P ≤ 0.05) increased by supplementing 2% linseed oil and 2% linseed oil plus 0.5% green tea as compared to the other treatments followed by those supplementing 0.5% green tea, increases in mean plasma total and high-density lipoprotein cholesterol concentrations. But low-density lipoprotein cholesterol (LDL-chol) was not significantly affected by supplementing 2% linseed oil or 0.5% green tea and control group. Also, Saleh *et al.* (2013) showed that dietary supplementation of linseed oil with or without organic selenium decreased plasma total cholesterol and LDL, while, plasma HDL and glutathione peroxidase were increased in linseed oil plus organic selenium. This effect might be attributed to the lipolysis which was increased by selenium feeding (Miezeliene *et al.,* 2011). Zeweil *et al.* (2016) showed that serum total lipids, total cholesterol and triglycerides were significantly (P ≤ 0.01) reduced due to addition of 100 or 200 mg lycopene in growing rabbit diets in comparison with the control group.

Exposing growing rabbits to high temperature conditions during summer season resulted in significant decrease ($P \leq 0.001$) in serum total antioxidant capacity and elevated ($P \leq 0.05$) serum MDA which was obtained in the control group, however, including flaxseed oil or flaxseed oil plus different feed additives used in the present study appeared to antagonize the effect of high temperature during summer (Table 8). The total antioxidant capacity in blood serum of rabbits fed flaxseed oil, flaxseed oil plus selenium, linseed oil plus 110 mg lycopene /kg diet and combined of flaxseed oil plus selenium and 110 mg lycopene increased its value by about 12.1, 12.1, 7.7 and 9.9 %, respectively, as compared with the control group. However, these treatments reduced lipid peroxidation in serum expressed as serum malondialdehyde (MDA) by 35.0, 32.2, 33.4 and 26.9 %, respectively, in comparison with the control one free of flaxseed oil and different feed additives.

Heat stress through summer conditions causes increased free radical production (Halliwell and Gutteridge, 1989) and lowers the concentrations of antioxidant vitamins and minerals such as E, C, A and Zn in serum and tissues (Sahin and Kucuk, 2003). Free radicals trigger the metabolic disorder, cell death and growth retardation (Okada, 1996). Salama (2011) showed that dietary treatment with 2% linseed oil and/ or 0.5% green tea significantly increased total antioxidant capacity, superoxide dismutase and glutathion peroxidase activity, however, MDA concentration was significantly reduced comparing to the control group. Also, Abdulkareem (2011) proved that different levels of dietary organic selenium showed a positive effect on antioxidative properties as measured by total antioxidant capacity when compared with control ($P \leq 0.05$). Fattening rabbits fed 0.3 ppm organic selenium had the highest total antioxidant capacity value in blood plasma (2.02 mg /dl) compared with control (1.30 mg /dl). Also, the authors observed that plasma TBARS values were decreased insignificantly when fattening rabbits fed organic selenium. Zeweil *et al.* (2016) showed that exposing growing rabbits to high temperature conditions during summer season resulted in significant decrease ($P \leq 0.05$) in serum total antioxidant capacity which was obtained in the control group, however, supplementation of 100 or 200 mg lycopene / kg of growing rabbit diets appeared to antagonize the effect of high temperature. The different levels of lycopene (100 and 200 mg) increased total antioxidant capacity in blood serum to rich an increase their value by 51.9 and 49.4 %, respectively, in comparison with the control group. In conclusion, the addition of flaxseed oil with organic selenium or lycopene could be recommendable to increase n-3 PUFA in rabbit meats, providing a healthier and functional rabbit meat to consumer.

Table (7). Effects of flaxseed oil without or with organic selenium, lycopene and organic selenium plus lycopene on blood serum lipid profile

Treatments	Total lipids (mg/dl)	Trigly-cerides (mg/dl)	Total cholesterol (mg/dl)	HDL (mg/dl)	LDL (mg/dl)	HDL/LDL
Control	375.5±8.6^{a}	70.4±4.4	69.4±2.1^{a}	21.9±1.3^{b}	20.8±0.4^{a}	1.1±0.08^{b}
Flaxseed oil 2%	346.5±10.1^{ab}	63.0±16.0	60.4±3.3^{bc}	27.1±1.0^{a}	17.3±0.2^{b}	1.6±0.07^{a}
Flaxseed oil 2% + Se (0.25mg/kg)	330.3±2.9^{b}	60.3±1.8	56.0±3.0^{c}	27.4±0.9^{a}	18.3±0.6^{b}	1.5±0.11^{a}
Flaxseed oil 2% +Lyco (110 mg/kg)	328.1±19.4^{b}	64.1±2.2	61.5±3.2^{abc}	27.2±0.6^{a}	17.8±0.3^{b}	1.5±0.04^{a}
Flaxseed oil 2% +Se(0.25mg/kg) +Lyco (110 mg/kg)	327.3±6.8^{b}	65.1±3.7	67.8±1.6^{ab}	26.7±0.9^{a}	17.9±0.5^{b}	1.5±0.07^{a}

Different letters (a-c) within a column denote significant differences between treatments (P ≤ 0.05)
HDL=high density lipoprotein, LDL= Low density lipoprotein

Table (8). Effects of flaxseed oil without or with organic selenium, lycopene and organic selenium plus lycopene on blood serum lipid profile

Treatments	Total antioxidant capacity (mM/L)	Malondialdehyde (nmol/ml)
Control	0.91±0.01^{b}	6.43±0.65^{a}
Flaxseed oil 2%	1.02±0.03^{a}	4.18±0.53^{b}
Flaxseed oil 2% + Se (0.25mg/kg)	1.02±0.04^{a}	4.36±0.54^{b}
Flaxseed oil 2% +Lyco (110 mg/kg)	0.98±0.03^{ab}	4.28±0.15^{b}
Flaxseed oil 2% + Se (0.25mg/kg) + Lyco (110 mg/kg)	1.00±0.01^{ab}	4.70±0.41^{b}

Different letters (a-b) within a column denote significant differences between treatments (P ≤ 0.05)

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الملخص العربي

تأثير كلا من السلينيوم العضوى والليكوبين المضاف الى عليقة الأرانب المحتوية على زيت الكتان على الأداء الانتاجى، الذبيحة ، ومحتوى العضلات من اوميجا ٣،٦ ودهون الدم والحالة الضد تأكسدية فى الأرانب

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تهدف هذه الدراسة الى بحث تأثير كلا من السلينيوم العضوى والليكوبين المضاف الى عليقة الأرانب المحتوية على زيت الكتان على الأداء الانتاجى ومحتوى العضلات من اوميجا ٣ ، ٦ ودهون الدم والحالة الضد تأكسدية والأ ستجابة المناعية لكريات الدم الحمراء للاغنام خلال فصل الصيف فى مصر. أستخدم ٦٠ أرنب من سلالة V-line من كلا الجنسين عمر خمسة أسابيع خلال موسم الصيف من شهر يوليه الى سبتمبر٢٠١٥ ووزعت الأرانب عشوائيا على خمسة معاملات وبكل معاملة ١٢ أرنب. وبكل معاملة ٤ مكررات وبكل مكررة ٣ أرانب. المجموعة الأولى تناولت عليقة أساسية لا تحتوى أى زيت كتان أو أى أضافات وأستخدمت كمجموعة شاهد. المجموعة الثانية تناولت عليقة بها ٢ % زيت كتان ، المجموعة الثالثة تناولت العليقة المحتوية على زيت الكتان مع ٠.٢٥ ملجم من السلينيوم العضوى ، المجموعة الرابعة تناولت العليقة المحتوية على زيت الكتان مع ١١٠ ملجم ليكوبين / كجم عليقة أما المجموعة الخامسة فقد تناولت العليقة المحتوية على زيت الكتان مع ٠.٢٥ ملجم من السلينيوم العضوى بالاضافة الى ١١٠ ملجم ليكوبين /كجم عليقة. أوضحت النتائج أن المعاملات المختلفة لم يكن لها أى تأثير على وزن الجسم المكتسب ، أستهلاك العليقة ، الكفاءة التحويلية ، وصفات الذبيحة. تلاحظ زيادة الأوميجا ٣ نتيجة لاحتواء العليقة على زيت الكتان ، زيت الكتان مع ٠.٢٥ ملجم من السلينيوم العضوى ، زيت الكتان مع ١١٠ ملجم ليكوبين /كجم عليقة ، زيت الكتان مع ٠.٢٥ ملجم من السلينيوم العضوى بالاضافة الى ١١٠ ملجم ليكوبين / كجم عليقة. كما تلاحظ زيادة الأوميجا ٦ نتيجة لاحتواء العليقة على زيت الكتان مع ٠.٢٥ ملجم من السلينيوم العضوى ، زيت الكتان مع ١١٠ ملجم ليكوبين /كجم عليقة ، زيت الكتان مع ٠.٢٥ ملجم من السلينيوم العضوى بالاضافة الى ١١٠ ملجم ليكوبين /كجم عليقة مقارنة مع مجموعة الشاهد بينما لوحظ زيادة معنوية فى الكولسترول مرتفع الكثافة والنسبة بين الكولسترول مرتفع الكثافة الى

الكولسترول منخفض الكثافة نتيجة لجميع الاضافات المستخدمة. وجد أن تعرض الأرانب للحرارة المرتفعة خلال فصل الصيف أدى الى زيادة المالوندهايد بينما انخفضت السعة التاكسدية الكلية فى سيرم الدم فى مجموعة الشاهد. ولكن أحتواء العليقة على زيت الكتان أو خليط من زيت الكتان مع الاضافات المختلفة حد من تأثير الحرارة المرتفعة على هذه الصفات خلال فصل الصيف.

وتوصي الدراسة بتغذية الارانب النامية تحت الظروف الحارة للبيئة المصرية على زيت بذرة الكتان مع السيلينوم العضوي او الليكوبين لرفع محتوى لحم الارانب من الاميجا ٣ وذلك لتوفير لحوم وظيفي وصحى للمستهك.

Effects of Allicin and Lycopene on Performance, Carcass, Hematological Profile and Antioxidant Status of Growing Rabbits Through Summer Season

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ABSTRACT: Forty-five growing V-line rabbits of both sexes, 5 weeks old, were used for the study through summer season from July to September. The rabbits were randomly allocated to five treatments groups of 9 rabbits each. Each treatment was further sub-divided into 3 replicate of 3 rabbits. Group one fed control diet free of feed additives and served as a control. Group 2 and 3 supplemented with 100 and 200 mg allicin / kg diet. Group 4 and 5 supplemented with 100 and 200 mg lycopene / kg diet, respectively. Results showed that the groups fed allicin 200 mg/kg and lycopene100 mg/kg in their diets recorded the best ($P \leq 0.05$) significant average daily weight gain as compared with the control group. The other experimental groups were numerically best in comparison with the control group. Significant improvement in feed conversion ratio was recorded in all experimental groups in comparison with control. Carcass traits and hematological parameters were insignificantly affected by different treatments. All feed additives used in the present study significantly increased antibody titters against $SRBC_s$ compared with control group at 7, 14 and 21 days after vaccination. Serum total lipids was significantly ($P \leq 0.05$) decreased due to addition of different feed additives, except with 200 mg allicin in the diet serum total lipids was equal to the control group. Blood serum total cholesterol and triglycerides were significantly ($P \leq 0.05$) reduced by feeding diets containing different levels of allicin or lycopene in comparison with the control group. The results showed that low density lipoprotein was numerically decreased, however, high density lipoprotein and HDL/LDL ratio were numerically increased due to inclusion different feed additives in the diets. Exposing growing rabbits to high temperature conditions during summer season resulted in elevated ($P \leq 0.05$) serum MDA, while serum total antioxidant capacity was decreased as presented in the control group, however, supplementation of allicin and lycopene appeared to antagonize the effect of high temperature. In conclusion, rabbit dietary supplementation with allicin or lycopene could have beneficial effects on performance under summer environment without any side effects.

Key words: Allicin, lycopene, rabbits, performance, blood lipid profile, blood serum

INTRODUCTION

Large number of feed additives are available for inclusion in animal and poultry diets to improve animal performance. However, the use of chemical products especially antibiotics, may cause unfavorable side effects. Moreover, there is evidence indicating that some products could be considered as pollutants for human which threaten health on the long-run. Attempts to use the natural materials such as medical plants could be widely accepted as feed additives to improve the efficiency of feed utilization and animal productive performance (Zeweil *et al.,* 2013). Lycopene (LP) is an aliphatic hydrocarbon, a bright red pigment, which is a naturally present carotenoid in fruits and vegetables. Tomatoes are known to be the major source of LP with the content of 3100–8600 µg per 100 g of tomatoes or their products (Stahl and Sies 1996). The most well-known

biological effects of LP intake are acting as antioxidant or hypocholesterolemic agent (Di Mascio *et al.,* 1989). It has been known that the hypocholesterolemic or triglyceride-lowering effect of LP is attributed to inhibition of de novo cholesterol synthesis and lipogenesis (Chung *et al.,* 2012; Palozza *et al.,* 2012). Indeed, Fuhrman *et al.* (1997) proved that LP suppressed the cholesterol synthesis from acetate by 73 % using the macrophage cell line, and confirmed *in vitro* observation in healthy males *in vivo* that the concentration of plasma low-density lipoprotein (LDL) cholesterol was reduced by 14 % by LP intake for 3 months. Allicin is an organosulfur compound obtained from garlic, a species in the family Alliaceae (Eric, 1985). Allicin has a distinctively pungent smell and exhibits antibacterial, anti-fungal, anti-inflammatory and antioxidant properties (Lindsey *et al*., 2005). Allicin has been found to lower serum and liver cholesterol (Qureshi *et al*., 1983), inhibit bacterial growth (Cavallito *et al.,* 1994) and reduce oxidative stress (Lindsey *et al*., 2005 and Choudhary, 2008). Also allicin has immune-stimulatory effect (Cho *et al*., 2006). The objective of this study is to investigate the effect of feeding allicin and lycopene in two different doses on performance, carcass traits, hematological, blood serum lipid profile and antioxidant status of growing rabbits through Egyptian summer season.

MATERIALS AND METHODS

Forty-five growing V-line rabbits of both sexes, 5 weeks old, with initial weights of 791.7 ± 14.1 g were used for the study. The rabbits were randomly allocated to five treatments groups of 9 rabbits each. Each treatment was further sub-divided into 3 replicate of 3 rabbits. Rabbits were housed in wire floor batteries of 45 x 36 x 36 cm and were offered diets for duration of the feeding trial until reaching 15 weeks of age through summer season from July to September. All animals were kept under similar hygienic conditions. Rabbits were housed in well ventilated block building. Fresh air circulated in the house using exhaust fans. The rabbits were kept within a cycle of 16 h light and 8 h dark. Five pelleted diets were prepared. Group one fed control diet free of feed additives and served as a control group. Group 2 and 3 contained 100 and 200 mg allicin (Double Ok Life Co., Ltd-Fujian China “Mainland”) / kg diet. Group 4 and 5 contained 100 and 200 mg lycopene (Roche, Levent-Istanbul) / kg diet, respectively. Each group of rabbits was fed one of five experimental diets. Fresh water was automatically available at all times through stainless steel nipples for each cage. The experimental diets were offered to rabbits *ad libitum*. The formula of basal experimental diet is presented in Table (1) that formulated to cover the requirements of rabbits according to NRC (1977).Individual body weight and feed consumption were recorded weekly. Body weight gain and feed conversion ratio were also calculated. The incidence of dangerous diseases was largely avoided and rabbits have never been treated with any kind of systematic vaccination or medication. At the end of the feeding trial, 3 rabbits were selected from each treatment group randomly, starved of food but not water for 12 hours and slaughtered for carcass analysis. Before slaughtering, 6 ml of blood sample was taken from the ear vein with a sterile syringe. 3 ml of the

blood was put into a bijon bottle containing ethylene diamine tetracetic acid (EDTA) as an anticoagulant for haematological assay. The remaining 3ml of the blood sample was put into a sterile vacutainer tube without an anticoagulant for serum biochemical analysis. The haematological assay was carried out to determine erythrocyte indices such as packed cell volume (PCV), and haemoglobin (Hb) values. Red blood cell (RBC) counts were counted on an AO Bright line hemocytometer using a light microscope at 400X magnification after diluting blood samples 200 times with a physiological saline (0.9% NaCl solution) before counting (Natt and Herrick, 1952). White blood cell (WBC) were counted on an AO Bright line hemocytometer using a light microscope at 100X magnification after diluting blood samples 20 times with a diluting fluid (1% acetic acid solution with a little of Leishman's stain) before counting (Hepler, 1966). Total lipids, triglycerides, cholesterol, low density lipoprotein (LDL) and high density lipoprotein (HDL), concentrations in serum were estimated using commercial kits (Bio Merieux, France) according to the procedure outlined by the manufacturer.

Table(1). Composition and chemical analyses of the basal experimental diet.

Ingredients	%
Yellow corn	19.0
Wheat bran	11.0
Barley	17.2
Berseem hay	33.0
Soybean meal (44%)	15.0
Molasses	3.0
Di-calcium phosphate	1.0
L-lysine	0.1
DI-Methionine	0.1
Premix	0.3
Salt	0.3
Total	**100**
Chemical analyses:	
Dry matter (DM), %	91.36
Crude protein%	17.24
Ether extract%	3.26
Crude fiber%	12.58
Nitrogen free extract%	50.47
Ash%	7.57
Organic matter (OM), %	92.42
DE (kcal/kg DM)[2]	2749.78

[1]Vit+Min mixture provides per kilogram contains: Vit A 6000 IU; Vit D_3 450 IU; Vit E 40 mg; Vit K_3 1 mg; Vit B_1 1 mg; Vit B_2 3 mg; Vit B_3 180 mg; Vit B_6 39 mg; Vit B_{12} 2.5 mg; Pantothenic acid 10 mg; biotin 10 mg; folic acid 2.5 mg; choline chloride 1200 mg; Manganese 15 mg; Zinc 35 mg; Iron 38 mg; Copper 5 mg; Selenium 0.1 mg; Iodine 0.2 mg; Selenium 0.05 mg. [2]Analyzed values according to AOAC (1995). DE calculated according to Fekete and Gippert (1986) as: DE (kcal/kg DM) = 4253 - 32.6(Crude fibre % DM) - 144.4(ash% DM).

Three rabbits of each treatment were immunized with 0.1 ml of a 2.5% Sheep Red Blood Cells (SRBCs) via the marginal ear vein at 15 days after starting the dietary treatment supplementation, to measure Antibody titer against Sheep Red Blood Cells.

The dosage of SRBC for inoculation was pre-determined by a separate trial. Antiserum to SRBCs was collected 7, 14 and 21 days post challenge. One ml of blood without any anticoagulant was refrigerated to allow red blood cells to settle. If sedimentation was not complete, samples were centrifuged for 1 to 2 min at 3000 rpm to separate serum and erythrocytes, and the supernatant was collected. Briefly, 96-well plates were first filled with 25 µl of physiological saline solution in each well. Then 25 µl of antiserum was pipetted into the first well in duplicates after which 25 µl from the first well was pipetted into the second well, and so forth using an automatic pipette. Finally, a 0.75% of SRBC solution was added to each well. Plates were incubated at 37 ^{o} C for 3 hours and then examined visually for agglutination Wegmann and Smithies, (1966). The agglutination titer was expressed as the $\log^2$ of the reciprocal of the highest serum dilution giving complete agglutination (Nelson *et al.,* 1995). The results were expressed as the mean ± SEM. All data were analyzed using one way analysis of variance (ANOVA) using SPSS 11.0 statistical software (SPSS, Inc., Chicago, Il, 2001). Significant differences between means were detected using new Duncan multiple range test (Duncan, 1955).

RESULTS AND DISCUSSIONS

Results concerning the effect of dietary supplementation of allicin and lycopene on performance of growing V-line rabbits are illustrated in Table 2. It was observed that there were no significant differences in initial body weight among different treatments showing the random distribution of the experimental rabbits among treatments.

The results illustrated in Tables 2 showed that dietary allicin and lycopene supplementation did not significantly influence the final live body weight of the V-line growing rabbits. But in general it was noted that all the experimental groups including different levels of allicin and lycopene showed numerical increase in final live body weight in comparison with the control one. The obtained results showed that the groups fed allicin 200 mg/kg and lycopene 100 mg/kg in their diets recorded the best ($P \leq 0.05$) significant average daily weight gain. As compared with the control group. These groups surpassed the control one by 8.2 and 7.6 %, respectively.

Table (2). Effect of allicin and lycopene on performance of growing V-line rabbits

Characteristics	Control	Allicin		Lycopene	
		100 mg/kg diet	200 mg/kg diet	100 mg/kg diet	200 mg/kg diet
Initial body weight, g	775.6±31.5	761.2±27.5	704.4±29.3	755.0±26.7	793.3±23.5
Final body weight, g	2380.0±24.9	2424.4±42.1	2440.0±28.4	2482.2±25.4	2468.1±33.3
Daily weight gain, g	22.92±0.52^{b}	23.76±0.36^{ab}	24.79±0.47^{a}	24.67±0.34^{a}	23.93±0.30^{ab}
Daily feed intake, g	87.1±0.6	82.7±0.7	83.0±1.7	85.0±1.9	83.3±1.7
Feed conversion ratio	3.82±0.09^{a}	3.49±0.07^{b}	3.36±0.09^{b}	3.45±0.09^{b}	3.49±0.11^{b}

Different letters (a-b) within a raw denote significant differences between treatments (P ≤ 0.05)

Feed intake was insignificantly affected by the difference treatments. Jain *et al.* (1999) reported that live weight and feed intake were not affected by lycopene supplementation in rat diets. Significant improvement in feed conversion ratio reached to 8.6, 12.0, 9.7 and 8.6 % for the rabbits fed diets supplemented with 100 and 200 mg allicin and 100 and 200 mg lycopene in comparison with the control group, respectively. The results suggested by Onyimonyi *et al.* (2012) found that broilers fed garlic essential oil at a level of 100 mg/Kg improved feed conversion ratio. The possible explanation for this positive growth promoting effect could be attributed to allicin, an organosulfur compound contained in garlic that promotes the performances of the intestinal flora there by enhance digestion (Pourali *et al.,* 2010). Ramakrishna *et al.* (2003) showed that garlic supplementation enhances the activity of pancreatic enzymes and provides an environment for better absorption of nutrients. Also, Stanaćev *et al.* (2011) demonstrated that the chicks fed diets with garlic have achieved better feed conversion ratio since it reduced by 10%, while the birds maintained good health status in comparison with the control group. On the other hand, Aji *et al.* (2011) reported that administration of 100 mg of garlic resulted in improved body weight gain of broiler chicks, without change in feed conversion ratio.

The results in Table 3 showed that the different treatments had insignificant effect on all carcass traits at 15 weeks of age. Hossian *et al.* (2015) reported that there was no significant(P ≤ 0.05) differences in carcass traits of rabbits fed control group and rabbits fed diets containing 0.25 and 0.50 % dried garlic.

Table (3). Effect of allicin and lycopene on carcass traits of growing V-line rabbits at 15 weeks of age

Characteristics	Control	Allicin		Lycopene	
		100 mg/kg diet	200 mg/kg diet	100 mg/kg diet	200 mg/kg die
Pre-slaughter weight,g	2353.3±73.8	2266.7±33.8	2365.0±16.0	2416.7±26.8	2405.0±58.9
Cold carcass,%	52.5±2.5	53.6±1.3	55.9±3.4	53.2±0.3	53.5±1.0
Total edible parts,%	60.5±2.0	58.1±0.9	64.9±4.6	59.0±0.7	60.4±0.4
Non-edible	39.5±2.0	41.9±0.9	35.0±4.6	41.0±0.7	39.6±0.4
Parts,%Head,%	5.2±0.2	5.7±0.2	5.6±0.2	5.9±0.2	4.9±0.3
Fur, %	13.7±0.6^{ab}	13.1±0.4^{abc}	11.7±0.2^{c}	14.5±0.8^{a}	12.5±0.6^{bc}
Liver, %	2.59±0.26	2.80±0.32	2.33±0.15	3.09±0.32	2.61±0.23
Heart, %	0.34±0.05	0.28±0.03	0.31±0.02	0.32±0.04	0.35±0.04
Kidney, %	0.47±0.00	0.49±0.04	0.53±0.06	0.57±0.05	0.51±0.01
Kidney fat,%	0.20±0.05	0.18±0.06	0.18±0.04	0.18±0.05	0.18±0.06
Giblets, %	3.40±0.26	3.56±0.25	3.17±0.18	3.98±0.24	3.47±0.20
Lungs, %	0.50±0.07	0.67±0.08	0.55±0.02	0.65±0.07	0.54±0.01
Spleen%	0.06±0.01	0.05±0.01	0.07±0.01	0.07±0.01	0.06±0.01

Different letters (a-c) within a raw denote significant differences between treatments ($P \leq 0.05$).

The findings of Fadlalla *et al.* (2010), using broilers reported a non-significant effect on broiler dressing percentage values, but numerically higher, due to the inclusion of garlic powder. El Azab *et al.* (2012) reported that all carcass traits did not find any significant difference between the different groups of rabbits fed diets containing 0, 5 and 10% tomato pomace as a source of lycopene for 8 weeks, except lungs weight.

Results presented in Table 4 showed that the average values of hematological parameters were within the normal range without any significant differences among treatments and the control group, indicating that all tested feed additives had no adverse effects on blood components. Results of Ademola *et al.* (2009) reported that the red blood cells and hemoglobin concentration of broiler chickens were not affected by dietary garlic. Abd El-Latif *et al.* (2013) reported that addition of garlic essential oils to broiler diets did not significantly affect RBCs count and it was similar to those of the control group. The RBCs, PCV and Hb values were nearly similar among the control and treatment groups and also fall within the normal range of 3.7 - 8.0 x10^6, 25 – 50% and 8.9 – 17.5 mg/dl reported for healthy rabbits by Mitruka and Rawnsley (1977). The normal PCV indicates the absence of normocytic anaemia which only detected by a decreased number of RBCs or PCV (Coles, 1986). The normal hemoglobin concentration for all the experimental rabbits is probably an indication that different levels of allicin and lycopene used in the present study supported hemoglobin synthesis, which according to Sirosis (1995) is among other factors, primarily affected by protein intake. Njidda *et al.* (2006) reported that normal range of values for Hb indicated that the vital physiological relationship of hemoglobin with oxygen in the transport

of gases (oxygen and carbon dioxide) to and from the tissues of the body has been maintained and was normal. The WBCs counts are used as indicator of stress response and are sensitive biomarkers crucial to immune functions (Graczyk *et al.,* 2003). In the present study, WBCs values were not significantly affected by the dietary treatments as compared with control group. However, the WBCs counts fell within the normal physiological range reported by Mitruka and Rawnsley (1977). This indicates that body defense system of the rabbits in all the treatment groups was not negatively affected by different levels of allicin or lycopene used in the present study. High WBCs counts are usually associated with microbial infection or the presence of foreign body or antigen in the system (Ogbuewu *et al.,* 2010). The comparable mean WBCs counts in all the treatment groups in this study ruled out the possibility of microbial infection.

Antibody titters against SRBCs determined are shown in Table (4) as affected by allicin and lycopene. The results indicated that all feed additives used in the present study significantly increased antibody titters against SRBCs compared with control group at 7, 14 and 21 days after vaccination. The use of different feed additives used in the present study played a role in increasing immune response against some diseases. It is shown that allicin and lycopene were an immunomodulatory. It stimulated humoral immune response of growing rabbits in comparison with the control group.

Table 5 represents the results of the effects of allicin and lycopene on rabbit's serum total lipids, triglycerides, total cholesterol, LDL and HDL concentrations. Results indicated that serum total lipids was significantly ($P \leq 0.01$) decreased due to addition of different feed additives, except with 200 mg allicin in the diet serum total lipids was equal to the control group. Blood serum total cholesterol and triglycerides were significantly ($P \leq 0.05$) reduced by feeding diets containing different levels of allicin or lycopene in comparison with the control group. The results showed that low density lipoprotein was numerically decreased; however, high density lipoprotein and HDL/LDL ratio were numerically increased due to inclusion different feed additives in the diets. It was noticed that lycopene was more pronounced on these traits than allicin. Cholesterol is one of the cell and tissue components and is used as a starting material for synthesis of numerous compounds. The animal body utilizes both dietary and endogenous cholesterol. The endogenous part can be converted into bile acids and steroid hormones, while the exogenous portion undergoes intestinal emulsification by bile acids. Roussel *et al.* (1982) reported that circulating cholesterol level is known to be influenced by the activity of steroid producing organs. Rao and Shen (2002) showed a decrease in blood plasma cholesterol as a result of dietary lycopene supplementation. Sahin *et al.* (2006) described an increase in the blood plasma HDL concentration of Japanese quail and a significant decrease in the LDL concentration because of lycopene addition. Oshima *et al.* (1997) reported that human LDL could be protected against photosensitized oxidative damage by lycopene. Paran and Engelhard (2001) reported that lycopene supplementation reduced blood lipids,

lipoproteins and oxidative stress markers in hypertensive patients. Tocopherols and tocotrienols in dried tomato pomace lowers serum cholesterol by suppressing the posttranscriptional action of 3-hydroxy-3-methylglutaryl coenzyme A (HMG-CoA) reductase, the rate -limiting enzyme in the mevalonate pathway of endogenous cholesterol synthesis by the liver (Song-Hae *et al.,* 1999). The literature concerning cholesterol lowering by bioactive phytochemicals often concludes that the excretion of bile acid and cholesterol and the resulting depletion of the enterohepatic bile acid pool are important mechanisms of cholesterol-lowering. The physiological observations are supported by changes in expression of genes regulating bile acid and cholesterol metabolism. Enhanced excretion of bile acid, cholesterol and total fat were observed in dried tomato seed supplemented diet and the related genes expressions were also modulated (Shao *et al.,* 2013). There is a linear relationship between enzyme activity and CYP7A1 gene expression (Bartley *et al.,* 2010), so the observed up-regulation of CYP7A1 likely indicates bile acid synthesis was increased although the bioactive component is not known. Although the expression of HMGCoA reductase (3-hydroxy- 3-methylglutaryl CoA reductase) was not determined, the reduction of hepatic cholesterol and up-regulations of gene CYP51 and CYP7A1 would suggest that the expression of HMGCoA would also be increased.

It is generally accepted that dietary garlic supplementation inhibits the hepatic activities of lipogenic and cholestrogenic enzymes in pigs (Qureshi *et al.,* 1987) and rats (Mathew *et al.,* 2004). Similarly, significant reductions in blood plasma concentrations of triglycerides were observed in broilers (Al-Homidan, 2005) in response to feeding garlic-supplemented diets compared with control birds. The present results are in accordance also with the findings obtained by Prasad *et al.* (2009), who found that blood plasma total cholesterol; triglycerides, low density lipoprotein and very low density lipoprotein were significantly decreased, while high density lipoprotein was significantly increased by garlic supplementation in broiler chickens in comparison to the control group.In addition, Choi *et al.* (2010) indicated that dietary garlic powder significantly decreased total and low-density lipoprotein cholesterol and increased high-density lipoprotein cholesterol in broiler blood. Mirhadi *et al.* (1992), reported allicin that present in garlic, significantly inhibited hypercholesterolemia, reduced tissue cholesterol, lowered low density lipoprotein concentration (LDL) and raised high density lipoprotein concentration (HDL). This may probably be due to the possible mechanism of hypocholesterolaemic and hypolipidemic action of garlic products which depresses the hepatic activities of lipogenic and cholesterogenic enzymes such as malic enzyme, fatty acid synthase, glucose-6-phosphatase dehydrogenase (Chi *et al.,* 1982; Qureshi *et al.,* 1983a) and 3-hydroxyl-3-methyl-glutaryl-CoA (HMG-CoA) reductase (Qureshi *et al.,* 1983b, 1987). Afzal *et al.* (1985) reported that polyunsaturated fatty acids prevent atherosclerosis through the formation of cholesterol esters. They further reported the presence of higher polyunsaturated fatty acids like arachidonate and eicosapentenoate in garlic which could well be responsible for preventing atherosclerosis. Furthermore, garlic powder can

facilitate activity of enzymes which are involved in the conversion of cholesterol to bilious acids and subsequently, there will be less cholesterol in the carcass (Bordia *et al.,* 1975; Raeesi *et al.,* 2010).

Exposing growing rabbits to high temperature conditions during summer season resulted in significant decrease ($P \leq 0.05$) in serum total antioxidant capacity which was obtained in the control group, however, supplementation of allicin and lycopene appeared to antagonize the effect of high temperature. The different levels of allicin (100 and 200 mg) and lycopene (100 and 200 mg) increased total antioxidant capacity in blood serum to rich an increase their value by 75.3, 43.2, 51.9 and 49.4 %, respectively, in comparison with the control group. Heat stress causes increased free radical production (Halliwell and Gutteridge, 1989) and lowers the concentrations of antioxidant vitamins and minerals such as E, C, A and Zn in serum and tissues (Sahin and Kucuk, 2003). Free radicals trigger the metabolic disorder, cell death and growth retardation (Okada, 1996).

Malondiaidehyde (MDA) used as a marker of the oxidative stress. Exposing growing rabbits to high temperature through summer season resulted in elevated ($P \leq 0.05$) serum MDA as presented in the control group, however, supplementation of allicin and lycopene appeared to antagonize this effect. The mean concentration of malondialdehyde (MDA) level was significantly ($P \leq 0.05$) lower in the group given 100 mg/kg dietallicin containing diet (13.07), followed by those group had 200 mg allicin containing diet (14.37), then lycopene 100 and 200 mg fed groups (15.0 and 15.57, respectively) without significant differences between the last two groups. The control group recorded the highest value of MDA (17.57). Therefore, the obtained results showed that 100 and 200 mg/kg dietallicin and 100 and 200 mg lycopene resulted in lowering blood serum MDA in descending order by 25.6, 18.2, 14.6 and 11.4 %, respectively, in comparison with the control group. Generally it was observed that the low levels of allicin and lycopene was more effective in decreasing blood serum lipid peroxidation in comparison with the high levels. These results were in disagreement with those presented by Farag (2014) who showed that the lowest MDA value was obtained from the highest levels of lycopene and of allicin (300 mg/ kg diet). Also, the obtained results indicated that allicin was more superior in comparison with lycopene fed groups.

Phytochemicals present in aged garlic extract are believed to act in synergistic way and they exert their antioxidant activity by promoting scavenging of reactive oxygen species by means of enhancing the cellular antioxidant enzyme superoxide dismutase, catalase, glutathione peroxidase, and increase the level of glutathione in cells and some of the important defense mechanism in living cells. Some of the potential benefits of aged garlic extract include decreasing the cardiovascular diseases by suppressing/inhibiting lipid peroxidation and oxidation of LDL (Amagase *et al.,* 2001 The overall effect of the garlic compounds would perhaps be to prevent or reduce injuries through oxidative stress and free radicals.

Lycopene, a major carotenoid present in tomatoes, is one of the most potent antioxidants among the dietary carotenoids. Antioxidant properties of lycopene are thought to be responsible primarily for its biological effects, which may be important in the prevention of chronic diseases associated with oxidative stress such as cancer and cardiovascular diseases. Studies have provided evidence in support for the protective role of lycopene in chronic diseases (Rao and Shen, 2002). Lycopene is the most potent singlet oxygen quencher natural carotenoid (Rao and Agarwal, 1999; DiMascio *et al.,* 1989; Nguyen and Schwartz, 1999; Agarwal and Rao, 2000). Lycopene was reported to inactivate hydrogen peroxide and nitrogen dioxide (Bohm *et al.,* 1995). Agarwal and Rao (1998) have shown that blood lycopene levels increased by dietary lycopene supplementation. Also, Jain *et al.* (1999) reported that dietary lycopene increased serum and liver lycopene and thiols levels and decreased serum TBARS (14% reduction) concentration in rats. This supports the findings of Rao and Agarwal (1998) which showed that dietary lycopene protected lipid, protein and DNA from oxidation. The protective action of lycopene on MDA confirms previously reported findings of other investigators (Rao and Agarwal, 1999; Rao and Shen, 2002; Jain *et al.* 1999). Leal *et al.* (1999) reported that the broilers exposed to lycopene showed a reduction in MDA production. Paran and Engelhard (2001) reported that lycopene supplementation reduced oxidative stress markers such as homocysteine in hypertensive patients. However, an inverse association between MDA and antioxidant vitamins has been mentioned by others (Halliwell and Gutteridge, 1989).

Table (4). Effect of allicin and lycopene on hematological parameters and sheep RBCs rabbits

Characteristics	Control	Allicin		Lycopene	
		100 mg/kg diet	200 mg/kg diet	100 mg/kg diet	200 mg/kg diet
Red blood cells * 10^6	3.87±0.12	3.30±0.36	3.57±0.08	3.53±0.12	3.54±0.09
White blood cells* 10^3	6.07±0.18	5.53±0.32	6.40±0.31	7.37±0.43	5.57±0.92
Hemoglobin (Hb) g/dl	11.47±0.29	10.67±0.33	10.70±0.26	10.53±0.26	10.50±0.17
PCV, %	32.70±3.17	33.30±9.10	33.03±0.73	33.30±0.85	33.30±0.65
Sheep RBCs					
7 days	0.66±0.03^{c}	0.79±0.02^{ab}	0.79±0.02^{ab}	0.84±0.00^{a}	0.77±0.00^{b}
14 days	0.69±0.00^{b}	0.77±0.00^{a}	0.82±0.02^{a}	0.82±0.02^{a}	0.82±0.02^{a}
21 days	0.66±0.03^{c}	0.82±0.02^{ab}	0.77±0.00^{b}	0.82±0.02^{ab}	0.84±0.00^{a}

Different letters (a-c) within a raw denote significant differences between treatments ($P \leq 0.05$)

In conclusion, rabbit dietary supplementation with allicin or lycopene could have beneficial effects on performance under summer environment without any side effects.

Table (5). Effect of allicin and lycopene on blood serum lipid profile of growing V-line rabbits at 15 weeks of age

Characteristics	Control	Allicin		Lycopene	
		100 mg/kg diet	200 mg/kg diet	100 mg/kg diet	200 mg/kg diet
Total lipids, mg/dl	310.67±7.22^{a}	264.00±1.73^{b}	320.00±2.65^{a}	226.67±4.06^{c}	230.00±2.89^{c}
Triglycerides, mg/dl	76.33±1.33^{a}	63.70±1.10^{c}	70.10±0.95^{b}	63.97±0.80^{c}	71.20±0.52^{b}
Cholesterol, mg/dl	97.40±1.22^{a}	87.63±1.48^{c}	93.00±1.15^{b}	70.53±0.86^{d}	61.90±0.46^{e}
HDL, mg/dl	48.67±0.67	49.67±0.33	50.00±0.58	50.33±0.88	50.67±0.67
LDL, mg/dl	47.00±1.15	45.33±1.45	46.87±2.44	43.33±1.20	43.67±2.03
HDL/LDL ratio	1.04±0.02	1.10±0.04	1.07±0.05	1.16±0.03	1.17±0.05
TAC, mmol/l	0.81±0.06^{c}	1.42±0.08^{a}	1.16±0.07^{b}	1.23±0.06^{ab}	1.21±0.05^{ab}
MDA, nmol/ml	17.57±.23^{a}	13.07±.15^{d}	14.37±.07^{c}	15.00±.25^{b}	15.57±.19^{b}

Different letters (a-e) within a raw denote significant differences between treatments ($P \leq 0.05$)
HDL= high density lipoprotein, LDL= Low density lipoprotein, TAC= tTotal antioxidant capacity, MDA = malondialdehyde

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الملخص العربى

تأثيرات اللأليسين والليكوبين على معدل الأداء ، الذبيحة ، والصفات الهيماتولوجية للدم والحالة الضد تأكسدية للأرانب النامية خلال فصل الصيف

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أستخدم ٤٥ أرنب من سلالة V–line من كلا الجنسين عمر خمسة أسابيع خلال موسم الصيف من شهر يوليه الى سبتمبر ٢٠١٤ ووزعت الأرانب عشوائيا على خمسة معاملات وبكل معاملة ٩ أرانب. وبكل معاملة ٣ مكررات وبكل مكررة ٣ أرانب. المجموعة الأولى تناولت عليقة أساسية لا تحتوى أى أضافات وأستخدمت كمجموعة شاهد. المجموعة الثانية والثالثة تناولت ١٠٠ ، ٢٠٠ ملجم أليسين / كجم عليقة على التوالى. المجموعة الرابعة والخامسة تناولت ١٠٠ ، ٢٠٠ ملجم ليكوبين / كجم عليقة على التوالى. أوضحت أهم النتائج أن المجاميع التى تناولت ٢٠٠ ملجم أليسين ، ١٠٠ ملجم ليكوبين / كجم عليقة حققت أفضل زيادة معنوية فى وزن الجسم مقارنة مع مجموعة الشاهد. كما حققت المجاميع الأخرى زيادة رقميه ولكن لم تكن معنوية. حدث تحسن معنوى فى الكفاءة التحويلية فى جميع المجاميع التجريبية مقارنة مع مجموعة الشاهد. لم يتأثر كل من صفات الذبيحة والصفات الهيماتولوجية بالمعاملات المختلفة. جميع المعاملات التجريبية أدت الى تحسن معنوى فى الأ ستجابة المناعية لكريات الدم الحمراء للاغنام وجدت عند٧ ، ١٤ ، ٢١ يوم من الحقن . أنخفض الدهن الكلى فى سيرم الدم نتيجة للمعاملات المختلفة مقارنة مع مجموعة الشاهد بأستثناء المجموعة التى تناولت ٢٠٠ ملجم أليسين حيث كانت متساوية مع مجموعة الشاهد. أنخفض كل من الكولسترول الكلى والدهون الثلاثية نتيجة لاضافة النسب المختلفة من الأليسين والليكوبين مقارنة مع مجموعة الشاهد. تلاحظ أنخفاض رقمى فى الكولسترول منخفض الكثافة بينما تلاحظ أرتفاع رقمى فى الكولسترول مرتفع الكثافة والنسبة بين الكولسترول مرتفع الكثافة الى الكولسترول منخفض الكثافة نتيجة لجميع الاضافات المستخدمة ولكن هذه الاختلافات لم تصل الى المعنوية مقارنة مع مجموعة الشاهد. وجد أن تعرض الأرانب للحرارة المرتفعة خلال فصل الصيف أدى الى زيادة المالوندهايد بينما انخفضت السعة التاكسدية الكلية فى سيرم الدم فى مجموعة الشاهد. ولكن أضافة الأليسين والليكوبين حد من تأثير الحرارة المرتفعة على هذه الصفات. وقد خلصت الدراسة الى أن أضافة كل من الأليسين والليكوبين له تأثير مفيد على أداء الأرانب خلال فصل الصيف بدون أى تاثيرات جانبيه.

Effect of Adding Selenium-enriched Dried Algae to Ration on Productive and Reproductive Performance of Male Barki Sheep

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ABSTRACT: This study was set for more than one year to evualte the effects of dietary addition of selenium-enriched dried algae on productive and reproductive performances of Barki sheep. Twenty eight ram-lambs (aged 4-5 months) were randomly divided into four equal groups (n=7). Basal concentrate mixture was prepared and supplemented with or without Se-algae (selenium enriched micro-algae Spirulina, *Atrhrospira platensis*). Four experimental concentrate mixtures were prepared, the control (basal concentrate mixture without any supplementation) (I) and the other three experimental concentrate mixtures (II, III and IV) were supplemented by Se- algae at levels of 0.2; 0.4 and 0.6 mg/kg DM of the diet, respectively. Animals of the four groups were randomly assigned to feed on one of these four concentrate mixtures. In addition of concentration mixture animals of all groups were fed *ad libitum* on berseem hay.Feed supplementation with Se-algae significantly increased animal's final live body weights and weight gains compared with control group. Significant increases in white blood cells counts were observed in animals fed diets supplemented with Se-algae when compared with the control group. Animals receiving concentrate mixture supplemented with Se-algae at 0.4 mg recorded the highest ($P<0.05$) value of packed cell volume when compared with the other two treatment groups. Dietary inclusion of different levels of Se-algae resulted in significant increases in blood total protein and albumin relative to the control group. The lowest value ($p<0.04$) of plasma globulin was observed in group fed diet containing Se-algae at 0.6 mg. Plasma urea nitrogen was significantly increased as a result of supplementing diets with 0.4 mg of Se-algae. However, Se-algae supplementation reduced plasma cholesterol ($p<0.046$) and total lipid ($p<0.0001$) contents as compared with the control group. The plasma aspartate aminotransferase (AST) and alkaline phosphatase (ALP) levels of ram-lambs were significantly affected by adding Se-algae to their diets. Significant increases in T-AOC, GSH-Px and SOD as Se-algae level increased. Conversely, plasma malondialdehyde (MDA) was significantly decreased in a dose-dependent manner. Sperm ejaculate volume, progressive motility, normal sperm, live sperm, total sperm output, total motile sperm and total functional sperm fraction (TFSF) were increased ($P\leq0.05$) in groups supplemented with Se-algae comparing with the control group. As opposed to the previous effect, sperm concentration, abnormal sperm and dead sperm significantly ($P\leq0.05$) decreased comparing with the control group. Seminal plasma total protein increased ($P<0.05$) in the groups given 0.4 and 0.6 mg Se-algae. Seminal plasma albumin increased ($P<0.05$) in the group that received 0.4 mg Se-algae diet as compared to the control group, while seminal plasma globulin was decreased ($P<0.05$). Seminal plasma total lipids decreased ($P\leq0.02$). Seminal plasma cholesterol and triglycerides were not significantly affected. Seminal plasma ALT and ALP significantly ($P\leq0.01$) decreased due to including Se-algae in ram-lambs diet as compared to the control group.In conclusion, addition of Se-algae to the diet of ram-lambs improved their growth performance, semen quality, antioxidant status and blood constituents during rearing periods.

Keywords: Sheep, Hematology, Serum constituents, Semen characteristics, Oxidative status

INTRODUCTION

Sheep production, as most agricultural enterprises, is affected by economic forces as well as environmental factors (Marai, 1987). Exposure to these factors causes a series of strong changes in the sheep biological

functions that include depression in feed intake, efficiency and utilization, disturbances in metabolism of water, protein, energy, and mineral balances, enzymatic reactions, hormonal secretions and blood metabolites. Such changes end with low live body weight and impaired reproduction, i.e. depression in age at puberty, reproductive activity and fertility (Habeeb *et al.,* 1992). In sheep, sexual behavior and semen quality are the main factors that limit male reproduction efficiency along the year (Aller *et al.,* 2012). The efficiency of sperm production, libido and quality of sperm tend to remain uniform throughout the reproductive life of an animal but may be significantly altered by age, nutrition, environment, health status, drugs, and chemicals (Togun and Egbunike, 2006). Reproductive functions are highly demanding in both nutrients quality and quantity; in this way, nutritional status is a very important modulator of reproduction in sheep and goats (Blache *et al.,* 2008).

Several studies have demonstrated interaction between nutrition and reproduction in sheep and goats. For example, flushing or minerals have been shown to improve production and reproduction parameters (Madibela *et al.,* 2002; Griffiths *et al.,* 2007). Selenium (Se) occurs in all cells and body tissues; its content in an organism varies according to the amount of the element in the feed ration (Kim and Mahan, 2001).The role of selenium as an antioxidant indicated importance for maintaining or improving semen quality in animals (Irvine, 1996). The increase in the formation of reaction oxygen species (ROS) was noted to decrease fertility, as the ROS will attack the membranes of the spermatozoa and decrease their viability (Irvine, 1996). Selenium increases the antioxidant glutathione peroxidase (GSH-Px) activity, which decreases the ROS and preserves semen quality and, subsequently, fertility in rams (Kendall *et al.,* 2000). Moreover, organic Se is a highly available form of Se for livestock and provides antioxidant protection at a level greater than inorganic Se (Mahan, 1999; Mahmoud and Edens, 2003; Al-Waeli *et al.,* 2013).

It is necessary to mention that Spirulina (*Atrhrospira platensis*) is a rich source of phycocyanin, as antioxidant biliprotein pigment and carotenoids (Cheong *et al.,* 2010). However, scientific information available on performance and antioxidative status in Barki ram-lambs fed combinations of algae and Se are still limited.

In view of these facts, the present research was conducted on weaned ram-lambs to study the effect of dietary selenium-enriched micro-algae Spirulina (*Atrhrospira platensis*) supplementation on growth performance, blood biochemical constituents, semen characteristics and anti-oxidative status, under summer environmental condition of Egypt.

MATERIALS AND METHODS

Animals and housing

This trial was carried out at the Experimental Station of Animal Production, Borg-El Arab, Alexandria Governorate, belonging to Animal Production Research Institute, Agricultural Research Center, Ministry of Agriculture, Egypt. Twenty eight Barki ram-lambs 4-5 months of age and weighing 26.83 – 27.67 kg were divided according to age and weight into four

similar groups of six animals each and were housed in separate stalls. The experimental animals were kept under the same managerial and hygienic conditions. Before beginning the experiment animals were treated against internal and external parasites and intero-toximia.

Source of selenium-enriched dried algae

The selected cyanobacterium *Spirulina platensis* (*Arthrospira platensis***)** were obtained from Agric. Microbiology Dept. National Research Centre (NRC), Giza, Egypt.

Experimental diets

Basal concentrate mixture consists of 37% crushed corn, 30% crushed barley, 20% wheat bran, 10% soybean meal, 2% lime stone and 1% salt. Basal concentrate mixture was supplemented with or without Se-algae (selenium enriched micro-algae Spirulina, *Atrhrospira platensis*)**.** Four experimental concentrate mixtures were prepared, the control (basal concentrate mixture without any supplementation, I, and the other three experimental concentrate mixtures (II, III and IV) were supplemented by Se- algae at levels of 0.2, 0.4 and 0.6 mg/kg DM of the diet, respectively. Animals of the four groups were randomly assigned to feed on one of these four concentrate mixtures. In addition to these concentrate mixtures animals of all groups were fed *ad libitum* on berseem hay.

Algae contain 1 mg Se/g algae; the control diet, thus contains only the endogenous Se contained in the ingredients of the diet. Control was the basal diet containing 0.08mg Se/kg diet. The four groups of lambs were randomly assigned to fed *ad libitum* on the four experimental diets in feeding experiment that lasted until sexual maturity. Animals were kept for two weeks prior to the start of the experiment for adaptation.

Growth performance and body weight gain

Lambs were individually weighed monthly in the morning before access to feed and water. Individual live weights of every treatment group were totaled and the average monthly weight gain was calculated by subtracting the average initial body weight of a certain period from the final average body weight of the same period.

Blood collection and analyses

Blood samples were collected monthly from the jugular vein of each lamb in the morning before access to feed and water. A part of blood samples were immediately withheld into heparinized tubes to analyze red blood cell (RBCs) counts and white blood cell (WBCs) counts according to Provan *et al.* (2004). Hemoglobin (Hb) and packed cell volume (PCV) were determined according to conventional methods (Hepler, 1966). Semen are obtained from coagulated blood samples centrifugation at 3000 rpm for 20 min, and serum were harvested and stored at -20ºC for later analyses. Serum total protein, albumin, glucose, urea-N, creatinine, total cholesterol, total lipids, triglycerides, ALT, AST, ALP, MDA, T-AOC, SOD and GSH-Px enzymes activities, were

assayed using chemical commercial kits of Diamond Diagnostics, Egypt. Globulin was estimated by subtraction of albumin from total protein.

Sampling and semen traits

Semen samples were collected weekly over 8 weeks using an artificial vagina and the samples of each week were subjected to chemical analysis. Semen collection and handling were carried out and evaluated according to the international guidelines (IRRG, 2005). Ejaculated volume was measured to the nearest 0.01 ml immediately after collection, semen was maintained at 35℃ in a water bath for evaluation. Fresh semen samples were used for measure went of sperm concentration by using the improved Neubauer hemocytometer slide method as described by Smith and Mayer (1955).Total sperm output (TSO) was calculated by multiplying semen ejaculate volume by semen concentration. Individual sperm motility was estimated at 400× magnification (Kamar, 1960). Assessment of live and abnormal spermatozoa was performed using an eosin–nigrosin blue-staining mixture (Blom, 1950). The percentages of live, dead and abnormal spermatozoa were determined using stains that penetrated cells with damaged membranes. Normal live sperm exclude the eosin stain and appear white in color, whereas dead sperm take up eosin and appear pinkish in color because of loss of membrane integrity. Normal sperm have an oval head with a long tail. Abnormal sperm have head, midpiece or tail defects, such as a large or a misshapen head or a crooked or a double tail. The total number of motile sperm was calculated by multiplying the percentage of motile sperm by the total sperm outputs. The total functional sperm fraction (TFSF) was also calculated by multiplying the total sperm output and sperm motility and normal-morphology sperm (Correa and Zavos, 1996). Evaluation of seminal initial fructose was carried out immediately after collection according to Mann (1948).

Seminal plasma was separated by centrifugation at 3000 rpm for 20 minutes and stored at -20 ^{o} C in Eppendorf tubes for further analysis of total protein and albumin. Globulin values were obtained by subtracting albumin values from corresponding values of total protein. Total lipids, triglycerides, cholesterol alkaline phosphatase, aspartate aminotransferase (AST), alanine aminotransferase (ALT), lipid peroxidation (Malondialdehyde) (MDA), total antioxidant capacity (TAC), superoxide dismutase (SOD) and glutathione peroxidase (GSH-Px) were determined in seminal plasma calorimetrically using commercial kits obtained from (Bio-Diagnostics, Egypt) according to the procedure outlined by the manufacturer.

Statistical analysis

Data of each growing and slaughter experiments were analyzed using general linear model (GLM) procedure (SAS, 2002). Duncan's Multiple Range Test (1955) was used to detect any variations between means.

RESULTS AND DISCUSSION

Body weight and weight gain

Data on the effect of dietary Se-algae supplementation on growth performance of Barki ram-lambs are presented in Table (1). The data indicated

that Se-algae significantly increased their final body weight (P<0.05) and total body weight gain at the end of the feeding experiment (P<0.002) as compared to the control group. Dietary supplementation of Se-algae at 0.2, 0.4 and 0.6 mg Se-algae/kg had positive effects on growth performance.These improvement agree with previous studies on the effects of selenium on the digestibility of nutrients. Naziroglu *et al.* (1997) reported that combined supplementation of Se and vitamin E increased acetic, propionic, butyric and total volatile fatty acids concentration, and the total counts of protozoa of the ruminal fluid of lambs *in vivo.* Our results suggest that the good effectiveness of Se from Se-enriched alga can be explained by the high bioavailability of selenomethionine. Although inorganic selenite can be utilized for selenoprotein biosynthesis, only selenomethionine can be incorporated nonspecifically into body proteins in place of methionine (McConnell and Hoffman 1972), because tRNA Met does not discriminate between Met and Se-Met (Schrauzer, 2000). Mahan and Parrett (1996) reported that selenium retention in the organism is higher when Se-enriched yeast rather than sodium selenite is used as a dietary Se source. About 64% of consumed Se is excreted in case of sodium selenite while only 47% of Se is excreted when Se-enriched yeast is fed. Also, Se from Se-enriched yeast does not have higher absorption from the gastrointestinal tract compared to sodium selenite. Therefore the high bioavailability of Se from Se-enriched yeast is not caused by higher absorption.

Table (1). The effect of different levels of dietary Se-algae supplementation on the body weight and weight gain of Barki ram-lambs (n=7)

Parameters	Se-algae supplementation (mg/kg DM)				P- value
	Control	0.2	0.4	0.6	
Initial body weight (kg)	24.98±1.65	24.62±0.90	23.65±1.26	23.00±0.73	NS
Final body weight (kg)	40.31^{b}±1.50	46.58^{a}±6.16	43.68^{ab}±0.81	42.42^{ab}±1.25	0.05
Body weight gain (kg)	15.33^{b}±0.36	21.70^{a}±1.28	20.03^{a}±1.08	19.42^{a}±1.20	0.002

^{a,b}Means within rows with different superscript letters differ significantly (P<0.05).
NS=not significant.

Blood hematology

The effects of dietary Se-algae supplementation levels on blood hematological characteristics of ram-lambs are presented in Table (2). Jones and Allison (2007) reported that hematological values of sheep were 9-15x10^6 cells/µl for RBC's, 27-45% for PCV and 9-15g/dl for Hb. Hemoglobin concentrations and red blood cell counts obtained from this study were between (11.45 and 11.62 g/dl) and (10.94 and 11.68x10^6 mm^3), respectively. The hemoglobin and red blood cells level of the control rams were similar to those of rams supplemented with Se-algae. However, dietary Se-algae supplementation caused a significant increase in white blood cell counts when compared with the control group. Rame-lambs supplemented with Se-algae at levels 0.4 and 0.6 mg recorded the highest (P<0.0001) values of white blood cell counts (10.64 and 10.47×10^3/mm^3 respectively). These results agree with those reported by Ali *et al*. (2009) who found that after 3 months of treated Awassi rams with 175 mg/ram vitamin E and 70 mg/ram vitamin E plus 2800 mg selenium, the

percentage of lymphocytes was increased compared with the untreated group. Leucocytes play an important role in non-specific or innate immunity and their count can be considered as an indicator of relatively lower disease susceptibility (Matanović *et al.,* 2007).

Table (2). The effect of different levels of dietary Se-algae supplementation on blood hematologic parameters of the experimental ram-lambs (n=7)

Parameters	Se-algae supplementation (mg/kg DM)				P- value
	Control	0.2	0.4	0.6	
Hb (g/dl)	11.62±0.11	11.59±0.25	11.58±0.15	11.45±0.48	NS
RBC_S ($x10^6$ /mm^3)	11.46±0.17	10.94±0.36	11.68±0.27	11.41±0.22	NS
WBCs ($x10^3$/mm^3)	9.75^{c}±0.06	10.14^{b}±0.09	10.64^{a}±0.05	10.47^{a}±0.08	0.0001
PCV (%)	29.63^{ab}±0.62	28.73^{b}±0.16	30.53^{a}±0.23	29.06^{b}±0.60	0.05

$^{a-c}$Means within rows with different superscript letters differ significantly (P < 0.05).
NS = not significant.

In addition, supplementation of Se-algae at 0.4 mg was the highest (P<0.05) group in packed cell volume when compared with control and the other treatment groups. The increase in the PCV might be due to the boosting effects of moderate levels of selenium on the immune system which enhance the process of the production of red blood cells in the body while decline in the PCV with increased selenium could probably be due to inhibitory constituents of the fed which was not determined in this case.

Blood constituents

The effects of dietary Se-algae supplementation levels on blood constituents of Barki ram-lambs are presented in Table (3). Results of the present study demonstrated that dietary Se-algae supplementation caused significant increases in plasma total protein and albumin when compared with the control group. Plasma albumin of the ram-lambs on 0.6 mg Se-algae supplementation was significantly (p<0.0001) higher than those of lambs on 0.2 Se-algae diets. On the other hand, animals fed on diet supplemented with Se-algae at 0.6 mg recoded the lowest (P<0.05) value of plasma globulin (3.02 g/dl). McConnell and Hoffman (1972) attributed these increases in total protein and albumin to the fact that seleno-methionine was incorporated into liver polypeptides via the methionine pathway. Selenium is present in two biologically active forms, Se containing enzymes and Se-containing proteins in animals (Zhang *et al.,* 2011). The control group (without supplementation of Se-algae) showed the lowest total protein and albumin, this reduction might be due to oxidative damage in proteins ranges from specific amino acid modifications and peptide breakage to loss of enzyme activity (Stadtman and Levine, 2003). Little information on the selenium form in Se-enriched Spirulina is available for the present time. Selenium is assumed to be built into the protein structure similar to that into Se-enriched yeast (Machat *et al.,* 2005), so Se-enriched spirulina may be used as a potential form of organic selenium supplemented to sows diets (Kotrbaček *et al.,* 2004).

The results of Table (3) revealed that plasma concentrations of glucose, creatinine, triglycerides and enzyme alanine aminotransferase (ALT) were not affected significantly by dietary supplementation with different levels of Se algae.Data in Table (3) indicated that dietary Se-algae supplementation significantly reduced plasma cholesterol and total lipid contents compared with the control group. Ram-lambs fed diets supplemented with 0.2 and 0.4 mg Se-algae had the lowest values of cholesterol content (78.37 and 77.72 mg/dl, respectively). This may be attributed to the anabolic role of Se on fat deposition. The effects of this supplementation were to modulate fatty acid composition in the whole body. These alterations could be also due to the *Spirulina* components such as polyunsaturated fatty acids, phycocyanin which are thought to be compounds with antioxidant abilities according to Nagaoka *et al.* (2005). Similarly, Ebied *et al.* (2012) noted that rabbits fed diets supplemented with 0.15 or 0.3 ppm organic Se significantly reduced total lipid compared with the control groups.

Ram-lambs on 0.4 mg Se-algae diet had plasma ALT level less than that of the groups on 0.2 mg and 0.6 mg Se-algae or control group, with insignificant differences ($p>0.05$) between them. However, plasma AST level of the ram-lambs fed diet containing 0.4 mg Se-algae was significantly ($p<0.05$) higher when compared to those of other groups. In addition, plasma ALP of the control group was significantly ($p<0.0001$) higher as compared to those of groups fed diets supplemented with different levels of Se-algae. Abood *et al.* (2012) reported that Awassi ewes and their newborn lambs suffering from deficiency of vitamin E and selenium in their diet, AST levels reaching (143.71± 4.28U/L) and (145.40 ± 7.94U/L) in deficient groups of ewes and lambs, respectively compared with non-deficiency groups in which levels reached (69.14± 2.78U/L) and (72.85± 2.33U/L) respectively.

Table (3). The effect of different levels of dietary Se-algae supplementation on blood constituents of the experimental ram-lambs (n=7). (Mean±SE)

Parameters	Se-algae supplementation (mg/kg DM)				P-value
	Control	0.2	0.4	0.6	
Total protein (g/dl)	6.43^{b}±0.03	6.61^{a}±0.05	6.71^{a}±0.05	6.65^{a}±0.05	0.001
Albumin (g/dl)	3.23^{c}±0.06	3.46^{b}±0.03	3.55^{ab}±0.02	3.63^{a}±0.03	0.0001
Globulin (g/dl)	3.20^{a}±0.07	3.15^{a}±0.02	3.16^{a}±0.02	3.02^{b}±0.02	0.04
Glucose (mg /dl)	59.22±1.23	57.91±1.19	61.02±1.00	59.14±1.32	NS
Urea -N (mg/dl)	57.80^{b}±1.13	60.57^{ab}±0.63	63.16^{a}±1.20	60.13^{b}±0.80	0.0085
Creatinine (mg/dl)	1.05±0.01	1.02±0.02	1.02±0.02	1.01±0.02	NS
Total Lipids (mg/dl)	990^{a}±0.008	904^{b}±0.005	900^{b}±0.004	909^{b}±0.009	0.0001
Cholesterol (mg/dl)	82.45^{a}±1.54	78.37^{b}±0.66	77.72^{b}±1.74	81.01^{ab}±0.62	0.046
Triglycerides (mg/dl)	42.70±0.27	39.26±0.24	41.91±2.23	39.60±0.45	NS
AST (u/l)	55.13^{b}±1.17	57.74^{b}±1.30	61.69^{a}±0.94	55.20^{b}±1.69	0.03
ALT (u/l)	47.55±2.15	47.87±1.36	43.86±1.54	46.86±2.55	NS
ALP (u/l)	571.23^{a}±10.03	452.25^{b}±10.48	391.85^{c}±9.24	359.14^{d}±3.41	0.0001

[a-d] Means within rows with different superscript letters differ significantly ($P<0.05$).

NS=not significant.

AST=Aspartate aminotransferase, ALT=Alanine aminotransferase, ALP=Alkaline phosphatase

Animal's antioxidative status

Data on the effect of dietary inclusion of Se-algae at different levels on antioxidantive status of Barki ram-lambs are presented in Table (4). Dietary Se-algae supplementation resulted in significant effects on plasma blood antioxidative properties as measured by T-AOC and MDA as an index of oxidation and antioxidant enzymes such as GSH-Px and SOD. There were gradual and significant increases in T-AOC, GSH-Px and SOD as Se-algae level increased. Ram-lambs fed diet supplemented with 0.6 mg Se-algae recorded the highest levels of T-AOC., GSH-Px and SOD as compared with other levels of Se-algae supplementation. These results are in agreement with those of Cao *et al.* (2014) who found that the T-AOC of serum from pig fed on 0.3 mg/kg DL-Se Met supplemented diet was significantly higher compared with the low-Se and 0.3 mg/kg sodium selenite groups ($P<0.05$).

Yue *et al.* (2009) found that serum SOD activity was higher ($p<0.05$) in goats supplemented with both 0.30 and 0.50 mg Se/kg DM than in control goats and goats supplemented with high level of selenium 1.00 mg Se/kg DM. In accordance with our results, Faixova *et al.* (2007) found that lambs fed diet supplemented with 0.3 mg·kg^{-1} DM in the form of Se-enriched yeast and giving a total daily intake 278 µg of Se per animal.recorded the highest GSH-Px (830.85 ± 69.23 U/g Hb) when compared with the control group (that received a basic diet providing a daily intake 50.6 µg of Se only). A high and linear parallel between the Se concentration and GPx activity of blood has been reported by several authors (Pavlata *et al.* 2001; Rock *et al.,* 2001). Our results prove the positive correlation between blood Se content and the activity of this selenoenzyme. Opposite results were reported by Svoboda *et al*. (2009) who found that GSH-Px activities of the whole blood in both sows and piglets did not differ between groups fed on diet supplemented with inorganic Se (sodium selenite, 0.3 mg/kg) and those fed on diet supplemented with organic Se from Se-enriched alga (0.3 mg/kg). Also, Mahan and Peters (2004) and Yoon and McMillan (2006) found that both Se from Se-enriched yeast and inorganic form are adequate for the synthesis of GSH-Px.

Results shown in Table (4) also indicated that dietary Se-algae supplementation significantly ($P<0.0001$) reduced MDA compared with the control, and this reduction was dose-dependent reaching 31.1 % as compared with the control group at o.6 mg Se-algae. MDA is one of the final products of polyunsaturated fatty acid peroxidation in cells and is considered as a marker of oxidative stress (Gawel *et al.,* 2004). Zhan *et al.* (2007) reported that supplementing 0.3 mg/kg of Se to the diet of finishing pig significantly decreased the content of MDA both in liver and muscle. However, the content of tissue MDA in selenomethionine-treated group was slightly lower than that in sodium selenite group, especially in muscle (Wang *et al.,* 2011). Increased GSH-Px and decreased MDA are good indicators of improved oxidative defense of animal tissues (Celli, 2010).

Table (4). The effect of different levels of dietary Se-algae supplementation on antioxidative status of the experimental ram-lambs (n=7). (Mean±SE)

Parameters	Se-algae supplementation (mg/kg DM)				P- value
	Control	0.2	0.4	0.6	
MDA (mmol/l)	14.65^{a}±0.56	13.40^{b}±0.28	12.26^{c}±0.30	10.10^{d}±0.13	0.0001
T-AOC (mmol/l)	133.92^{d}±1.59	144.85^{c}±1.23	150.21^{b}±1.55	159.64^{a}±0.34	0.0001
SOD (u/l)	24.83^{b}±0.6	30.22^{a}±0.30	32.91^{a}±0.80	35.71^{a}±0.50	0.0001
GSH-Px (u/l)	456.04^{d}±7.24	530.42^{c}±6.37	563.02^{b}±11.01	650.52^{a}±14.30	0.0001

$^{a-d}$ Means within rows with different superscript letters differ significantly($P < 0.01$).
NS = not significant.
MDA=Malondialdehyde, T-AOC=Total antioxidant capacity, SOD=Superoxide dismutase and GSH-Px = Glutathione peroxidase.

Semen characteristics

The influence of addition different levels of Se-algae to the diet of lambs on their semen traits are presented in Table (5). Results showed that ejaculate volume of Barki rams increased as a result of supplementing their diets with se-algae. This increase ($p<0.01$) reached 7.45% for animals receiving diet containing o.6 Se-algae compared to the control group, while the increases were insignificant and amounted 3.33 and 4.40% for animals fed diets supplemented with 0.2 and o.4mg Se-algae, respectively. Semen volume is an important factor in semen evaluation and reproductive performance in males (Ax *et al.,* 2000). Hashem (2014) showed that the average volume of semen was 1.03± 0.001 ml in Siwa Barki sheep during a 12-month period (four seasons).

Hydrogen ion concentration (pH) was not affected significantly by adding different levels of Se-algae to the diet. However, semen hydrogen ion concentration showed numerical decrease due to inclusion of Se-algae in the diets as compared to the control group. This decrease in pH of the selenium supplemented group may be due to the decrease in percentage of dead sperm.

The highest values of Sperm progressive motility were recorded in the group receiving 0.6 mg Se-algae containing diet. Selenium supplementation improved ($p<0.0001$) motility of ram semen. Sperm motility is a fairly reliable indication of the viability of fresh semen (Grahman *et al.,* 1980). The motile spermatozoa provide strong evidence for sperm maturation. Ali *et al*. (2009) found that treating Awassi rams for 90 days twice weekly with 175 mg/ram vitamin E and 70 mg/ram vitamin E plus 2800 mg selenium caused individual motility to increase compared with untreated group.

Sperm concentration in semen of Barki ram-lambs showed significant ($P\leq0.05$) decrease in treated groups comparing with the control group. The lowest values of sperm concentration were recorded in the group receiving 0.4% Se-algae containing diet. In this respect,

selenium supplementation was reported to significantly decrease the sperm concentration in semen of boars supplemented by 0.3 and 0.6 mg Se/kg of feed mixture in inorganic form (Hork 2012). Hashem (2014) showed that average sperm concentration was $347x10^9$ml in Siwa Barki sheep. Hafez and Hafez (2000) reported that the sperm concentration of an ejaculate ranges from 3.5 to 6.0×10^9 ml in ram. Opposite to aim results was conducted by Ali *et al*. (2009) reported that after 3 months of treating Awassi rams with 175 mg/ram vitamin E and 70 mg/ram vitamin E plus 2800 mg selenium, the Sperm concentration was increased compared with untreated group.

Normal sperm and live sperm showed significant (P≤0.05) increases in treated groups comparing with the control group. The highest values of normal sperm was recorded in the group receiving 0.6 mg % Se-algae containing diet, but the highest values of live sperm was recorded in the group receiving 0.4 and 0.6 mg Se-algae containing diet. Beneficial effects of supplementary trace minerals (Zn, Co and Se) (Kendall *et al.,* 2000) and selenium (Anderson *et al.,* 1996) on percentages of live sperm in ram lambs have been reported. Abnormal sperm and dead sperm showed opposite trends. The best values of abnormal sperm and dead sperm was recorded in the group receiving 0.6 mg% Se-algae containing diet. These results agree with these of Ali *et al*. (2009). The present data showed that inclusion of Se-algae in the ram-lambs diets significantly (P≤0.05) increased total sperm output and total motile sperm. Results also showed that TFSF was significantly (P≤0.0002) increased by different levels of Se-algae. The best values for total sperm output, total motile sperm and TFSF were recorded in the groups of ram-lambs fed diet containing 0.6 mg Se-algae as compared to the control or the other experimental groups.

Table (5). Means ±SE of semen traits of mature Barki rams fed diets supplemented with different levels of Se-algae (n=7)

Parameters	Se-algae supplementation (mg/kg DM)				P-value
	Control	0.2	0.4	0.6	
Ejaculate volume(ml)	0.87b±0.02	0.90ab±0.02	0.91ab±0.02	0.94a±0.02	0.01
Semen pH	6.69±0.02	6.51±0.03	6.51±0.02	6.50±0.02	NS
Progressive motility (%)	67.90b±0.84	77.90a±1.42	82.80a±1.78	83.10a±2.65	0.0001
Sperm concentration(x107/ml)	312.70a±8.02	285.30b±3.84	282.40b±2.87	293.30b±4.54	0.05
Normal sperm (%)	77.06b±0.66	78.83b±0.74	79.13b±0.37	81.31a±0.57	0.003
Abnormal sperm (%)	22.94a±0.66	21.17b±0.74	20.88b±0.37	18.69c±0.57	0.0005
Live sperm (%)	79.66c±0.74	83.00b±2.44	85.33a±3.40	86.50a±0.76	0.0001
Dead sperm (%)	20.83a±2.76	17.00b±2.47	14.83c±3.33	13.83c±2.78	0.0001
Sperm output(x107/ ejaculate)	288.09ab±6.79	271.80b±7.03	270.96b±7.99	294.36a±7.48	0.05
Motile sperm(x107/ ejaculate)	195.01c±4.32	213.07bc±3.77	229.94ab±10.37	250.45a±13.07	0.0018
TFSF (x107/ejaculate)	151c±3.24	170bc±8.64	185ab±12.05	206a±13.61	0.0002

[a-c] Means within rows with different superscript letters differ significantly(P < 0.05). NS = not significant. TFSF = Total functional sperm fraction.

Effect of dietary addition different levels of Se-algae on seminal plasma constituents

Data on the influence of feeding Barki ram-lambs on diets supplemented with different levels of Se- algae on seminal plasma constituents are presented in Table (6). Results showed that seminal plasma total protein, albumin and globulin are significantly (P ≤ 0.05) affected by dietary addition of different levels

of Se-algae as compared to the control group. Seminal plasma total protein showed significant increase in the groups given 0.4 and 0.6 mg Se-algae diets as compared to the control group. Seminal plasma albumin showed insignificant increase in the groups receiving 0.4 and 0.6 mg Se-algae diet as compared to the control group. On the other hand, seminal plasma globulin showed significant decrease in the group receiving 0.4 mg Se-algae diet as compared to the control group.

Concentration of total lipids in semen plasma significantly decreased with inclusion of Se-algae in the diets and these decreases reached 7.15, 6.25 and 9.69% for diets containing Se-algae at levels of 0.2, 0.4 and 0.6 respectively, as compare to control group. However, seminal plasma cholesterol and triglycerides were not significantly affected by the inclusion of Se-algae in the diets.

Seminal plasma analysis presented in Table (6) showed significant ($P \leq 0.01$) decreases in concentrations of ALP and ALT as a result of dietary inclusion of Se-algae when compared with the control group. The decline in transaminase enzyme in supplemented groups may be due to the presence of Se ions (Underwood et al., 1977) which may had a protective action to reduce the damage of cell membrane of sperms and sperm dead count which leads to a decline in the release of transaminase enzyme in seminal plasma.

Transaminase enzyme levels of whole semen showed significantly higher activity during stress. These enzymes may rise as a result of the destruction of spermatozoa due to stress factors and the high levels of transaminase enzymes are used as indicator of the degree of membrane damage of spermatozoa (Corteel, 1980). Moreover, Se-algae treatments resulted in a decrease in seminal plasma alkaline phosphates which may play a role in enhancing semen properties as high seminal alkaline phosphates activity in the buffalo was associated with lower sperm numbers, decreased motility and percent of live cells, depressed dehydrogenase activity and a slight and non-significant decrease in fructolytic rate (Abdou *et al.,* 1978). The improvement in biochemical constituent's concentration of seminal plasma of ram-lambs on Se-algae supplementation found herein generally are in agreement with those reported by Kamel (2012) who found that administration of selenium and folic acid or their combination increased ($P<0.05$) seminal plasma total proteins, globulins, alkaline phosphatase, acid phosphatase and lactate dehydrogenase.

Conversely, seminal plasma aspartate aminotransferase, alanine aminotransferase were significantly decreased compared to the control group. Although, initial fructose was non-significantly affected by different treatments, the results showed numerical increase in initial fructose in the groups fed all levels of Se-algae diets. The numerical increases of initial fructose were 2.1, 3.8 and 8.9 % for 0.2, 0.4 and0.6 mg Se-algae fed groups, respectively.

Table (6). Means ±SE of semen constituents of Barki mature rams fed diets supplemented with different levels of Se-Algae (n=7)

Parameters	Se-algae supplementation (mg/kg DM)				P-value
	Control	0.2	0.4	0.6	
Total protein (g/dl)	6.10^{b}±0.09	6.22^{ab}±0.12	6.38^{a}±0.13	6.33^{a}±0.11	0.0192
Albumin (g/dl)	3.09^{c}±0.04	3.16^{c}±0.06	3.57^{a}±0.07	3.37^{b}±0.06	0.0001
Globulin (g/dl)	3.01^{a}±0.12	3.04^{a}±0.06	2.82^{b}±0.06	2.96^{ab}±0.05	0.05
Total lipids (mg/dl)	908^{a}±0.005	843^{b}±0.011	851^{b}±0.011	820^{b}±0.024	0.0288
Triglycerides (mg/dl)	238.10±4.50	225.70±9.19	221.60±11.02	220.00±17.05	NS
Cholesterol (mg/dl)	213.60±3.49	204.80±10.67	201.70±11.71	200.60±9.35	NS
ALT (u/l)	65.09^{a}±1.39	60.74^{b}±3.83	60.15^{b}±4.55	61.55^{b}±3.14	0.05
AST (u/l)	84.62±0.61	86.75±2.03	86.86±2.06	87.25±1.63	NS
ALP (u/l)	17.48^{a}±0.08	15.80^{b}±0.43	13.63^{c}±0.25	12.70^{d}±0.37	0.0001
Initial fructose (mg/dl)	269.40±0.21	275.16±0.24	280.01±0.23	295.60±0.26	NS

$^{a-d}$Means within rows with different superscript letters differ significantly($P < 0.05$).
NS = not significant.
AST=aspartate aminotransferase, ALT=alanine aminotransferase, ALP=alkaline phosphatase

In conclusion, results of the present study demonstrated that supplemented diets of Barki ram-lambs with different levels of Se-algae increased final body weight and weight gain also; it improved their anti-oxidative status and semen quality.

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الملخص العربى

تأثير إضافة الطحالب المجففة الغنية بالسيلنيوم الى العلائق على الأداء الإنتاجى والتناسلى لذكور أغنام البرقى

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يهدف البحث لدراسة تأثير إضافة طحالب *Spirulina platensis* المجففة الغنية بالسيلنيوم الى علائق ذكور أغنام البرقى وذلك على النمو وبعض مكونات الدم وصفات السائل المنوى وايضا بعض إنزيمات الكبد المضادة للاكسدة . وقد أستمرت هذه الدراسة لمدة أكثر من عام وتم إجرائها بمحطة بحوث الإنتاج الحيواني ببرج العرب بالإسكندرية. استخدم فى هذه التجربة ثمانية وعشرون من الحملان البرقى متوسط أعمارها (٤ - ٥ شهور) تم تقسيمها عشوائيا إلى أربع مجاميع متساوية كل مجموعة تضم ٧ حيوانات تم تحضير مخلوط علف مركز أساسى يتكون من ٣٧% ذرة مجروشة ، ٣٠% شعير مجروش ، ٢٠% ردة ، ١٠% كسب فول صويا ،٢% حجر جيرى ، ١% ملح طعام. وقد تم تحضير أربع علائق تجريبية العليقة الاولى (مجموعة المقارنة) وهى عبارة عن مخلوط العلف المركز الاساسى بدون أى أضافات مع دريس البرسيم وكانت العلائق الثلاثة الأخرى (٢، ٣، ٤) تتكون من العليقة الأولى مع أضافة الطحالب المجففة الغنية بالسيلنيوم الى مخلوط العلف المركز بمستويات ٠.٠٢ ٠.٠٤ و ٠.٠٦ ملجم / كجم علف مركز ، على التوالي.وقد تم تغذية مجاميع الحيوانات الأربعة عشوائيا على العلائق التجريبية الأربعة .

وكانت أهم النتائج المتحصل عليها كالتالى:-

١-أظهرت النتائج أن إضافة الطحالب الغنية بالسيلينيوم أدت الى زيادة معنوية فى وزن الجسم ومعدل النمو مقارنة بالمجموعة المقارنة. كما لوحظ أرتفاع معنوى فى عدد كرات الدم البيضاء ومستوى البروتين الكلى وانخفاض مستوى الكولسترول والدهون الكلية مقارنة بالمجموعة المقارنة. لوحظ أيضا أرتفاع قيمة الهماتوكريت فى الحملان المغذاة على العليقة المحتوية على ٠.٤ ملجم سيلينيوم / كجم عليقة مقارنة بالمجاميع الاخرى بينما ارتفع البيومين الدم وانخفض الجلوبيولين عند مستوى ٠.٦ ملجم / كجم عليقة.

٢-أظهرت نتائج تحليل الدم أن هناك تأثيراً ملحوظا لاضافة الطحالب الى العليقة على مستوى إنزيمات الكبد (AST) وايضا أنزيم ALP ولو أن هذا التاثير كان فى الحدود الطبيعية المتعارف عليها كما لوحظ حدوث إرتفاع معنوي فى مستوى انزيمات الكبد المضادة للنأكسد (T-AOC,GSH-Px,SOD) بينما إنحفض مستوى المركب MDA معنويا وذلك عند المقارنة بالمجموعة المقارنة.

٣-أوضحت نتائج تحليل السائل المنوى حدوث زيادة معنوية فى حجم القذفة والعدد الكلى للإسبرمات فى القذفة الواحدة وكذلك معدل الحركة التقدمية للحيوانات المنوية بالنسبة للحيوانات المغذاة على العلائق المضاف لها السيلينيوم مقارنة بالمجموعة المقارنة .أيضا لوحظ إرتفاع معنوى فى مستوى البروتين الكلى فى بلازما السائل المنوى فى الحيوانات التى على علائق محتوية على مستوى ٠.٤ و ٠.٦ ملجم سيلينيوم مقارنة بباقى المعاملات الاخرى.بينما لوحظ إنخفاض معنوى فى مستوى الالبيومين والدهون الكلية وكذلك مستوى ALP, ALT فى الحيوانات المعاملة مقارنة بالمجموعة المقارنة.

من النتائج السابقة نستنتج أنه يمكن أستخدام الطحالب المجففة الغنية بالسيلنيوم فى علائق ذكور الاغنام النامية حيث تؤدى الى زيادة معنوية فى معدلات النمو وتحسين جودة السائل المنوى ومضادات الاكسدة ومكونات الدم الهامة والتى تنعكس بالأيجاب على الحالة الصحية والانتاجية للحيوان بصفة عامة.

Effect of Organic and Potassium Fertilization on Productivity and Quality of Sugar Beet in Sandy Soil

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ABSTRACT: Two field experiments were carried out at the Experimental Farm of El-Nubaria Agriculture Research station, Alexandria, Egypt, at the Kilometer 71 North west to study the effect of potassium fertilizers and organic manure (Farmyard manure) on yield and quality of sugar beet (var. Kumara) during the winter seasons of 2014/2015 and 2015/2016. The experimental design was split plot design with three replicates.The main results could be summarized as followers: (1) All characters for yield and quality was significantly affected by potassium fertilization. Application of 60 kg K_2O/fed, gave the greatest values of root length, top yield/fed, root yield/fed biological yield/fed and sugar yield/fed as well as sucrose% and TSS% in the both seasons except purity% in the two seasons. (2) All characters increased by increasing rate of organic manure up to 10 m^3/fed, except purity% in the two seasons. (3) The interaction indicated that the highest all yield sucrose% and TSS% was obtained by application 60 kg K_2O/fed, with rate of 10 m^3/fed farmyard manure in both seasons. The farmyard manure plays a major role in crop production in deserts soils sence it inirriazant the use of chemical fertilizer and decreases environmental pollution.
Key words: Sugar beet, Potassium levels, Organic manure, yields Quality.

INTRODUCTION

Sugar beet (*Beta vulgaris,* L.) is one of the two crops (the older being sugar cane) which represent the important source of sucrose product. The importance of sugar beet crop to agriculture is not only confined to sugar production, but also it well known to be adapted to poor, saline, alkaline and calcareous soil.

The economic maybe increasing sugar productivity could be achieved through development appropriate new technology package for sugar beet crop that includes agronomic management to the yield and quality of sugar beet (Mokadem, 1993, Kandil *et al.,* 2002 and Esmail and Abo El- Hamd, 2007).

Potassium plays a fundamental role in sucrose synthesis and storage. The influence of potassium not only on carbohydrate assimilation but also in nitrogen metabolism (Abdel Rahiman, 1996, El- Maghraby *et al*., 1998) mentioned that plant length, root diameter, root, top and sugar yield/fed, as well as sucrose and T.S.S. percentage significantly increased by increasing potassium level up to 48 kg K_2O/fed. On the other hand, Hegazy *et al.* (1992), found that there was significant decrease in top and sugar yields by increasing potassium level from 0 up 45 kg K_2O/fed and added that sucrose and purity percentage were not significantly affected by potassium rates.

The organic manure is known by enhancing soil physical properties by increasing the moisture holding capacity. In addition, it can change the chemical properties of soil through lowering pH and extensively their beneficial effects are known for long time. Application of organic matter provides many essential nutrients needed by plants. The increase in crop yield due to using of animal

manure have been imperative many times as resulted manily from the nitrogen, phosphorus or potassium on the combination of the three mentioned elements (Negm *et al*., 2003). Zalat and Nemeat Allah (2001) reported that farmyard manure (FYM) increased sucrose% and T.S.S%.

Therefore, the investigation was designed to study the effect of potassium fertilization and organic manure on yield and quality of sugar beet crop.

MATERIALS AND METHODS

Two filed experiments were carried out through two successive season of 2014/2015 and 2015/2016 at the Experimental farm Station Research, El-Nubaria, Buhyra, Egypt at the 71th Km West Alexandria- Cairo deresat road. To investigate the effect of potassium fertilizer and organic manure levels and their interaction of yield and quality on sugar beet (*Beta vulgaris*, L.) var. kumara.

Maize (*Zea mays,* L.) was the preceding for the two seasons. The experimental design was split plot design with three replicates. Potassium fertilization (zero, 20, 40 and 60 kg K_2O/fed) occupied the main plots. The sub-plot were assigned to three organic manure (sheep catle manure) (Untreated, 5 and 10 m^3/fed). Some physical and chemical properties of the experimental field soil and organic matter (farm yard manure) during the two seasons were done and the data are shown in Tables (1 and 2).

Potassium sulfate (48% K_2O) was applied at how many rates. Nitrogen fertilizer was added in the form of ammonium nitrate (33.5%N) as a side dressing at the rate of 60 kg N/fed, in two equal parts, one after thinning (before the first irrigation and the other before the second irrigation. Calcium super phosphate (15.5% P_2O_5), was applied during tillage operation at the rate of 100 kg/fed. Seeds ball were hand sown at the usual dry sowing on one side of the redge in hills 25 cm apart at the rate of 4-5 seed ball per hill on 3rd and 14th September in 2014/2015 and 2015/2016 seasons, respectively. The experimental basic unit area was 10.5 m^2 (1/400 feddan) and includes 6 redges each of which 50 cm width and 3 meter length.

At harvest (200 days after sowing) five plants were chosen at random from the iner redges of each sub- plot to estimate yield components and quality characters as follows:

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

Soil properties	2014/2015	2015/2016
A- Mechanical analysis		
Sand%	85.70	88.23
Clay%	6.30	4.80
Silt%	8.00	6.97
Soil texture	sandy	sandy
B- Chemical analysis		
pH (1:1)	8.50	7.35
EC (dS/m)	1.20	1.14
1- Soluble cations (1:2) (cmol/kg soil)		
K^+	0.82	1.20
Ca^{++}	2.76	3.10
Mg^{++}	1.90	2.30
Na^{++}	4.35	4.65
2- Soluble anions (1:2) (cmol/kg soil)		
CO^-_3+ HCO^-_3	2.72	2.72
CL^-	7.90	7.09
SO^-_4	1.15	0.98
Calcium carbonate (%)	6.12	6.72
Total nitrogen (mg/kg)	33.00	23.00
Available Phosphorus (mg/kg)	3.17	3.14
Organic matter (%)	0.37	0.83

Table (2). Some chemical properties of farmyard manure

Analysis	Values
Moisture %	27.00
O.M. %	26.00
pH (1:1)	7.20
N%	2.06
P%	3.13
K%	1.48
C:N raito	7.32:1

1- Top yield (ton/fed).
2- Root yield (ton/fed)
3- Biological yield (ton/fed).
4- Sugar yield (ton/fed).
5- Sucrose%: it was determing according to Mc Ginnu (1971).
6- Juice purity%: It was calculated according to Le – Decte (1927)

$$\text{Juice purity \%} = \frac{\text{Sucrose\%}}{\text{T.S.S.\%}} \times 100$$

7- Total soluble solids (T.S.S.%)

$$= \frac{\text{Sucrose \%}}{\text{Purity\%}}$$

Statistical analysis:

All collected data here subjected to the statistical and analysis following the procedure described by Gomez and Gomez (1984). The least significantly differences test (L.S.D.) at 0.05 was used to compare between means of the different treatments.

RESULTS AND DISCUSSION

A- Effect of potassium fertilization on yield and quality:

Data presented in Tables (3 and 4) revealed that all character of yield and quality were significantly affected by potassium levels in both seasons. A gradual increase to root length, top yield/fed, root yield/fed, biological yield, sugar yield/fed, sucrose%, purity% and T.S.S.% increased as K- levels raised from 0 to 60 kg K_2O/fed, in the both seasons. Such increase in root yield/fed, mounted by 28.13, 35.50 and 60.83% in the first season, being 20.56, 32.29 and 67.15% in the second season, as K- levels raised from 0 to 20 and 60 kg K_2O/fed. Similar significant increase in sugar yield/fed, amounted to 45.83, 48.74% and 80% in the first season, being 29.24, 37.28 and 78.39% compared to control in the second season. These results could be attributed to the important role of potassium in physiological process in plant such as translocation of sugar and carbohydrates of assimilates from the top to the root (Ibrahim *et al.,* 2002). Also, its role in nutritional balance, which increased organic compounds through phytosynthesis (El- Howary, 1999). Similar results were obtained by Mekki and El- Gazzar (1999), Omar *et al*. (2002) and Esmail and Abo El- Hamd (2007).

Data presented in Tables (3 and 4) showed that, root length, top yield/fed, root yield/fed, biological yield, sugar yield/fed, sucrose% purity% and T.S.S.% were affected significantly by tested organic manure during the two growing seasons. Application of 10 m^3/fed, organic manure gave the tallest roots (32.75 and 35.33 cm) heaviest top yield/fed (9.70 and 7.75 ton), heaviest root yield (26.96 and 24.46 ton), heaviest biological yield/fed (35.8 and 32.26 ton), highest sugar yield (4.85 and 4.35 ton), highest sucrose% (18.25 and 17.59%) purity% (86.22 and 84.90%) and highest T.S.S.% (21.17 and 21.50%) in the first and second seasons, it could be concludes that treated of traits with organic fertilizer levels on increase yield and quality characters. This may be due to the role of microorganisms activity, phytohormones formation and translocation of the plant especially (IAA, Gas and CKs). Also, it has important role in increasing photosynthesis rate. These results are similar to those of Bassal *et al* (2001), Ali (2003) and Ibrahim (2007).

The interaction between potassium levels and organic manure levels had significant effect on all yield and quality character except purity% in both seasons. Application of 60 kg K_2O/fed, gave the highest values for this traits except purity % treated with 10 m^3/fed, resulted the maximum mean in both seasons Tables (4 and 6).Finally it could be concluded that under condition of this study the highest root and sugar yield/fed produced by application of 60 kg K_2O/fed treated with 10 m^3/fed

Table (3). Yield and its components as affected by potassium fertilizer and organic manure in 2014/2015 and 2015/2016 seasons

Treatments	Root length (cm)		Top yield (ton/fed)		Root yield (ton/fed)		Biological yield (ton/fed)		Sugar yield (ton/fed)	
	2014/2015	2015/2016	2014/2015	2015/2016	2014/2015	2015/2016	2014/2015	2015/2016	2014/2015	2015/2016
A) K- fertilizer										
0	25.56^{d}	28.45^{c}	6.14^{c}	5.36^{d}	14.68^{c}	14.40^{d}	20.92^{d}	19.71^{d}	2.40^{c}	2.36^{c}
20	30.22^{c}	31.11^{b}	7.83^{b}	5.91^{c}	18.81^{b}	17.36^{c}	26.61^{c}	23.25^{c}	3.50^{b}	3.05^{b}
40	32.33^{b}	32.00^{b}	8.25^{b}	6.67^{b}	19.82^{b}	19.05^{b}	28.13^{b}	25.81^{b}	3.57^{b}	3.24^{b}
60	34.49^{a}	35.00^{a}	9.41^{a}	7.98^{a}	23.61^{a}	24.07^{a}	32.78^{a}	32.05^{a}	4.32^{a}	4.21^{a}
L0.S.D. (0.05)	**1.50**	**1.60**	**0.50**	**0.54**	**1.20**	**1.50**	**1.39**	**2.05**	**0.50**	**0. 55**
B) Organic manure										
Control	26.42^{c}	27.25^{c}	7.12^{b}	5.60^{b}	12.31^{c}	12.53^{c}	19.40^{c}	18.03^{c}	2.02^{c}	22.03^{c}
5 m^{3}/fed	30.75^{b}	32.34^{b}	6.91^{b}	6.12^{b}	18.43^{b}	19.18^{b}	25.13^{b}	25.26^{b}	3.24^{b}	3.23^{b}
10m^{3}/fed	33.75^{a}	35.33^{a}	9.70^{a}	7.72^{a}	26.96^{a}	24.46^{a}	36.80^{a}	32.26^{a}	4.95^{a}	4.39^{a}
L.S.D. (0.05)	**2.20***	**2.40***	**0.72***	**0.65***	**2.40***	**2.70***	**4.80***	**4.40***	**0.80***	**0.65***
Interations										
AxB	*	*	*	*	*	*	*	*	*	*

Means of each designated by the same letter not significantly different at 5% using least significant difference L.S.D.
* Significant at 0.05 levels of probability

Table (4). Interaction between potassium fertilizer and organic manure in 2014/2015 and 2015/2016 seasons on yield and components

Treatments		Root length (cm)		Top yield (ton/fed)		Root yield (ton/fed)		Biological yield (ton/fed)		Sugar yield (ton/fed)	
Org. manure	K-levels	2014/2015	2015/2016	2014/2015	2015/2016	2014/2015	2015/2016	2014/2015	2015/2016	2014/2015	2015/2016
Control	control	25.00	25.00	5.73	5.38	10.28	9.14	16.01	14.18	1.51	1.43
	20	25.00	25.67	7.40	5.33	10.76	10.76	18.10	16.10	1.72	1.76
	40	28.33	28.33	7.63	4.70	12.58	13.52	20.53	18.20	2.13	2.23
	60	29.33	30.00	7.70	6.98	15.64	16.64	22.95	23.62	2.17	2.71
5 m^3/fed	control	25.00	26.67	5.76	5.43	12.30	13.95	18.04	19.38	2.01	2.23
	20	31.00	32.67	6.84	6.18	17.82	17.82	24.67	23.86	3.21	3.09
	40	33.33	33.33	6.44	6.44	18.18	18.86	34.61	25.30	3.21	3.14
	60	33.67	36.67	8.09	6.43	25.08	26.09	33.21	32.51	4.53	4.44
10m^3/fed	control	26.67	33.67	6.93	5.26	21.12	20.12	28.11	25.38	3.67	3.41
	20	34.67	35.00	9.24	6.23	27.85	23.51	37.05	29.74	4.98	4.29
	40	35.33	34.33	10.19	8.86	28.72	24.72	39.25	33.92	5.36	4.36
	60	40.33	38.33	12.45	10.54	30.47	29.47	42.18	40.01	5.71	5.48
L.S.D. 0.05		2.30*	2.50*	0.80*	0.85*	2.50*	2.75*	3.70*	4.20*	0.95*	0.70*

Table (5). Sugar beet quality as affect by potassium fertilizer and organic manure in 2014/2015 and 2015/2016 seasons

Treatments	Sucrose %		Purity %		T.S.S. %	
	2014/2015	2015/2016	2014/2015	2015/2016	2014/2015	2015/2016
A) K- fertilizer						
0	16.00^{c}	16.45^{c}	81.12^{d}	80.03^{d}	19.89^{b}	19.89^{c}
20	17.33^{b}	16.89^{b}	83.20^{b}	81.20^{c}	20.78^{a}	21.00^{a}
40	17.78^{b}	17.22^{c}	82.70^{c}	81.70^{b}	20.55^{a}	20.55^{b}
60	18.11^{a}	17.33^{a}	83.80^{a}	82.40^{a}	20.86	21.33^{a}
L0.S.D. (0.05)	**0.38**	**0.35**	**0.40**	**0.42**	**0.50**	**0.45**
B) Organicmanure						
Control	16.25^{c}	16.25^{c}	84.20^{b}	82.60^{c}	20.09^{b}	20.20^{c}
5 m^{3}/fed	17.42^{b}	17.08^{b}	85.16^{ab}	83.40^{b}	20.08^{b}	20.58^{b}
10m^{3}/fed	18.25^{a}	17.59^{a}	86.22^{a}	84.90^{a}	21.17^{a}	21.50^{a}
L.S.D. (0.05)	**0.60***	**0.45***	**0.65***	**0.50***	**0.60***	**0.52***
Interations						
AxB	*	*	**ns**	**ns**	*	*

Means of each designated by the same letter not significantly different at 5% using least significant difference L.S.D. * Significant at 0.05 levels of probability

Table (6). Interaction between potassium fertilizer and organic manure on quality of sugar beet in 2014/2015 and 2015/2016 seasons

Treatments		Sucrose %		Total soluble soild (T.S.S.%)	
Org. manure	**K- levels**	**2014/2015**	**2015/2016**	**2014/2015**	**2015/2016**
Control	**control**	14.67	15.67	20.00	19.33
	20	16.00	16.33	20.67	20.33
	40	17.00	16.67	20.00	20.00
	60	17.33	16.33	19.67	20.33
5 m^{3}/fed	**control**	16.00	16.67	19.33	20.00
	20	18.00	17.33	20.33	21.00
	40	17.67	17.33	20.33	20.33
	60	18.00	17.00	20.33	21.00
10m^{3}/fed	**control**	17.33	17.00	20.33	20.33
	20	18.00	17.67	21.33	21.67
	40	18.67	17.67	21.00	21.33
	60	19.00	18.67	22.00	22.67
L.S.D. 0.05		**0.70***	**0.50***	**0.70***	**0.60***

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الملخص العربي

تأثير التسميد العضوي والبوتاسي على الإنتاجية وجودة بنجر السكر في الأرض الرملية

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أجريت تجربتان حقليتان بالمزرعة البحثية بمركز البحوث الزراعية بالنوبارية – البحيرة – عند الكيلو ٧١ غرب الطريق الصحراوي – إسكندرية – القاهرة – لدراسة تأثير التسميد البوتاسي والعضوي على المحصول وجودة بنجر السكر لصنف كواجير أثناء موسمي ٢٠١٤/٢٠١٥، ٢٠١٥/٢٠١٦. التجربة صممت بنظام القطع الشقية مرة واحدة مع ثلاث مكررات.

ويمكن تلخيص أهم النتائج فيما يلي:

- جميع الصفات للمحصول والجودة كانت متأثرة معنوياً بواسطة التسميد البوتاسي عند إضافة ٦٠كجم بو٢أ/ فدان أعطت أفضل قيم لطول الجذر محصول العروش/فدان، محصول الجذور/فدان والمحصول البيولوجي/فدان، محصول السكر/فدان وأيضا النسبة المئوية للسكر والنسبة المئوية للمواد الصلبة في كلا الموسمين ماعدا النسبة المئوية للنقاوة في الموسمين.
- جميع الصفات زادت بواسطة زيادة السماد العضوي عند ١٠م٣/فدان ماعدا النسبة المئوية للنقاوة في كلا الموسمين.
- أدى التداخل إلى ارتفاع كل صفات المحصول والنسبة المئوية للسكروز والنسبة المئوية للمواد الصلبة الذائبة الكلية وكانت أفضل النتائج المتحصل عليها عند إضافة ٦٠كجم بو٢أ/فدان مع التسميد العضوي ١٠م٣/فدان (سماد بلدي) في كلا الموسمين.
- السماد البلدي تحت الدراسة له تأثير كبير في زيادة إنتاج المحصول خصوصاً في الأرضي الصحراوية نظراً لتحسين الصفات والخواص الفيزيائية للتربة وتقليل التلوث البيئي حيث أنها تخفض من معدلات السماد الكيماوي (طريقة تسميد صديقة للبيئة).

In vitro Propagation and *Ex vitro* Acclimatization of *Solidago Canadensis* Using Nodal Segment Explants

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ABSTRACT: *Solidago canadensis* is a rhizomatous perennial plants, involved in multiple purpose as one of the most important commercial cut flowers, with landscape importance and much more importance as a highly valuable medicine plants. Therefore, an efficient plant tissue culture protocol for golden rod (*Solidago canadensis)* was developed from the nodal cuttings explants. Nodal cuttings, after being disinfected superficially, sterilized with different concentrations of mercuric chloride ($HgCl_2$). Another procedure for surface sterlization take place, the above-mentioned explants were immersed in different concentrations of sodium hypocholrite solution (NaOCl). For *in vitro* initiation stage propagation, surface sterilized explants were cultured on Murashige and Skoog (MS) medium augmented with varied concentrations of both applied plant growth regulants 6-benzylamino purine (BA) and in combination with naphthalene acetic acid (NAA). Different parameters including the mean number of each shoots, shoot length (cm), mean number of leaflets, mean number of roots formed and per propagule were studied during the course of all tested stage. Neoformed shoots of initiation stage were divided into single nodes with one axillary bud per node each which were used for all micropropagation satage (i.e. initiation, multiplication and rhizogenesis). For acclimatization the plantlets produced from rooting stage were transplanted *ex vitro* in small 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. In general, the present study revealed that BA and NAA at (nil) 0.00 or 0.25 mg/l and 0.00 and 0.50 mg/l, respectively achieved the best results for initiation stage. Meanwhile, fortified medium with BA and NAA at 0.50 and 0.50 mg/l, consecutively, gave rise to the best results for multiplication stage. Regarding rhizogenesis stage, the best results were recorded when the explants were cultured on MS medium plus IBA and NAA at IBA at 1.50 mg/l and NAA at 2.00 mg/l; which led to the highest mean number of roots formed per propagule., each in turn. Neoformed plantlets were acclimatized *ex vitro* and *in vivo* vigorously in mixture of perlite and peatmoss at either (1:1) or (1: 2) and (1: 3), respectively, resulted in the highest mean value (100%) of survival percentage/ plant. and successfully showed true-to-type plants.

keywords: golden rod, *Solidago canadensis*, *in vitro* culture, plant growth regulators, nodal segments, surface sterilization, initiation, multiplication, rhizogenesis, rooting, *in vivo*, acclimatization

INTRODUCTION

Solidago canadensis, L.or goldenrod is a rhizomatous perennial (Weber and Jakobs, 2005) which belongs to the family *Asteraceae.* The genus name derived from the Latin solidus meaning whole, refering to its traditional healing properties.

Solidago canadensis are produced annually by cuttings from a perennial branched rhizome system. The species is self-incompatible, self fertile (Schmid and Dolt, 1994) and diploid 2n = 2X = 18 (Melville and Morton, 1982). To maintain its quality, crop should be replanted every 2-3 years (Nowak and Rudnicki, 1990), or as early as 1/4 of the flowers have opened (Bartels, 2001). It became one of the most important commercial cut flowers in the recent five years. With respect to landscape importance, the plant is used in meadow and natural gardens, borders, cut flower, bee and butterfly

gardens because it provides good colour and contrast for the late summer to early fall (LiPing *et al*, 2003). Some investigators are using *Solidago* plants as a source of biochemical secondary metabolites. The extract of *Solidago* plants inhibit the growth of human gastric adenocarcinoma, spasmolytic, antihypertensive and diuretic effects at the same time, the extract of *Solidago* plants is very important in immunodularty and anti-inflamatory activity (Kruedener *et al*. ,1995; Matsunaga *et al*., 1999; Ivan-Razmilic *et al*., 2000; Sampson *et al*., 2000). Roots used in treatment of burns.Tea from flowers used to treat fevers and snakebites. Crushed flowers can be chewed for sore throats. Leaf extracts are diuretic. Therefore, attention about this genus is in upscalling for more production.

Pertaining *in vitro* propagation of *S. canadensis*, Abd-Elrahman (2002) reported that the best result for surface sterilization was done by using 40% clorox concentration(v/v) [NaOC,l 2.0%] produced the highest percentage of the free - contamined explants (80%) on."Toto"cv. and (85%) on "Tara" cv. and increasing strength of medium; produced the greatest shootlet number per explants for "Toto" and "Tara" cvs Li *et al.* (2012) found that the nodal explants with axillary buds of *Solidago canadensis* L. were collected from field-grown plants of goldenrod. Also, Li *et al.* (2012) found that the nodal explants with axillary buds of *Solidago canadensis* L. were collected from field-grown plants of goldenrod. The excised nodal segments (0.5-1 cm long) without leaves were surface sterilized in 70% (v/v) ethanol for 30 to 40 s, followed with 8-min in 1 g/l $HgCl_2$, and rinsed five times with autoclaved distilled water. Further, Paul *et al.* (2013) stated that various explants (node, internode and leaves) of *Solidago virgaurea* L. were thoroughly washed in running tap water for 30min. followed by the treatment in 1% Labolene, (a neutral detergent Qualigens, India) for 3min. and finally rinsed with the distilled water for 4-5 times to remove the surface microflora. The washed explants were surface sterilized with 0.1% (w/v) aqueous mercuric chloride ($HgCl_2$) for 3 min. and the chemical sterilent was removed by rinsing the materials with sterilized and cooled distilled water 4-5 times. However, Ailstock (1985) reported that explants obtained from terminal and subterminal nodes of vegetative stems were cultured on various media combinations. Adventitious shoots were initiated within three weeks on Murashige's minimal organic medium (Murashige and skoog,1962) supplemented with 1-3 mg/l Kinetin. These shoots, when separated and placed on similar media with and without auxins, formed roots within five days and could be transferred to peat pots for greenhouse culture in 10 days. However, due to the greatest importantce of this plant species economically, the present study was undertaken to develop an integrated protocol for *in vitro* and *ex vitro* acclimatization of *Solidago canadensis*.

MATERIALS AND METHODS

The experiments regarding the effect of different concentrations of certain growth regulators and their combinations on micropropagation of *Solidago canadensis* plantlets using nodal segments as explants were

conducted in the Plant Tissue Culture Laboratory of the Faculty of Agriculture Saba Basha, Alexandria University, during the period of 2012 to 2015.

Plant materials:

The explant materials were collected from 3-months old *Solidago canadesis, L*., kindly, gifted by a commercial farm (3H Co.) on Cairo-Ismailia highway. The healthy mother plants were grown under plastic house conditions. The collected material, were brought to the laboratory to process the washing and to be ready for sterilization and tissue culture manipulation then the shoots used from cuttings were washed thoroughly in the water, using liquid soap for 30 min. The excised explants were placed under running tap water for 30 minutes then dipped in 70% ethanol for 15 sec. After pretreatment with ethanol, the explants were rinsed with double distilled water twice, to lower the toxic effect of ethanol. Nodal segments of only 1cm long nodal segment which contained a single node were then surface sterilized with different concentrations of mercuric chloride ($HgCl_2$) at 0.05, 0.1, 0.15 and 0.2% (v/v) with a few drops of wetting agent "Tween-20" (surfactant agent) for five minutes (Ilahi *et al*., 2007). The similar procedure was repeated, but the explants were immersed in different concentrations of sodium hypocholrite solution (NaOCl) at 30, 35, 40 and 45% (v/v). After the surface sterilization of explants with mercuric chloride and sodium hypocholrite solutions were decanted and the explants were rinsed with sterile double distilled water for four times, so as to lower the toxic effects of $HgCl_2$ and NaOCl and became ready for culturing. Determination of contamination ratio for each sterilant agent used in sterilization of culture explants was done.

***In vitro* experimental stages**

1. Initiation stage

Explants were cultured on solidified Murashige and Skoog (1962) medium which solidified with gelrite (3g/l). The pH of the tested media was adjusted to 5.7 before adding gelrite, and then sterilized autoclaving at 121℃ for 20 min., then explants were cultured into the given MS medium which contained different concentrations of cytokinin (BA at four concentrations: 0.0 (nil), 0.25, 0.50 and 0.75 mg/l, in combinations with auxin (NAA) at five concentrations 0.0 (nil), 0.5, 1.0, 1.5 and 2.0 mg/l.

2. Multiplication stage

The neoformed propagules of the initiation stage were sectioned into single leaflets nodes. The excised nodal cuttings explants of the different positions were cultured, randomly, in the multiplication media which supplemented with BA at five concentrations: 0.0 (nil), 0.5, 1.0, 1.5 and 2.0 mg/l, in combinations with NAA at five concentrations: 0.0 (nil), 0.25, 0.50, 0.75 and 1.0 mg/l.

3. Rhizogenesis

The obtained shoots of *Solidago canadesis* from the multiplication stages were, individually, cultured on a rooting medium, contained MS salts, sucrose at 30 g/l. and two types of auxins were tested, IBA at five concentrations: 0.0 (nil), 0.5, 1.0, 1.5 and 2.0 mg/l, in combinations with NAA at five concentrations: 0.0 (nil), 0.5, 1.0, 1.5 and 2.0 mg/l.

Generally, each treatment was represented by 3 jars and three explants per each jar (175 ml) containing 20 ml medium. 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 chamber at 25 ± 1℃ under 16 hr daily light and 8 hr darkness illumination by a florescent light intensity of 2880 Lux (40µmol $m^{-2}s^{-1}$ PPF).

Acclimatization of neoformed plantlets

The plantlets produced from rooting stage of *Solidago canadensis* was 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 (10cm) plastic pots contained an autoclaved mixture of the perlite and peatmoss at (0, 1, 2, 3, volume) each; 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 at (RH) 80% 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.

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

Experimental design and 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) and means were compared by L.S.D (Steel *et al*., 1997) and significance was determined at $p \leq 0.05$.

Generally, the following characters were recorded per propagule at initiation, multiplication and rooting stages after 35 days in culture:
1. Mean number of shoots formed/propagule.
2. Mean shoot length (cm)/propagule.
3. Mean number of leaflets formed/propagule.
4. Mean number of roots formed/propagule.

RESULTS AND DISCUSSION

1. Surface sterilization

The obtained results in Table (1) indicated that using chlorox (commercial bleach) at 40% (v/v) achieved the highest percent survival (90%) compared to the other treatments which reflected on contamination percent (%), too.

Table (1). Effect of some sterilization treatments on the percentage of survival and contamination of *Solidago canadensis* explants in vitro after 35 days in culture.

Stelization treatments	concentreation	Survival % (visually)	contamination% (visually)
Chlorox	30%	30%	70%
	35%	40%	60%
	40%	90%	10%
	45%	60%	40%
Mercuric Chloride(mg/l)	0.5	40%	60%
	1.0	80%	20%
	1.5	40%	60%
	2.0	20%	80%
NaOCl +M.C	40% + 1.0 (mg/l)	100%	0%

Chlorox sodium Hypochlorite (NaOCl) Mercuric chloride ($HgCl_2$) which abbreviated as M.C.

This finding may be accounted for the profound effect of this surface sterliant on elimination of external microorganism which could compete with the growth the given explants; subsequently, enhanced the growth of cultured propagules (Perkins, 1983). In this respect, using 1.00 mg/l of mercuric chloride, led to the highest percentage of survival of uncontaminated explants, i.e. 80% and 20% for contamination percent. The combination sterilants, chlorex and mercuric chloride at 40% and 1.00 mg/l, orderly; brought about was the highest percent of survival (100%) compared with all treatments. This finding could be attributed to that both disinfectant's combination was toxic to microorganisms, but non-toxic for plant material.

Then, tissue cultures become possible with the use of convening and effective disinfectants such as alcohol and mercuric chloride (Pavan, 1999). Many investigators found that chlorox was the best treatments for explants disinfection (Mackay and Kitto, 1988; Mittal *et al.,* 1989). Abd-Elrahman (2002) on *Solidago altissima,* confirmed the obtained results, whereas reported that the best result for surface sterilization was taken place due to using 40% clorox concentration (v/v) [NaOCl at 2.0%], which produced the highest percentage of the free - contamined explants (80%) for"Toto" and (85%) var. "Tara" cultivar. On the other hand, Beura *et al*. (2003) stated that in the case of axillary buds explants of *Gladiolus* cv. American Beauty, the treatment of 1% NaOCl for 10 min. was found to be the best; where it had 100% aseptic culture and survival of explants. Furthermore, Rozali *et al.* (2014) reported that the lowest contamination percentage of *Calathea crotalifera* was recorded when the cultured explanted were treated with combination of 30% (v/v) NaOCl, 70% (v/v) ethanol, and 0.3% (w/v) $HgCl_2$. In

addition, Joshi *et al.* (2015) found that the best result of surface explants of *Spilanthes acmella* were surface sterilization using (1% and 4%) sodium hypochlorite and (0.01% and 0.1%) $HgCl_2$.

2. Initiation stage

Data presented in Table (2) and plate (1) exhibit that both applied growth regulators (BA and NAA) and their combinations exerted significant effects on the initiation stage's characters of single node explants of *Solidago canadensis* grown *in vitro*. Concerning the main effect of BA on the studied characters, i.e. numbers of shoot, shoot length, number of leaflets, roots formed per propagule and callus formation in general, there was an inverse relationship between BA levels and the given traits, i.e. as BA level increased, the given trait decreased. However, the highest mean values were always recorded at the absence of either BA from the culture medium (nill level) or 0.25mg/l, but the lowest ones were noticed at its highest level (2.00 mg/l) except for the number of roots and callus formation which recorded at 0.00 mg/l.

Table (2). Effect of different levels of BA and NAA (mg/l) and their combinations on the initiation stage of *Solidago canadensis* cultured *in vitro* for 35 days.

Characters	BA Level (mg/l)	NAA levels (mg/l)					Average (BA)	Significance		
		0.00	0.50	1.00	1.50	2.00		NAA	BA	NAA X BA
(a) Mean number of shoots formed/propagule										
	0.00	1.00	2.00	2.22	1.44	0.67	1.47	**	**	**
	0.25	1.67	1.78	0.67	0.22	0.44	0.96			
	0.50	0.89	0.56	0.00	0.00	0.11	0.31			
	0.75	0.22	0.00	0.11	0.11	0.00	0.09			
Average (NAA)		0.94	1.08	0.75	0.44	0.31				
L.S.D. (0.05)								0.23	0.20	0.49
(b) Mean shoot length (cm)/propagule										
	0.00	0.78	1.01	0.33	0.27	1.00	0.68	**	**	**
	0.25	0.68	1.18	0.64	0.21	0.34	0.61			
	0.50	0.56	0.33	0.00	0.00	0.08	0.19			
	0.75	0.14	0.00	0.06	0.04	0.11	0.07			
Average (NAA)		0.54	0.63	0.26	0.13	0.38				
L.S.D. (0.05)								0.18	0.16	0.38
(c) Mean number of leaflets formed/propagule								**	**	*
	0.00	4.22	6.11	6.00	3.67	4.00	4.80			
	0.25	9.67	8.67	4.89	1.56	3.67	5.69			
	0.50	4.78	3.00	0.00	0.00	1.11	1.78			
	0.75	1.44	0.00	0.78	1.11	0.00	0.67			
Average (NAA)		5.03	4.44	2.92	1.58	2.19				
L.S.D. (0.05)								1.59	1.42	3.43
(d) Mean number of roots formed/propagule								**	**	**
	0.00	0.33	0.00	0.11	0.11	5.00	1.11			
	0.25	3.89	1.67	1.11	1.11	2.78	2.11			
	0.50	0.00	0.00	2.22	0.00	2.33	0.91			
	0.75	2.00	3.00	0.78	0.11	0.11	1.20			
Average (NAA)		1.56	1.17	1.06	0.33	2.56				
L.S.D. (0.05)								0.41	0.37	0.89

L.S.D. (0.05) = Least significant difference test at 0.05 level of probability.
*, **: Significant or highly significant.

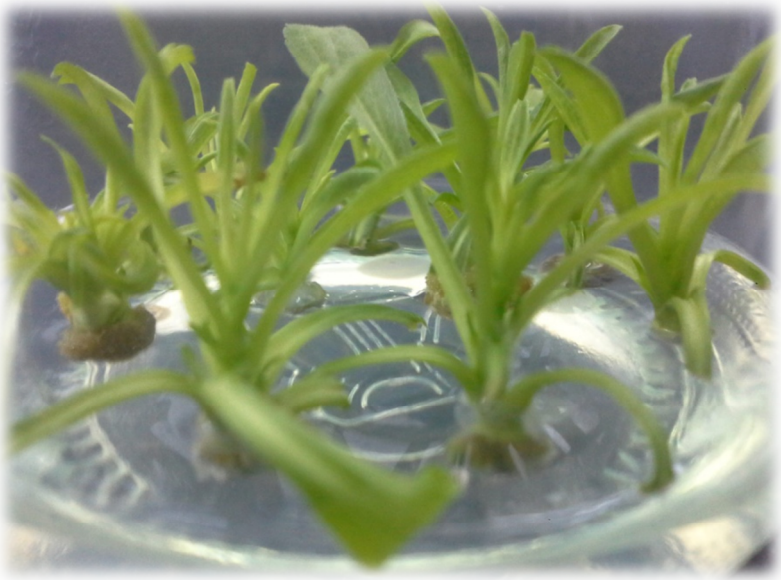

Plate (1). Initiation stage of *Solidago canadensis* nodal explants cultured on MS medium supplemented with BA and NAA at 0.0 and 0.25 mg/l, respectively

Regarding the main effect of NAA tested levels on the above-mentioned traits, commonly; as NAA levels increased the given characters decreased. However, the highest mean values were always recorded at either the absence of NAA or at 0.50 mg/l for number of shoot, shoot length and number of leaflets formed per propagule. On the other side, the number of roots formation showed the highest mean values at 2.00 mg/l NAA added in the culture medium, but the lowest ones were noticed at its highest level (1.5 mg/l). The above-mentioned results indicated, generally, that decreasing the mean values of the studied characters was concomitant with increasing BA, could be attributed to accumulation supra-optimal level of cytokinins within tissues which exerts adverse effects on growth performance (Murashige, 1974; Tomas, 1987; George *et al*., 2008).

Hence, Murashig and skoog (1962) medium without BA; resulted in the highest mean value of shoot length was taken place. As for NAA this finding could be attributed to the mode of action of enhanced auxin (NAA) either endogenously or exogenously within cultured tissues which is capable of controlling various distinctive processes such as cell growth and elongation (George and Sherrington, 1984 ; George *et al*., 2008). Furthermore, it is known that the role and mode of action of auxin for their abilities to enhance root formation was reported by many research workers (Chen *et al*., 1985; Liu *et al*., 1998; George *et al*., 2008; Waseem *et al*., 2011). Concerns to the interaction between both applied growth regulators at both 0.00 or 0.25 mg/l BA, and 0.00 and 0.50 mg/l NAA; expressed significant effects on the same tested traits.

3. Multiplication stage

Results in Table (3) and plate (2) describe the effect of various levels of both growth regulators and their combinations on the studied characters of *Solidago canadensis*. Respecting the main effect of BA, it showed that its presence in the culture medium at 0.50 mg/l; resulted in the highest mean number of shoots, shoot length and number of leaflets per propagule, Meanwhile, its absence from the basal medium, led to the highest mean roots formed per propagule.

Table (3). Effect of different levels of BA and NAA (mg/l) and their combinations on the multiplication stage of *Solidago canadensis* cultured *in vitro* for 35 days

Characters	NAA Level (mg/l)	BA levels (mg/l)					Average (NAA)	Significance		
		0.00	0.50	1.00	1.50	2.00		BA	NAA	BA X NAA
(a) Mean number of shoots formed/propagule								**	**	**
	0.00	0.78	0.89	0.89	1.11	2.11	1.16			
	0.25	1.11	2.56	1.56	0.89	0.44	1.31			
	0.50	0.78	1.33	3.11	2.44	2.22	1.98			
	0.75	2.11	2.67	0.56	0.22	0.00	1.11			
	1.00	0.33	4.33	4.11	3.89	3.00	3.13			
Average(BA)		1.02	2.36	2.04	1.71	1.56				
L.S.D. (0.05)								0.54	0.54	1.28
(b) Mean shoot length (cm)/propagule								**	N.S	*
	0.00	0.76	1.12	1.00	1.10	0.80	0.95			
	0.25	0.69	0.50	0.56	0.48	0.33	0.51			
	0.50	0.73	0.87	1.20	1.42	0.82	1.01			
	0.75	0.87	0.76	0.24	0.20	0.00	0.41			
	1.00	0.21	0.88	0.83	0.82	0.76	0.70			
Average (BA)		0.65	0.82	0.77	0.80	0.54				
L.S.D. (0.05)								0.22	0.22	0.52
(c) Mean number of leaflets formed/propagule								**	**	**
	0.00	4.44	6.22	6.89	7.11	5.33	6.00			
	0.25	4.89	7.56	7.33	4.67	3.33	5.56			
	0.50	6.44	9.33	8.67	6.89	8.22	7.91			
	0.75	8.00	10.22	2.22	2.00	0.00	4.49			
	1.00	2.67	4.22	4.67	3.56	4.22	3.87			
Average (BA)		5.29	7.51	5.96	4.84	4.22				
L.S.D. (0.05)								1.42	1.42	3.36
(d) Mean number of roots formed/propagule								**	**	**
	0.00	0.00	0.00	0.00	0.00	1.33	0.27			
	0.25	2.56	0.44	0.00	0.00	0.00	0.60			
	0.50	1.44	0.11	0.00	0.00	0.44	0.40			
	0.75	5.78	1.00	0.00	0.00	0.00	1.36			
	1.00	2.67	0.22	0.00	0.00	0.00	0.58			
Average (BA)		2.49	0.36	0.00	0.00	0.36				
L.S.D. (0.05)								0.37	0.37	0.87

L.S.D. (0.05) = Least significant difference test at 0.05 level of probability.
*, **, N.S.: Significant, highly significant, or not significant, respective

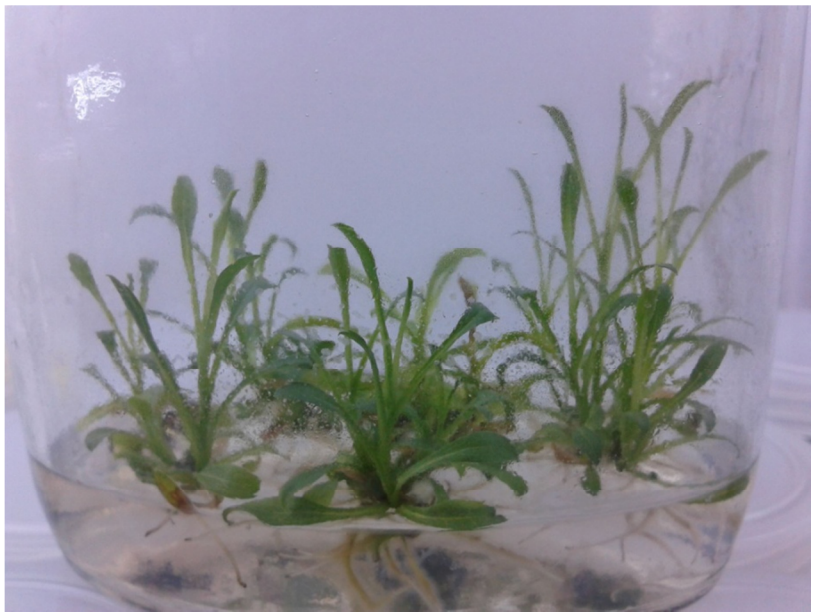

Plate (2). Multiplication stage of *Solidago canadensis* newly formed nodal segments during of initiation stage, upon culturing then on MS medium augmented with BA and NAA at 0.50 and 0. 50 mg/l, consecutively.

On the other end, the main effect of NAA declared that augmenting the basal medium with it at 0. 50 mg/l, brought about the highest number of shoots, shoot length and number of leaflets. However, its presence in the basal medium at 0.75 mg/l, give rise to the highest mean number of roots formed /propagule. Meanwhile, the interaction between BA and NAA at 0.50 and 0.50 mg/l, respectively, led to the highest mean number of shoots, shoot length and number of leaflets formed per propagule.

It could be inferred from above results that BA at 0.50 mg/l, was the optimal concentration for better performance of this particular hormone. Whereas, any above or lower deviation from this concentration of that growth regulator, the propagules showed poor performance. These results could be brought about to the mode of action of cytokinins on stimulation both cell division and promotion growth of axillary shoots in plant tissue culture as, also, found by Tomas (1987), Trigiano and Gray (2000) and George *et al*. (2008). These results are cope with Waseem *et al*. (2011) who reported that BAP as a cytokinin at the rate of 1.0 mg/l resulted in an increased number of shoots in *Chrysanthemum morifolium* formed per propagule. Abd El-rahman (2002) found that adding 0.5 mg/l BA produced the highest shootlet number for *Solidago canadensis* var. “Toto” and “Tara”. Parihar *et al*. (2010) found that media supplemented with kinetin at 2.00 mg/l, was most effective for shoot induction, proliferation, and multiplication of *Aegle marmelos*.

In addition, Duhoky and Rasheed (2010) noticed that using kinetin at 2 mg/l, led to getting the highest length of new shoots of *Gardenia Jasminoides*. Gaber (2012) stated that the main effect of KIN showed its presence at the culture medium (2.0 mg/l), resulted in the highest mean shoot length.

Meanwhile, its absence from the basal medium, led to the highest mean number of leaflets, nodes and roots formed per propagul. Regarding the role of NAA; the results, in general, showed that an intermediate concentration i.e. 0.50 mg/l of NAA produced the best results in almost tested traits. The fact that higher doses failed to manifest their superiority of their mode of action.

These findings could be attributed to an obnoxious effect at higher concentration. On the other extreme, the ineffectiveness of the lower dose indicate inadequate dose of hormone as a consequence indicating poor performance. Likewise, this might be due to the mode of action of auxin (NAA) at the above-mentioned level within cultured tissues may enhance, control various distinctive processes such as cell growth and elongation (George and Sherrington, 1984). Wilkins (1989), additionally, stated 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. However, the presence of auxins in the culture medium positively increased the mean shoot length of *Trigonella foenum-graecum* (Aasim *et al*., 2010). It is know that average number of leaves per shoot and number of nodes is one of the important growth factors and is in directly proportional relationship to the length of the shoot, and if the shoot length increases, the number of leaves and number of nodes increase as well (Waseem *et al*., 2009). Gaber (2012) found that the main effect of NAA declared that augmenting the basal medium with it at 0.25 mg/l, brought about the highest shoot length.

However, its presence in the basal medium at 0.125 mg/l, led to the highest mean number of leaflets, nodes and roots formed per propagule. Also, El-Mahrouk *et al*. (2006) found that NAA promoted the shoot growth elongation which has more internodes and leaves of *Dieffenbachia sp*. regarding the mean number of roots formed /propagule, the presence of NAA at 0.75 mg/l or absence of BA brought about the highest rhizogenesis. This finding might be taken place due to the well-known role of auxin in inducing of root formation (George *et al*., 2008).

Furthermore, BA considers as antagonist for rhizogenesis and in favour of stimulates cell division, stimulates morphogenesis (shoot initiation/bud formation) in tissue culture and stimulates the growth of lateral buds-release of apical dominance. (Mauseth, 1991; Raven *el al*, 1992; Salisbury and Ross, 1992 and Davies, 1995). With respect to the combinations between both growths regulators (BA and NAA) led to significant effects on the studied traits**.**

4. Rhizogenesis

Results in Table (4) and plate (3) showed that the applied both auxin levels exerted significant effects on the studied characters of *Solidago canadensis*.

Table (4). Effect of different levels of IBA and NAA (mg/l) and their combinations on the rooting stage of *Solidago canadensis* cultured *in vitro* for 35 days.

Characters	NAA Level (mg/l)	IBA levels (mg/l)					Average (NAA)	Significance		
		0.00	0.50	1.00	1.50	2.00		IBA	NAA	IBA X NAA
(a) Mean number of shoots formed/propagule								**	**	**
	0.00	1	1.22	0.78	0.56	0.22	0.76			
	0.50	0.11	0.22	0.33	0.00	0.00	0.13			
	1.00	0.00	0.00	0.00	0.00	0.00	0.00			
	1.50	0.00	0.00	0.00	0.00	0.00	0.00			
	2.00	0.00	0.00	0.00	0.00	0.00	0.00			
Average (IBA)		0.22	0.29	0.22	0.11	0.04				
L.S.D. (0.05)								0.08	0.08	0.53
(b) Mean shoot length (cm)/propagule								**	**	**
	0.00	1.92	1.24	1.58	0.72	0.90	1.27			
	0.50	0.09	0.16	0.16	0.00	0.00	0.08			
	1.00	0.00	0.00	0.00	0.00	0.00	0.00			
	1.50	0.00	0.00	0.00	0.00	0.00	0.00			
	2.00	0.00	0.00	0.00	0.00	0.00	0.00			
Average (IBA)		0.40	0.28	0.35	0.14	0.18				
L.S.D. (0.05)								0.09	0.09	0.21
(c) Mean number of leaflets formed/propagule								**	**	**
	0.00	7.56	8.22	7.56	4.00	1.56	5.78			
	0.50	0.67	1.11	1.56	0.00	0.00	0.67			
	1.00	0.00	0.00	0.00	0.00	0.00	0.00			
	1.50	0.00	0.00	0.00	0.00	0.00	0.00			
	2.00	0.00	0.00	0.00	0.00	0.00	0.00			
Average (IBA)		1.64	1.87	1.82	0.80	0.31				
L.S.D. (0.05)								0.59	0.59	3.78
(d) Mean number of roots formed/propagule								**	**	**
	0.00	1.33	2.33	3.56	4.00	5.44	3.33			
	0.50	2.44	3.22	3.67	4.11	5.89	3.87			
	1.00	4.44	4.56	4.22	2.78	4.89	4.18			
	1.50	2.89	4.33	5.00	5.56	6.89	4.93			
	2.00	4.33	4.00	4.33	4.89	4.78	4.47			
Average (IBA)		3.09	3.69	4.16	4.27	5.58				
L.S.D. (0.05)								0.58	0.58	1.42

L.S.D. (0.05) = Least significant difference test at 0.05 level of probability.
**: highly significant

Plate (3). Rhizogenesis of *Solidago canadensis* microshoots of multiplication stage, upon culturing then on MS medium fortified with IBA and NAA at 1.5 and 2.00 mg/l, each in turn.

For IBA, the mean number of shoots at 0.50 mg/l, led to the highest mean values, and the main effect of NAA indicated that the absence of NAA recorded the highest mean value of the mean number of shoots.While, the interaction between IBA at 0.50 and NAA at nil (0.00) mg/l, resulted in the highest mean value of the studied trait. Concerning, the main effect of IBA tested levels on the mean number of shoot length; there was highly significant effects of the given trait at (nil) 0.00 mg/l. On the other side, the main effect of NAA at 0.00 mg/l recorded the highest mean value of shoot length. The interaction between IBA and NAA recorded no highly significant effects of the given trait at the absences of both IBA and NAA. Concerns of the number of leaflets formed per propagule, the effect of IBA, exerted highly significant effect on the given trait at 0.50 mg/l. In case of the main effect of NAA had highly significant effect on the given trait at 0.00 mg/l. The interaction between both BA and NAA at 0.50 and 0.00 mg/l, respectively, resulted in the highest mean values .

Regarding the number of root formed per propagule, results showed that there is a proportional relationship between IBA and the given trait the highest mean value was recorded at 2.00 mg/l (5.58). On the other side, the main effect of NAA indicated that supplying MS-basal medium with NAA at 1.50 mg/l recorded the highest mean value of the mean number of roots (4.93). The interaction between IBA at 2.00 mg/l and NAA at 1.50 mg/l, gave the highest mean value of the given trait (6.89).

The obtained results showed that the used auxins (NAA and IBA), in general, produced the best results in almost all studied traits, except number of leaflets formed/propagule. These results could be explained 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). However, the presence of auxins in the culture medium positively increased the mean shoot length of *Trigonella foenum-graecum* (Aasim *et al*., 2010). On the other end, the above-mentioned of auxin results indicated a marked superiority on root formation, whereas the highest concentration i.e. IBA at 2.0 mg/l, let to the highest number of roots formed /propagule. Moreover, IBA at the above-mentioned level confirmed its superiority over NAA. The reason for these differences in root inducing ability may be due to the slow and continuous release of IAA than IBA (Krieken *et al*., 1993 and Liu *et al*., 1998) and release of IBA through hydrolysis of conjugates (Epstein and Muller, 1993). These IBA conjugates were reported to be superior to free IBA in serving as an auxin source during later stages of rooting (Staswick *et al*., 2005). However, similar results regarding chrysanthemum were obtained by Karim *et al*. (2002) and Long *et al*. (2006). Also, Hoque *et al*. (1995) on *C. morifolium,* reported that maximum number of roots was obtained on MS media supplemented with IBA compare to NAA. Whereas, Long *et al*. (2006) stated that the highest number of roots were obtained when chrysanthemum microshoot cuttings were treated with IBA. Waseem (2008) reported that IBA showed its superiority over all other tested auxins (*viz*. NAA and IAA), when used alone. Litz and Jaiswal (1990) mentioned that IBA is considered as the most effective auxin for root induction. Our results 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) and Waseem *et al*. (2011) who suggested that IBA is the best auxin for root induction and development. Further confirmations, in this respect, were reported by Benelli *et al*., (2001) and Tanimoto (2005) who proved that IBA is the most effective auxin in olive rhizogenesis as compared to NAA. The inferior effect of NAA on the root number may be due to the reason that NAA is more persistent than IBA, remains present in the tissue and may block further development of root meristemoids (De Klerk *et al*., 1997 and Nanda *et al*., 2004).

Regarding to the interaction between both applied growth regulators between IBA at 0.50 mg/l and NAA at (nil) 0.00 mg/l, led to significant effects on the almost of vegetative growth. On the other hand, the interaction between IBA at 2.0 mg/l and NAA at 1.5 mg/l, led to good performance to enhance rhizogenesis.

5. Ex vitro and *in vivo* acclimatization of *Solidago canadensis*

Data presented in Table (5) exhibit that both applied 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 single node explants of *Solidago canadensis* grown *ex vitro* for four weeks and as shown in Figure (4).

Table (5). The effect of different potting mixtures of perlite and peatmoss (v/v) and their combination on the acclimatization of neoformed plantlets of *Solidago canadensis* after four weeks *ex vitro*.

Characters	Peatmoss levels	Perlite levels				Average Peatmoss	Significance		
		0	1	2	3		Peatmoss	Perlite	Peatmoss X Perlite
(a) Average survival percentage (%) / plant									
	0	0%	33%	11%	0%	11%	**	**	**
	1	33%	100%	33%	11%	44%			
	2	56%	100%	56%	44%	64%			
	3	100%	100%	56%	89%	86%			
Average Perlite		47%	83%	39%	36%				
L.S.D. (0.05)							0.11	0.11	0.23
(b) Average number of neoformed offshoots / plant									
	0	0.00	1.00	0.33	0.00	0.33	**	**	**
	1	2.00	3.89	1.33	0.33	1.89			
	2	2.33	5.22	2.89	1.78	3.06			
	3	4.89	5.00	2.22	1.78	3.47			
Average Perlite		2.31	3.78	1.69	0.97				
L.S.D. (0.05)							0.36	0.36	0.79
(C) Average plant height (cm) / plant									
	0	0.00	9.23	2.49	0.00	2.93	**	**	**
	1	10.70	11.92	11.40	2.81	9.21			
	2	14.19	11.41	13.13	11.70	12.61			
	3	13.07	14.57	13.43	13.48	13.64			
Average Perlite		9.49	11.78	10.11	7.00				
L.S.D. (0.05)							1.63	1.63	3.62
(d) Average number of neoformed leaves/plant									
	0	0.00	5.56	1.33	0.00	1.72	**	**	**
	1	11.22	12.89	8.67	1.78	8.64			
	2	10.78	14.22	11.33	9.89	11.56			
	3	13.33	14.22	8.67	12.89	12.28			
Average Perlite		8.83	11.72	7.50	6.14				
L.S.D. (0.05)							1.24	1.24	2.76

L.S.D. (0.05) = Least significant difference test at 0.05 level of probability.
****: highly significant.**

Plate (4). Acclimization of neoformed *Solidago canadensis* under combination of perlite and peatmoss at (1: 3 v/v)

Concerning the average of survival percentage/ plant, perlite had a highly significant effect on this trait. The highest mean value was recorded at level 1v/v (83%). Also, peatmoss had highly significant effect on the graven traits was recorded at level 3v/v (86%). Meanwhile, the interaction between peatmoss and perlite exerted highly significant effect. However, the combination of perlite and peatmoss at either 1:1or 1: 2 and 1:3, respectively, resulted in the highest mean value (100%). Respecting the average number of neoformed shoots / plant, perlite and peatmoss and their interactions, exerted significant effects on the given trait. In case of perlite the main effect at 1 v/v, brought about the highest mean value. On the other side, peatmoss had highly significant effect on number of neoformed shoots / plant at 3 v/v. However, the interaction between both added levels of perlite and peatmoss at 1:2 respectively, resulted in the highest mean values.

In this respect, a material substance 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 provides aeration (25%) and its neutral pH and the fact that it is sterile and weed–free. Hence, it is ideal for use as container growing substratum (Abido, 2016). Also, it is known that perlite decreases the bulk density of the soils and increases the porosity. Abd –Elrahman (2002) reported that the plantlets (5-6 cm) resulted from the previous *in vitro* culture of explants were transferred for four weeks into 0.2liter-capacity pots containing peatmoss with 0.2% Topsin- M70 fungicidal solution in therane-house; whereas, the culture pots were covered with transparent polyethylene bags. One week later, the polyethylene bags were repeatedly perforated with one hole for, four times at week intervals. After two weeks, the polyethylene bags were totally removed before transplanting out of door. At the end of acclimatization period (after four weeks), acclimatized plantlets were grown successfully and produced high survival percentage ranging from 97-99%. In addition, Li *et al.,* (2012) found that some of the plantlets were removed from rooting media, washed, and then transferred to pots containing a mixture of sterile soil, peat and vermiculite in a ratio of 1:1:1. Newly potted plantlets were covered with polythene bags for 1 week before transferring to a research greenhouse. Survival percentage was recorded four weeks after transplanting and acclimatized plants with 100% success. Also, Paul *et al.*, (2013) stated that *in vitro*-raised plantlets were hardened in polycups containing a mixture of sterile garden soil: sand (3:1), covered with polypropylene bags and irrigated with 10 X diluted MS liquid medium. The plants were kept in a culture room for 15 days then 63% of plants were successfully established in polycups. After 15 days the polycups hardened plants were transferred to pots and kept in greenhouse. However, 74% percent of plants were well established under greenhouse condition. After one month, the plants were transferred to the field. About 67% of plants were established in the field.In conclusion, this study established such techniques to propagate *solidago canadensis in vitro* and acclimatization *ex vitro* successfully.

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الملخص العربى

الاكثار المعملى الدقيق و الأقلمة خارج المعمل لنبات السوليداجو باستخدام القطع البرعمية الساقية

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يستخدم نبات السوليداجو وهى زهر نبات حولي ريزومي متعدد الأغراض كأزهار قطف تجارية وكذلك فى تنسيق الحدائق بالإضافة للعديد من الاغراض الطبية الهامة.أجريت هذه الدراسة في معمل زراعة الانسجة النباتية، قسم الانتاج النباتي، كلية الزراعة ساباباشا، جامعة الاسكندرية خلال الفترة من ٢٠١٢/٢٠١٥، لايجاد افضل مطهر

سطحى للأجزاء النباتية المستخدمة و كذلك البيئات المناسبة والفعالة لمراحل التنشئة، التضاعف والتجذير لنبات السوليداجو من خلال زراعة القطع البرعمية الساقيه، وذلك من خلال عمليه التطهير السطحى للأجزاء النباتية المستخدمة من خلال المعاملة بواسطة كلوريد الزئبيقك بتركيزات مختلفة (٠,٥، ١,٠، ١,٥ وكذلك ٢,٠ملجم/لتر) وإجراء مماثل للأجزاء النباتية بأربعة تركيزات مختلفة(٣٠، ٣٥، ٤٠ وكذلك ٤٥% v/v) من كلوركس (هيبو كلوريت الصوديم) .ففى مرحلة التنشئة تمت زراعة الأجزاء النباتية المعقمة على بيئة موراشيج وسكوج مدعمة بتركيزات مختلفة من السيتوكينين بنزيل أمينو بيورين (BA) مع توليفات مختلفة من الأوكسين حامض النفثالين اسيتك اسيد (NAA) وتم اخذ البيانات التالية خلال المراحل المختلفة (عدد النموات الخضرية – طول الافرع الخضرية – عدد الاوراق – عدد الجذور). اما خلال مرحلة التضاعف فتم تقسيم الافرع الخضرية الناتجة من مرحلة التنشئة الى عقدة واحدة تحمل برعم واحد وتمت زراعتها على بيئة موراشيج وسكوج مدعمة بتركيزات مختلفة من بنزيل أمينو بيورين مع توليفات مختلفة من الأوكسين حامض النفثالين اسيتك اسيد. اما بالنسبة لمرحلة التجذير فتم تقسيم الافرع الخضرية الناتجة من مرحلة التضاعف الى عقدة واحدة تحمل برعم واحد وتمت زراعتها على بيئة موراشيج وسكوج مدعمة بتركيزات مختلفة من اندول بيوتريك اسيد و حامض النفثالين اسيتك اسيد. وخلصت الدراسة إلى ان الجمع بين المعقمات كلوريد الزئبق والكلوركس بنسبة ١ ملجم /لتر و ٤٠% أدت إلى أعلى نسبة للبقاء على قيد الحياة اما بالنسبة لمرحلة التنشئة فكان التفاعل بين بنزيل أمينو بيورين(صفر و٠,٢٥ ملجم/لتر) و نفثالين استيك اسيد (صفر و ٠,٥٠ ملجم/لتر) ادى الى أعلى قيم متوسطة للصفات المدروسة. اما بالنسبة لمرحلة التضاعف فتم الحصول على افضل نتائج مع بنزيل أمينو بيورين (٠,٥٠ ملجم/لتر) ونفثالين استيك اسيد (٠,٥٠ ملجم/لتر).وبالنسبة لمرحلة التجذير فقد اظهرت النتائج ان استخدام حامض البيوتريك بتركيز(١,٥ ملجم/لتر) واستخدام حامض النفثالين بتركيز(٢,٠٠ ملجم/لتر) هى افضل التركيزات لمرحلة التجذير .وتمت اقلمة النباتات الناتجة من الزراعة المعملية خارج المعمل تحت ظروف الصوبة بنجاح بخلطة تربة وكانت افضل توليفة ١ :٣ حجم /حجم بيرليت: بيتموس مع حجم ثابت واحد من الرمل المغسول المعقم .

Effect of Paclobutrazol and Its Method of Application on The Growth of *Pentas lanceolata* Plants

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ABSTRACT: This study was carried out during the two successive seasons of 2013 and 2014 at Antoniades Research Branch, Horticulture Research Institute, A.R.C. Alexandria, Egypt . The experiment was carried out to investigate the effect of paclobutrazol (PBZ) at the concentrations of (30,60,90 and120 mg/L) and its application method (drench and spray) on the growth, flowering and chemical composition of *Pentas lanceolata,* L. plants .The results showed that all the treatments caused a positive effect on the reduction of the vegetative growth of pentas plants and the treatment of 120 mg/L PBZ caused the highest significant reduction on most studied characters of vegetative growth . While there was insignificant effect after PBZ application at all concentrations on the flowering characteristics. For roots dry weight, the chlorophyll content and total carbohydrate content there was a significant increase after the application of PBZ at different concentrations. Drench application of PBZ was more effective than foliar application of in reduction of the most studied vegetative growth characters and increasing roots dry weight, the chlorophyll content and total carbohydrate content.
Key wards: *Pentas lanceolata* L.,paclobutrazol ,soil Dench, foliar spray

INTRODUCTION

Growth retardants are commonly used in floriculture for height control and increasing the number of lateral shoots or suppressing the growth of shoots developing beneath the flower, resulting in a larger number of inflorescences (Whealy *et al*., 1988, Keever and Foster 1989).

Plant growers use chemical growth retardants to produce quality plants that can be held in greenhouse if needed, shipped properly, look appealing in the stores and grow out well for the end consumers (Sanchita, 2015).

Paclobutrazol is a plant growth regulator which inhibits the gibberellin biosynthesis or action. It is very effective for dwarfing a wide range of crops including tulips (Lever *et al.*, 1982, Menhenett and Hanks 1982). It is used primarily for reducing the extension of shoot growth, to increase the root growth, produce uniform compact plants, with enhancement of foliage colour and flowering in certain species. The response of plants to paclobutrazol applications differs depending on the time of application, method of application, concentration and plant species (Tsegaw *et al.,* 2005). It is used on ornamental plants grown in containers in nurseries, green houses, shade houses and interior scape in the crops like azaleas, hibiscus, poinsettias, chrysanthemum, and roses. It is mostly applied in the form of drench or spray (Sanchita, 2015).

Pentas lanceolata L. is a common plant, originating from tropical East Africa to Arabia. The most widely used names are “Egyptian Star Cluster” or “Pentas”. As a decorative plant, it has been spread all over the tropics and subtropics. The flowers can be white, pink, purple, or red. This species belongs to the family Rubiaceae (Mongrand *et al*., 2005).

The aim of this work was to study the effect of paclobutrazol and its application methods on vegetative growth, flowering and chemical composition of *Pentas lanceolata*.L.

MATERIALS AND METHODS

The present investigation was carried out during the two successive seasons of 2013 and 2014 at Antoniades Research Branch, Horticulture Research Institute, A.R.C., Alexandria.

Stem cuttings of *Pentas lanceolata* (semi-hard wood cuttings) with an average length of 15-17 cm were planted in plastic pots of 10 cm diameter using a mixture of sand and clay soils at ratio of (1:1 by volume) on 15th March 2013 and 1st April 2014 in the two seasons respectively. After six weeks, each rooted cutting was transplanted in 20 cm clay pots containing peat moss, clay and sand (1:1:1 v/v). The plants were pinched to the height of 20 cm. and two lateral shoots were left on each plant, while all other shoots or breaks were removed.

Five foliar treatments of paclobutrazol (PBZ) at concentrations of 0, 30, 60, 90 and 120 mg/L were applied till run off point at 20ml of PBZ per plant. The top of the pot was covered with plastic to keep the medium out of growth retardant contact, all treatments were applied using a hand sprayer.

Five drench treatment of PBZ at the same concentrations were also applied 7 days after of final transplanting. No water was applied for two days before the drenching. Each experimental unit received 90 ml of PBZ solutions. The control plants were sprayed or drenched with water only.

The requirement of plants for fertilization was covered by the addition of NPK chemical fertilization 19-19-19 at the rate of 2.5 g/pot. Each fertilization dose was repeated at 21 days intervals.

The layout of the experiment was randomized complete block design in a factorial experiment, containing three replicates. The experiment contained 10 different treatments (5 PBZ X 2 methods).

Three pots were used as an experimental unit for each treatment in each replicate. The data were subjected to statistical analysis of variance and the means were compared using the "least significant difference (L.S.D)" test at the 5% level of probability according to (Snedecor and Cochran, 1989).

The following data were recorded; the vegetative growth parameters including plant height (cm), stem diameter (cm), number of branches /plant , number of leaves/ plant, leaves dry weight (g), stem dry weight (g) and leaf area (cm^2) , roots dry weight (g), The flowering characteristics, included the time taken to showing color stage from planting date (day), flowers longevity (days) as a day from the showing color stage to fading and roots dry weight (g) , Chemical analysis of fresh leaf samples at showing coloring stage was conducted to determine their leaves total content of chlorophyll (a and b) (mg/g fresh weight) as described by Moran (1982) . Also, total carbohydrate content in dried leaf samples was determined according to Dubios *et al.*(1956) in the second season.

RESULTS

Vegetative growth characteristics

1. Plant height (cm)

Data in Table (1) showed that raising the PBZ concentration caused a significant reduction in plant height .The highest significant reduction was obtained from the concentration of 120 mg/L PBZ which gave (43.85 and 42.79 cm) in the first and second seasons, respectively. Table (1) also clarified that drench application of PBZ was more effective in plant height reduction. As for the effect of the combinations of PBZ and application method the highest significant decrease in plant height was obtained from the drench application of 120 mg/L PBZ (24.09 % and 30.77%) in the first and second seasons respectively.

2. Stem diameter (cm)

The data recorded in Table (1) showed that stem diameter of treated plants with different concentrations of PBZ decreased significantly. The thinnest stem was obtained from the treatments (90and 120 mg/L) in the two seasons. Table (1) also clarified that there was insignificant difference between the two PBZ application methods. Concerning the interaction effect between PBZ concentration and application method the drench application of 120 mg/ L PBZ caused the thinnest stem which recorded (0.42 cm) in both seasons.

3. Number of branches per plant

Results presented in Table (1) showed that there was significant difference between the concentrations of PBZ. The treatment 60 mg/L caused the highest significant increase in the number of branches per plant (13.70 and 14.00) ,while the treatment 120 mg/L PBZ caused the lowest significant number of branches (11.37 and 10.67) in the first and second seasons, respectively . With respect to the effect of application method, the table showed that soil drench caused a significant decrease in the number of branches per plant in the first season, while in the second one there was insignificant difference between the two application methods. Concerning the interaction effect between application method and PBZ concentrations, the lowest significant number of branches was recorded after the treatment 90 and 120 mg/L soil drench (8.56 and 9.17) in the first season and the treatment 90 mg/L soil drench (8.39) in the second one.

Table (1). Average of plant height (cm), stem diameter (cm) and number of branches /plant of *Pentas lanceolata* plants as influenced by paclobutrazol concentrations (C) , Method of application (M) and their interaction in the two seasons of 2013 and 2014.

Treatments		Plant height (cm)		Stem diameter (cm)		Number of branches / plant	
Method of application	Concentration (mg/L)	2013	2014	2013	2014	2013	2014
Drench	0	51.15	52.72	0.65	0.64	12.00	11.50
	30	46.93	48.04	0.60	0.59	13.20	12.67
	60	45.33	45.89	0.60	0.61	14.50	14.67
	90	42.34	44.44	0.50	0.48	8.56	8.39
	120	38.83	36.50	0.42	0.42	9.17	8.67
Average of drench method		**44.92**	**45.52**	**0.55**	**0.55**	**11.48**	**11.18**
Spray	0	52.83	55.28	0.64	0.56	11.56	12.00
	30	49.83	53.11	0.56	0.55	11.72	12.33
	60	50.77	51.56	0.54	0.54	12.89	13.33
	90	48.38	50.89	0.45	0.48	16.44	15.00
	120	48.86	49.07	0.52	0.54	13.56	12.67
Average of spray method		**50.14**	**51.98**	**0.54**	**0.53**	**13.23**	**13.07**
Average of application methods	0	51.99	54.00	0.65	0.60	11.78	11.75
	30	48.38	50.58	0.58	0.57	12.46	12.50
	60	48.05	48.39	0.57	0.58	13.70	14.00
	90	45.36	47.67	0.48	0.48	12.50	11.70
	120	43.85	42.79	0.51	0.48	11.37	10.67
L.S.D. at 0.05	Method of application (M)	0.95	0.97	N.S	N.S.	0.95	N.S.
	Concentration (C)	1.50	1.53	0.053	0.047	1.51	0.05
	M × C	2.13	2.17	0.074	0.067	2.14	0.07

4. Number of leaves per plant

Data in Table (2) showed that the highest significant decrease in leaves per plant was obtained from the concentration 120 mg/L which gave (134.75 and 132.72) in the first and second seasons respectively. The table also clarified that foliar spray application of PBZ caused a significant decrease in number of leaves per plant. For the interaction effect of application method and PBZ concentration the treatment 120 mg/ L PBZ as drench or foliar spray caused the lowest significant number of leaves per plant (136.5 and 133.11) and (133.00 and 132.33) in the first and second seasons respectively.

5. Leaves dry weight (g)

It is clear from Table (2) that the treatments 90 and 120 mg/L PBZ resulted in the highest significant decrease in leaves dry weight which recorded (7.20 ,6.43 and 6.46 ,6.24 g) in the first and second seasons respectively. The table showed that drench application of PBZ was more effective in reduction of leaves dry weight. For the effect of different combination of application method and PBZ concentration the drench application of 90 and 120 mg/L PBZ resulted in significant decrease of leaves dry weight which were (28.67 % , 23.58%) and (27.04% , 24.61 %) less than the control in the first and second seasons respectively .

6. Stem dry weight (g)

Table (2) showed that the treatment 30 mg/L PBZ resulted in the highest significant decrease in stem dry weight which recorded (10.72 and 8.37 g) for dry weight in the first and second seasons respectively. The table also cleared that foliar spray application of PBZ was more effective in reduction of stem dry weight. For the effect of different combination of application method and PBZ concentration the lightest stem dry weight (8.90 and 6.12 g) in the first and second seasons respectively were obtained from foliar spray of 30 mg/L PBZ.

Table (2). Average of number of leaves /plant, leaves dry weight (g) and stem dry weight (g) of *Pentas lanceolata* plants as influenced by Paclobutrazol concentrations (C) , Method of application (M) and their interaction in the two seasons of 2013 and 2014.

Treatments		Number of leaves/ plant		Leaves dry weight (g)		Stem dry weight (g)	
Method of application	Concentration (mg/L)	2013	2014	2013	2014	2013	2014
Drench	0	181.00	174.00	9.95	8.32	12.35	10.40
	30	184.10	181.17	8.32	7.51	12.53	10.62
	60	199.60	194.11	8.18	6.64	17.30	12.39
	90	163.20	151.00	5.39	5.36	14.53	11.29
	120	136.50	133.11	4.58	4.97	13.06	10.41
Average of drench method		**173.00**	**167.00**	**7.28**	**6.56**	**13.96**	**11.02**
Spray	0	180.30	172.33	10.19	8.29	12.64	10.49
	30	171.00	162.83	9.10	8.14	8.90	6.12
	60	152.30	150.15	9.06	7.90	9.28	6.19
	90	144.70	142.33	9.01	7.55	9.83	7.54
	120	133.00	132.33	8.28	7.51	9.89	8.56
Average of spray method		**156.00**	**152.00**	**9.13**	**7.88**	**10.11**	**7.78**
Average of application methods	0	180.65	173.17	10.07	8.31	12.50	10.45
	30	177.55	172.00	8.71	7.83	10.72	8.37
	60	175.95	172.13	8.62	7.27	13.29	9.29
	90	153.95	146.67	7.20	6.46	12.18	9.42
	120	134.75	132.72	6.43	6.24	11.48	9.49
L.S.D. at 0.05	Method of application (M)	**2.78**	**1.74**	**0.58**	**0.31**	**0.51**	**0.44**
	Concentration (C)	**4.39**	**2.75**	**0.91**	**0.48**	**0.81**	**0.69**
	M × C	**6.21**	**3.89**	**1.29**	**0.68**	**1.14**	**0.98**

7. Leaf area /plant (cm^2)

Table (3) showed that the treatments 90 and 120 mg/L PBZ (1812.46 and 1920.40 cm^2) in the first season and the treatment 120 mg/L (1662.06 cm^2) in the second season caused the highest significant reduction in leaf area. The soil drench of PBZ was more effective in reduction of leaf area. Concerning the interaction between the application method and PBZ concentrations the Table cleared that the treatment 120 mg/L as a soil drench caused the least leaf area which recorded (1264.42 and 1226.65 cm^2) in the first and second seasons respectively.

Root characteristics

1. Roots dry weight

Table (3) cleared that raising the PBZ concentrations caused a significant increase in roots dry weight .The highest significant root dry weight was obtained from the concentrations of 90 and 120 mg/L PBZ which gave (10.58 and 10.68 g) in the first season and (8.90 and 9.53g) in the second one . The table also cleared that drench application of PBZ was more effective in increasing roots dry weight. Concerning the effect of the different combination of application method and PBZ concentration the table showed that the drench application of PBZ at 90 and 120 mg/L led to a significant increase of root dry weight which were (95.02% and 92.46 %) in the first season and (61.97 % and 73.62%) in the second one .

Flowering characteristics

Concerning the flowering date (days) and flowers longevity (days), Table (4) showed that there were insignificant difference between treatments.

Table (3). Average of leaf area (cm^2) and roots dry weight (g) of *Pentas lanceolata* plants as influenced by paclobutrazol concentrations (C), Method of application (M) and their interaction in the two seasons of 2013 and 2014.

Treatments		Leaf area (cm^2)		Roots dry weight (g)	
Method of application	Concentration (mg/L)	2013	2014	2013	2014
Drench	0	2769.72	2648.58	6.23	6.18
	30	1480.83	1960.67	8.61	7.91
	60	1562.69	1862.06	10.73	8.62
	90	1312.95	1792.52	12.15	10.01
	120	1264.42	1226.65	11.99	10.73
Average of drench method		**1678.12**	**1898.10**	**9.94**	**8.69**
Spray	0	2693.54	2617.08	6.71	6.09
	30	2482.26	2432.64	8.00	7.40
	60	2604.74	2054.34	8.16	7.43
	90	2311.96	2188.21	9.01	7.78
	120	2576.37	2097.47	9.36	8.33
Average of spray method		**2533.77**	**2277.95**	**8.25**	**7.41**
Average of application methods	0	2731.63	2632.83	6.47	6.14
	30	1981.55	2196.66	8.31	7.66
	60	2083.72	1958.20	9.45	8.03
	90	1812.46	1990.37	10.58	8.90
	120	1920.40	1662.06	10.68	9.53
L.S.D. at 0.05	Method of application (M)	**133.15**	**131.16**	**0.49**	**0.41**
	Concentration (C)	**210.53**	**207.39**	**0.77**	**0.65**
	M × C	**297.74**	**293.29**	**1.09**	**0.92**

Table (4). Average of flowering date (days) and flowers longevity (days) of *Pentas lanceolata* plants as influenced by paclobutrazol concentrations (C), Method of application (M) and their interaction in the two seasons of 2013 and 2014.

Treatments		flowering date (days)		flowers longevity (days)	
Method of application	Concentration (mg/L)	2013	2014	2013	2014
Drench	0	274.22	284.89	36.13	32.11
	30	275.34	299.1	35.63	24.89
	60	276.2	297.89	41.77	29.45
	90	281.33	293.67	34.67	32.00
	120	281.11	291.67	33.90	36.67
Average of drench method		**277.64**	**293.45**	**36.42**	**31.02**
Spray	0	272.89	285.22	38.11	31.44
	30	275.00	293.00	39.03	26.67
	60	277.11	294.11	43.20	29.89
	90	277.78	300.89	39.57	27.11
	120	280.78	300.44	37.20	25.56
Average of spray method		**276.71**	**294.73**	**39.42**	**28.13**
Average of application methods	0	273.56	285.06	37.12	31.78
	30	275.17	296.06	37.33	25.78
	60	276.67	296.00	42.49	29.67
	90	279.56	297.28	37.12	29.56
	120	280.95	296.06	35.55	31.12
L.S.D. at 0.05	Method of application (M)	N.S	N.S	N.S	N.S
	Concentration (C)	N.S	N.S	N.S	N.S
	M × C	N.S	N.S	N.S	N.S

Chemical composition

1. Total chlorophyll content (mg/g fresh weight)

Data represented in Table (5)cleared that there was a significant increase after the application of different PBZ concentrations, the treatments 60,90 and 120 mg/L resulted in the highest increase in total chlorophyll content (32.19 , 32.51 and 33.05 mg/g) in the first season and in the second one the treatment 90 mg/L caused the highest increase in total chlorophyll (35.24 mg/g).Drench application of PBZ was more effective in increasing the total chlorophyll content in both seasons . Concerning the effect of the interaction between the application method and PBZ concentration Table (6) showed that the highest chlorophyll content (83.58 mg/g) was obtained after the soil drench of 120 mg/L PBZ in the first season and soil drench of 90 mg/L PBZ in the second one (40.01 mg/g) .

2. Total carbohydrate content (mg/g dry weight of leaves)

Data in Table (5) showed that the highest significant increase in total carbohydrate content was obtained after the treatment 90 mg/L PBZ which recorded (16.94 mg/g) in the second season. Concerning the application method soil drench of PBZ was more effective in increasing total carbohydrate content. For the effect of different combination of application method and PBZ concentration Table (6) showed that were insignificant different between treatments.

Leaves distortions

Figure (1) illustrated that there was some leaves distortion after the treatment of 120 mg/L PBZ in both foliar spray and soil drench application method.

Table (5). Average of total Chlorophyll (mg/g fresh weight) in the two seasons of 2013 and 2014 and total Carbohydrate (mg/g dry weight of leaves) in the season of 2014 of *Pentas lanceolata* plants as influenced by paclobutrazol concentrations (C) , Method of application (M) and their interaction in the two seasons of 2013 and 2014.

Treatments		Total Chlorophyll (mg/g fresh weight)		Total Carbohydrate (mg/g dry weight of leaves)
Method of application	**Concentration (mg/L)**	**2013**	**2014**	**2014**
Drench	**0**	24.57	26.65	15.35
	30	27.50	29.28	16.02
	60	35.62	33.00	16.17
	90	34.49	40.01	17.81
	120	38.58	34.39	16.03
Average of drench method		**32.15**	**32.67**	**16.28**
Spray	**0**	24.54	25.92	14.43
	30	25.09	28.78	16.13
	60	28.75	30.16	16.23
	90	30.52	30.47	16.07
	120	27.52	28.89	15.63
Average of spray method		**27.28**	**28.84**	**15.70**
Average of application methods	**0**	24.56	26.29	14.89
	30	26.30	29.03	16.08
	60	32.19	31.58	16.20
	90	32.51	35.24	16.94
	120	33.05	31.64	15.83
L.S.D. at 0.05	**Method of application (M)**	**0.80**	**0.87**	**0.92**
	Concentration (C)	**1.27**	**1.38**	**1.46**
	M × C	**1.79**	**1.95**	**N.S**

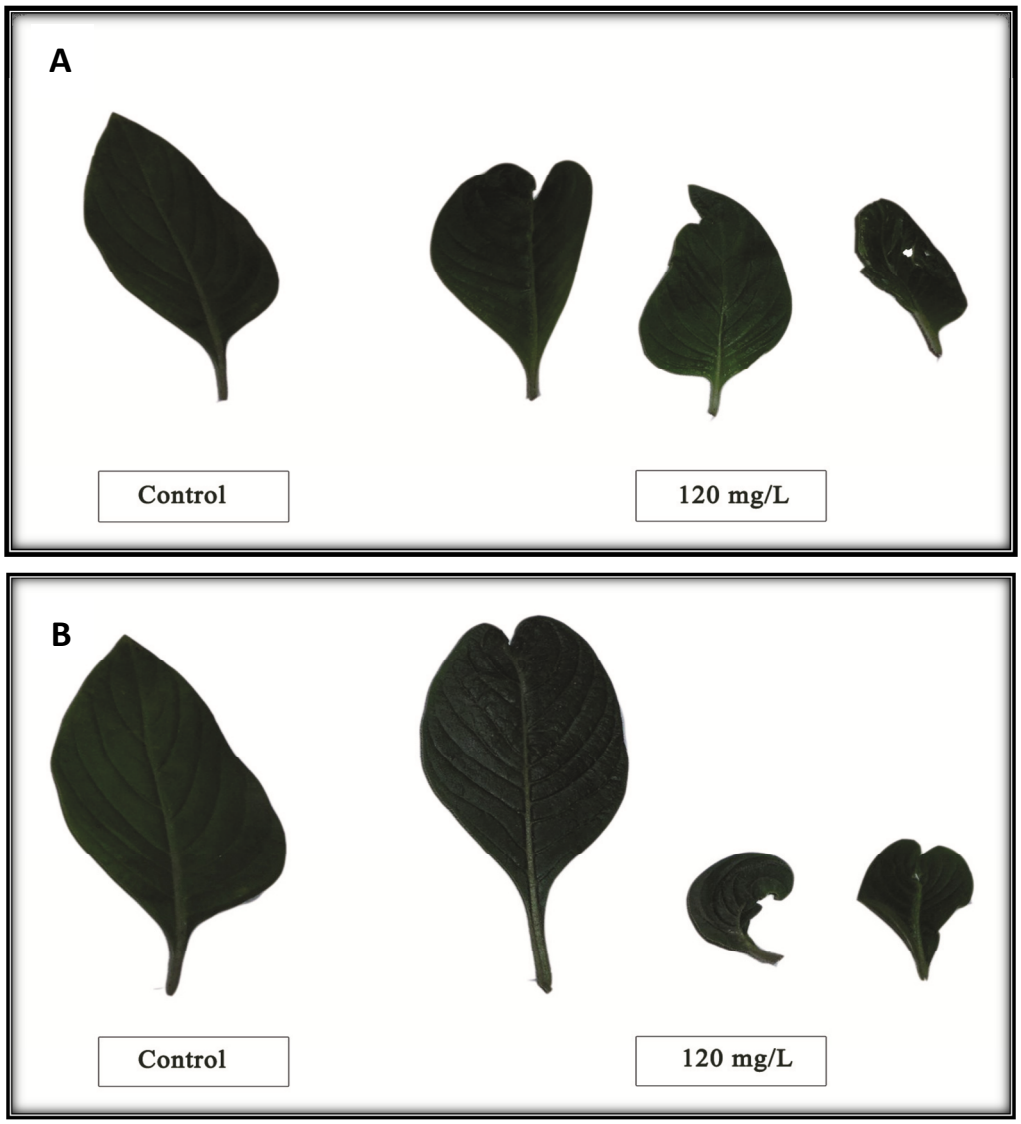

Figure (1). Leaves distortion after the treatment of 120 mg/L PBZ (A- drench application) and (B- foliar spray)

DISCUSSION

The present study showed that the high dose of PBZ caused a significant reduction in most studied vegetative growth parameters. This reduction may be due to fact that paclobutrazol inhibits gibberellins (GAs) biosynthesis in plant **(**Rademacher, 2000 and Sponsel, 1995) and hence, reduces cell elongation and retards the plant growth. The reduction in vegetative growth parameters is in agreement with the results obtained by Lenzi *et al.* (2015) who found that PBZ treatments caused a significant reduction of plant height of four cultivars of *Dianthus barbatus* x chinesis. Also, Ahmad (2012) mentioned that PBZ treatments reduced plant height and leaf area of *Hibiscus rosa-sinensis* plants and Adam and Bożena (2005) on rhododendron and azalea shoot length.

There was a significant increase in roots dry weight after the treatment of paclobutrazol. This increase may be explained on the rationale that its antagonize of GA biosynthesis or activity (GA is normally inhibitory to rooting) , (Davis and Sankhla, 1989) or an indirect effect resulting from shoot growth modification and a shift in carbohydrate allocation to the roots (Chaney, 2005) . This result is in harmony with those obtained by Chaturvedi, *et al*. (2009) on *Saussurea costus.*

Concerning the flowering parameters, the study showed that all the treatments caused insignificant difference compared to control .These results are in agreement with those obtained by Lenzi *et al.* (2015) on four cultivars of Dianthus *barbatus* x chinesis .

The increase in chlorophyll content by PBZ treatment could be explained on the basis of two facts: first, that the leaves of both treated and untreated plants may contain the same number of cells, but because the cells in treated ones are generally smaller, the chlorophyll is more concentrated inside the reduced cell volume. Second, there is also evidence that the amount of chlorophyll is actually increased due to increase in phytyl (an essential part of chlorophyll molecule), which is synthesized via the same terpenoid pathway as gibberellins **(**Dalziel and Lawrence, 1984). The obtained results are in agreement with those obtained by Lenzi *et al.* (2015) who mentioned that PBZ treatments enhanced leaf colour of four cultivars of Dianthus *barbatus* x chinesis. And Ahmad (2012) who found that PBZ treatments increased chlorophyll content of *Hibiscus rosa-sinensis .*

The increase in carbohydrate content after the PBZ treatments may be due to the increase in chlorophyll content which leads to a consequent increase in total carbohydrates. This result is in harmony with Azza *et al.* (2014) on *Schefflera arboricola* plants.

There was some leaf deformation after the treatment of 120 mg/L PBZ in both foliar spray or soil drench application method, this leaf deformation can be credited to the inhibitory impact of triazoles on gibberellin biosynthesis, which may cause harm or splitting of leaf primordia , unpredictable cell division or cell extension Mona (2001). These results are in agreement with those obtained by Matsoukis *et al*. (2001) who noticed some leaf distortion on *Lantana camara* plants treated with high concentrations of paclobutrazol and Joustra (1989) who found that paclobutrazol concentrations above approximately 125-250 mg/ L can cause leaf deformation on some rhododendron cultivars.

The difference in the suppression of growth with the method of application may be due to the difference in uptake of paclobutrazol by either the root or foliage and also the ability of the plant growth regulator to translocate in xylem and phloem (Keever *et al.,* 1990). The primary translocation of paclobutrazol occurs through the xylem. Drench application of paclobutrazol was more effective maybe because of the rapid uptake of the plant growth regulator by the roots as the translocation occurs through the xylem quickly reducing the activity of gibberellic acid resulting in reduced stem length. Roots

have fewer barriers that prevent entry of plant growth regulators. Foliar applied plant growth regulators first accumulate in the leaves and moves to the phloem and translocate into the xylem and takes more time before they become effective (Barrett and Bartuska, 1982). These results are in harmony with those obtained by Cramer and Brigden (1998) on *Mussaenda erythrophylla* potted plants

Conclusion

In conclusion, *Pentas lanceolata* can be used as a flowering pot plant since its height can be controlled by PBZ treatment. Paclobutrazol was applied as soil drench is considered more effective than foliar spray in reducing height. While the 120 mg/L of PBZ was more effective in producing short plants, it caused some leaf deformations. The treatment 90 mg/L was more effective in producing short and compact plants with no side effects on the plant appearance (Figure 2).

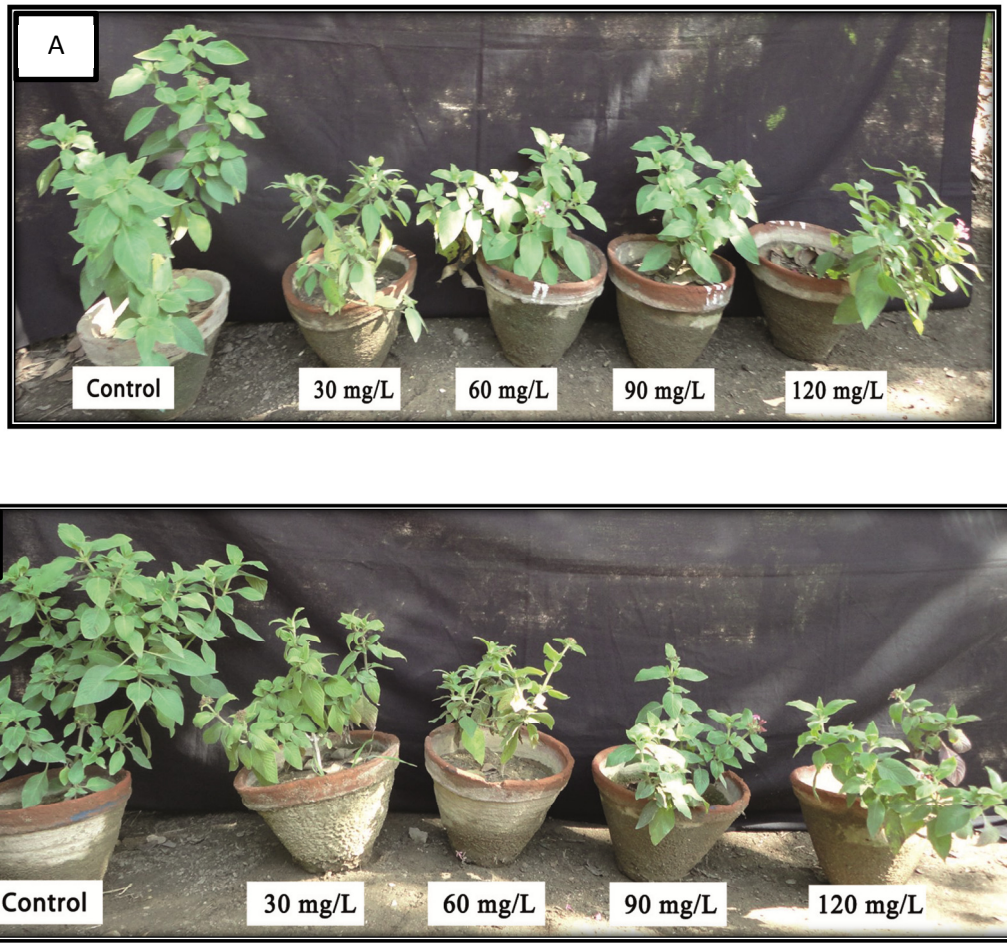

Figure (2). Effect of different paclobutrazol concentrations on the growth of *Pentas lanceolata* plants (A-drench application) and (B-foliar spray).

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الملخص العربي

تأثير الباكلوبيوترازول وطريقة اضافته على نباتات البنتس

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فرع بحوث نباتات الزينة بأنطونيادس – الإسكندرية – معهد بحوث البساتين – مركز البحوث الزراعية

أجريت هذه الدراسة خلال الموسمين الزراعيين ٢٠١٣ و ٢٠١٤ بفرع بحوث الزينة وتنسيق الحدائق بحديقة انطونيادس التابع لمعهد بحوث البساتين– مركز البحوث الزراعية – وزارة الزراعة– الاسكندرية– مصر. وذلك لدراسة تاثير استخدام الباكلوبيوترازول بتركيزات (٣٠ ، ٦٠ ، ٩٠ و١٢٠ ملجم / لتر) وطريقة إضافتها (رشا على الأوراق أو إضافة إلى التربة) على النمو الخضري والزهري والمحتوى الكيماوي لنبات البنتس . وأوضحت النتائج أن جميع المعاملات أدت إلى نقص في النمو الخضري لنبات البنتس وأن المعاملة ١٢٠ ملجم / لتر أدت إلى اكبر نقص معنوي في معظم صفات النمو الخضري المدروسة بينما كان تأثير جميع معاملات

الباكلوبيوترازول غير معنوي على الصفات الزهرية المدروسة أما بالنسبة للوزن الجاف للجذور ومحتوى النبات من الكلورفيل والكربوهيدارت الكلية اظهرت النتائج أن جميع المعاملات أدت إلى زيادة معنوية . اما بالنسبة لطريقة الإضافة اتضح ان الإضافة عن طريق التربة كان اكثر كفاءة من الرش على الأوراق في تقليل النمو الخضري وزيادة وزن الجذور ومحتوى النبات من الكلورفيل والكربوهيدارت.

الكلمات الكاشفة : نبات البنتس – الباكلوبيوترازول – الإضافة للتربة – الإضافة بالرش على الأوراق

Effect of Organic Manure and Sulfur Application on Maize (*Zea mays* L.)

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ABSTRACT: A field experiment was performed in Gemmiza Agricultural Research Station in 2013 and 2014 seasons and Nubaria Agricultural Research Stations in 2014 season to study the effect of manure and sulfur applications on maize grain yield and other traits. The results showed that the differences due to manure application significantly affected grain yield, plant height and kernels weight. The effect of manure application significantly increased grain yield, where both 10 and 20 m^3 of manure treatments gave the highest grain yield at Gemmiza in 2013 season (30.2, 30.5 ardab/fed.), and Nubaria in 2014 season, (31.1 and 33.3 ardab/fed), respectively. Manure application significantly affected on kernels weight, where 20 m^3 manure treatment gave the highest value of 100-kernel weight (39.7 g) followed by 10 m3 manure (37.1 g) at Gemmiza in 2013 season. It was noticed that 20 m^3 manure treatment gave the highest value of ear length. The application of 10 and 20 m^3 manure gave significantly the tallest plants. Significant differences were detected among sulfur application for grain yield. Sulfur application of 200 kg/fed gave more significant means of grain yield. Mean grain yield at Gemmiza in 2013 season for 200 kg/fed sulfur was 32.2 ard/fed compared with 28.5 ard/fad for 100 kg/fed sulfur treatment. At 2014 season, 200 kg/fed sulfur treatment gave 26.2 and 33.6 ard/fed at Gemmiza and Nubaria, respectively. Sulfur application of 200 kg/fed increase ear length with values of 22.2 cm compared with 21.2 and 21.7 cm for the other treatments (100 kg/fed and non sulfur) at Nubaria in 2014 season. Treatment of 200 kg sulfur had the tallest plants in 2014 season with values of 225.0 and 220.2 cm at Gemmiza and Nubaria, respectively. Manure-by-sulfur interaction significantly affected 100-kernel weight at Gemmiza location in 2013 and 2014 seasons, ear length and ear height at Nubaria location in 2014 season. Generally, manure and sulfur application increased 100-kernel weight at 2013 and 2014 seasons. Also, 20 m^3 manure with 200 kg sulfur treatment gave significantly the highest value of ear length at Nubaria region in 2014 season (22.7 g).

Keywords: Zea mays, Maize, Organic manure, Sulphur, Nubaria, Gemmiza.

INTRODUCTION

Continuous use of fertilizers creates potential polluting effect in the environment (Oad *et al.*, 2004). Synthesis of chemical fertilizers consumes a large amount of energy and money. However, an organic farming seems to be possible solution for these situations (Prabu *et al.*, 2003). Farming practices which involve heavy application of chemical fertilizers may cause depletion of certain nutrients in soil and certain others would generally accumulate in excess resulting in nutrient imbalance which affects the soil productivity. Some of these problems can be tackled by using bio-fertilizers, which are natural, beneficial and ecologically friendly. In agricultural production, organic manure and bio-fertilizer play an important role to possess many desirable soil properties and exerts beneficial effect on the soil physical, chemical and biological characteristics. Manure can substitute for inorganic N fertilizer and can mitigate potential soil deterioration under irrigated corn (*Zea mays* L.), (Ardell *et al.*, 2015). Fresh manure decreased corn emergence by 9.5% compared with the unamended, non fertilized control treatment. Applied manure increased maize grain yield and biomass at tasseling. The application of organic matter as a strategy to boost maize production can be increased up to 140% relative to treatments without organic matter application (Bernard *et al.,* 2016). These

relatively low responses to the application of organic matter are related to the low nitrogen recovery by a following crop. The combined application of organic matter and fertilizer can easily lead to 200 to 400% increases in maize grain yield relative to an unamended control and give absolute yield increases easily exceeding 2000 kg grain ha^{-1}.

The importance of sulfur in a fertilizer program for corn has been the focus of diverse research projects conducted over several years at various locations. Sulfur availability indicators are necessary for rational use of sulfur fertilizers (Agustin and Echeverria, 2011).Broadcast application of sulfur in a band near the seed at planting has proven to be satisfactory in most production situations (George and Clapp, 2008). Sulfur application significantly increased grain yield, total biomass, sulfur concentration and nitrogen concentration in total biomass. Sulfur deficiency symptoms are more often observed in crops at early stages of growth since sulfur can be easily leached from the surface soil (Kiyoko, *et al.,* 2005). Significant response to sulfur was shown by maize in all experiments. A response curve for sulfur showed that 5 to 10 kg/ha of Sulfur was optimal, with mean yield response ranging from 90 to 142 kg grain/kg sulfur (Ray and Mughogho, 2000). Sulfur application significantly increased grain yield of maize, and also increased total biomass (Agustin and Echeverria, 2011).

This study is carried out to determine the effect of manure and sulphur application on maize grain yield and other traits at two different environments.

MATERIALS AND METHODS

A field experiment was performed in Gemmiza Agricultural Research Station in 2013 and 2014 seasons and Nubaria Agricultural Research Station in 2014 season to study the effect of organic manure and sulfur applications on maize grain yield and other traits. Organic manure treatments were 10 and 20 m^3/faddan, while the rates of sulfur were 200 and 400 kg/faddan, in addition to treatment of zero application (control). Manure and sulfur were applied during soil preparation for cultivation at the plowed layer before planting. Maize variety SC.167 was used at this study. Soil samples were collected before planting and analyzed for some physical and chemical properties (Table 1). Also, samples of organic manure were analyzed according to Black (1982) and the most important characteristics are shown in Table (2). Farmyard organic manure was produced at Nubaria and used at both locations. The experimental design was split-plot with four replications. Manure treatments were randomly assigned to the main-plots, while sulfur treatments were randomly assigned to the sub-plots. Sowing date was in the first of June at both locations. Plot size was four rows, 6 m long and 80 cm apart and hills were spaced 20 cm along the row. Data were collected for number of days to mid-silking (silking date), plant and ear heights (cm), ear length (cm), 100-kernels weight (g) and grain yield (ardab/faddan). Ears per plot were weighed and about five kg/plot were taken for moisture percent determination. Grain yield was expressed as ardab/faddan (ard/fad^{-1}) at 15.5% moisture content. The obtained data were statistically analyzed according to Steel and Torrie (1980), using SAS software (1997).

Table (1). Physical and chemical analysis of the field experiment at Gemmiza and Nubaria, during 2014 season.

Variables	Nubaria	Gemmiza
Clay %	22.00	45.8
Silt %	28.50	21.5
Sand %	49.50	35.1
Texture	Sand clay loam	Clay
pH	8.2	8.3
Available N (mg/kg)	33.8	41.1
Available K (mg/kg)	119	198.5
Available P (mg/kg)	4.97	15.5

Table (2). Physical and chemical analysis of organic manure used in this study at Gemmiza and Nubaria.

Character		Value
Bulk density	kg/m^3	736
Moisture content	%	9.6
pH		7.4
EC (1:10 water extract)	dS/m	2.75
Organic matter	%	73.78
Organic carbon	%	43.40
C/N ratio	%	19.91
Total N	%	2.18
Total P	%	0.47
Total K	%	1.24
Available N	(mg/kg)	223
Available P	(mg/kg)	259
Available K	(mg/kg)	860

RESULTS AND DISCUSSION

1. Manure effects

The results in Table (3) showed that the application of manure fertilizer treatments were significantly affected the grain yield and plant height during 2013 and 2014 seasons at Gemmiza and Nubaria region at 2014. Significant differences were observed for ear height and kernels weight at Gemmiza 2013 season, as well as ear length and ear height at Nubaria 2014 season. Application of manure fertilizer increased plant height and grain yield. The positive effect of manure on plant growth might be attributed to its role in improving soil structure through aggregate formation, hydraulic properties and also through providing plants with some of their needs from macro and micro-elements. These results are in agreements with those obtained by Abou El-Maged *et al.,* (2008), Abd El-Wahed, (2009), Ahmed *et al*., (2011) and El-Mekser *et al*., (2014).The results in Table (4) showed that the manure application significantly increased grain yield, where both 10 and 20 m3 of manure treatments gave the highest mean grain yield at Gemmiza in 2013 season and Nubaria in 2014 season compared with non application of manure

(30.2, 30.5, 31.1 and 33.3 ard/fad, respectively, compared with 25.9 and 28.1 ard/fad. In Gemmiza in 2014 season, 20 m3 manure treatment gave significantly higher at value of grain yield (26.7 ard/fad) compared with the other two treatments (24.5 and 24.7 ard/fad). At Gemmiza in 2013 season, manure application had significant affect on kernels weight, where 20 m^3 manure treatment gave the highest value of 100-kernel weight (39.7 g) followed by 10 m^3 manure (37.1 g) compared with 35.3 g for no manure added (Table 4). Regarding ear length, at both locations in 2014 season, manure application increased ear length, where 20 m^3 manure treatment gave the highest value of ear length (21.5 and 22.2 cm) compared with the other treatments. Also, the application of 10 and 20 m^3 manure to maize plant gave significantly the tallest plants at Gemmiza in 2013 season (238.3 and 236.2 cm) compared with 227.9 cm with non manure added (control treatment), (Table 4). In 2014 season, at both locations, the treatment of 20 m3 manure gave significantly the tallest plants (224.6 and 221.7 cm), while, 10 m3 manure treatment was not significantly different from no application at Gemmiza and Nubaria. At Gemmiza in 2013 season and Nubaria in 2014 season, manure application of 20 m3 gave significantly increased of mean ear height (139.2 and 125.7 cm) compared with the other treatments, although 10 and 20m3 manure treatments didn't significant differe at Nubaria in 2014 season (124.7 and 125.7 cm). Results showed that manure application didn't affect number of days to mid-silking at both locations.

Table (3). Mean square for grain yield and other traits of three manure and three sulfur treatments at Gemmiza during 2013 and 2014 and Nubaria during 2014.

S.O.V.	df	Grain yield	100-Kernel weight	Ear length	Silking date	Plant height	Ear height
Gemmiza-2013							
Replications(Rep)	3	10.96	0.32	1.62	0.37	19.44	3.56
Manure (Man)	2	77.45**	57.03**	3.73	1.03	364.58*	136.11*
Rep x Man	6	0.56	2.88	1.75	0.40	36.80	16.67
Sulfur (Sul)	2	1118.19**	15.53**	0.27	0.19	14.58	21.53
Man x Sul	4	5.82	7.48**	0.54	0.07	47.92	17.36
Error	18	2.85	1.61	1.12	0.33	19.21	17.82
Gemmiza-2014							
Replications(Rep)	3	1.18	3.95	0.17	0.62	90.47	86.11
Manure (Man)	2	17.48*	9.48	2.46	0.08	118.75**	71.53
Rep x Man	6	2.15	6.82	0.53	0.23	20.60	68.75
Sulfur (Sul)	2	12.51*	12.46	0.01	0.08	133.33**	96.53
Man x Sul	4	0.78	35.68*	0.48	0.29	42.71	10.07
Error	18	2.18	9.61	1.07	0.22	21.06	34.26
Nubaria-2014							
Replications(Rep)	3	10.35	12.47	0.08	0.63	21.63	5.70
Manure (Man)	2	79.27**	7.88	2.07*	3.69	499.53*	93.25*
Rep x Man	6	7.52	5.72	0.33	1.55	87.71	9.40
Sulfur (Sul)	2	26.72*	32.47*	2.54*	1.03	197.44	93.00*
Man x Sul	4	2.88	19.27	2.44*	0.94	46.36	106.75**
Error	18	7.47	7.41	0.47	0.60	61.13	19.16

2. Sulfur effect

Significant and highly significant differences were detected among sulfur application treatments for grain yield at both seasons in Gemmiza and Nubaria locations (Table 3). Also, plant height was affected by sulfur application at Gemmiza location in 2014 season. Significant differences were observed at Nubaria location on 2014 season for ear height, ear length and 100-kernel weight. Manure-by-sulfur interaction was significant on 100-kernel weight at Gemmiza location in 2014 season, ear height and ear length at Nubaria in 2014 season.

Table (4). Averages of grain yield and other traits for manure and sulfur treatments at Gemmiza during 2013 and 2014 and Nubaria during 2014.

Treatment	GrainYield (Ardab/fed.)	100-Kernel weight(g)	Ear Length (cm)	Silking date(day)	Plant height (cm)	Ear Height (cm)
Gemmiza-2013						
Manure (m^3/fed.)						
0	25.9b	35.3c	20.8	60.2	227.9b	133.3b
10	30.2a	37.1b	21.6	60.5	238.3a	133.3b
20	30.5a	39.7a	21.8	59.9	236.2a	139.2a
$LSD_{0.05}$	**0.7**	**1.7**	**Ns**	**Ns**	**6.0**	**4.1**
Sulfur (kg/fed.)						
0	25.9c	36.3b	21.3	60.1	233.3	133.7
100	28.5b	37.2b	21.6	60.2	233.7	136.2
200	32.2a	38.6a	21.4	60.3	235.4	135.8
$LSD_{0.05}$	**1.4**	**1.1**	**Ns**	**Ns**	**Ns**	**ns**
Gemmiza-2014						
Manure (m^3/fed.)						
0	24.5b	42.0	20.6b	62.3	218.3b	137.1
10	24.7b	43.4	21.0ab	62.4	221.1ab	136.3
20	26.7a	43.7	21.5a	62.5	224.6a	140.8
$LSD_{0.05}$	**1.5**	**Ns**	**0.7**	**Ns**	**4.5**	**ns**
Sulfur (kg/fed.)						
0	24.2b	42.5	21.1	62.4	218.3b	135.8b
100	25.5a	42.3	21.0	62.5	221.7ab	137.1ab
200	26.2a	44.2	21.1	62.3	225.0a	141.3a
$LSD_{0.05}$	**1.2**	**Ns**	**Ns**	**Ns**	**3.9**	**5.0**
Nubaria-2014						
Manure (m^3/fed.)						
0	28.1b	34.6	21.4b	62.1	209.3b	120.5b
10	31.1a	37.1	21.5b	62.0	218.6ab	124.7a
20	33.3a	38.1	22.2a	61.1	221.7 a	125.7a
$LSD_{0.05}$	**2.7**	**Ns**	**0.6**	**Ns**	**9.3**	**3.1**
Sulfur (kg/fed)						
0	28.2b	35.5b	21.2b	61.7	212.2b	121.2b
100	30.8ab	37.5ab	21.7b	62.0	217.3ab	123.1ab
200	33.6a	38.7a	22.2a	61.4	220.2a	126.7a
$LSD_{0.05}$	**4.1**	**2.3**	**0.6**	**Ns**	**6.7**	**3.7**

Results in Table (4) showed that sulfur application of 200 kg/fad gave more significant means of grain yield than the other treatments at Gemmiza and Nubaria in 2013 and 2014 seasons. Mean grain yield at Gemmiza in 2013 season of 200 kg/fed sulfur was 32.2 ard/fad compared with 28.5 ardab/fed for 100 kg/fed sulfur treatments which were significantly higher than no application of sulfur (25.9 ard/fed). In 2014 season, 200 kg/fed sulfur treatment gave 26.2 and 33.6 ard/fed at Gemmiza and Nubaria, respectively, which was not significantly different from 100 kg/fad sulfur treatment (25.5 and 30.8 ardab/fed) at Gemmiza and Nubaria, respectively.

Also, 200 kg sulfur application had significantly heavier 100-kernel weight mean than the other treatments at Gemmiza in 2013 and Nubaria in 2014 seasons (38.6 and 38.7 g), while the treatment of 100kg sulfur didn't significantly differe from no application of sulfur (Table 4). Sulfur application of 200 kg/fad increase ear length with values of 22.2 cm compared with 21.2 and 21.7 cm under the other treatments (100 kg/fad and no sulfur) at Nubaria in 2014 season (Table 4). The same trend was observed for plant and ear heights due to sulfur application at Gemmiza and Nubaria in 2013 and 2014 seasons. Treatment of 200 kg sulfur gave the tallest plants in 2014 season with values of 225.0 and 220.2 cm at Gemmiza and Nubaria, respectively. Also, higher values of ear height were detected due to 200 kg sulfur in 2014 season with values of 141.3 and 126.7 cm at Gemmiza and Nubaria, respectively (Table 4). As shown in Table (3), It was noticed that sulfur application didn't affect number of days to mid-silking date at both tested locations, Gemmiza and Nubaria in 2013 and 2014 seasons.

Significant response of maize to sulfur was shown in all experiments. A response curve for sulfur showed that 5 to 10 kg/ha of Sulfur was optimal, with mean yield response ranging from 90 to 142 kg grain/kg sulfur (Ray and Mughogho, 2000). Sulfur application significantly increased grain yield of maize, and also increased total biomass (Agustin and Echeverria, 2011).

Manure-by-sulfur interaction significantly affected 100-kernel weight at Gemmiza location in 2013 and 2014 seasons, ear length and ear height at Nubaria location in 2014 season. Generally, manure and sulfur application increase 100-kernel weight in both seasons. Treatment of 20 m^3 of manure and 200 kg sulfur significantly increased 100-kernel weight more than the other treatments in both seasons, and gave values of 100-kernel weight of about 40.7 and 45.8 g in 2013 and 2014 seasons, respectively (Table 5), while the other treatments gave significantly the lowest values of 100-kernel weight. Also, 20 m^3 manure with 200 kg sulfur treatment gave significantly the highest value of ear length at Nubaria (22.7 g) as compared with the other treatments (Table 5). Treatment of 20 m3 manure with 200 kg sulfur gave significantly the highest mean of ear height at Nubaria (134.2 cm) as compared with the other treatments (Table 5).

Table (5). Effect of interaction between manure and sulfur application on some traits at Gemmiza during 2013 and 2014 and Nubaria during 2014.

Treatment		100-kernel weight (g)		Ear length (cm)	Ear height (cm)
		Gemmiza		Nubaria	Nubaria
Manure (m^3/fed.)	Sulfur (kg/fed.)	2013	2014	2014	2014
0	0	32.7	42.6	21.1	116.2
	100	36.0	40.8	21.1	121.2
	200	37.2	42.6	22.1	124.0
10	0	36.2	39.1	20.3	121.7
	100	37.2	43.9	21.6	126.2
	200	37.7	47.1	22.5	126.2
20	0	38.2	42.3	21.6	121.0
	100	40.0	42.8	22.1	122.0
	200	40.7	45.8	22.7	134.2
$LSD_{0.05}$		**0.6**	**1.5**	**0.3**	**2.1**

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الملخص العربى

تأثير اضافه السماد العضوى والكبريت على الذره الشاميه

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أجريت تجربه حقليه فى كلا من محطتى البحوث الزراعيه بالجميزه موسمى ٢٠١٣ و ٢٠١٤ والنوباريه موسم ٢٠١٤ وذلك لدراسة تأثير اضافة السماد العضوى والكبريت على محصول حبوب الذره الشاميه وبعض الصفات الأخرى. أجريت التجارب فى تصميم القطع المنشقه في أربع مكررات وتم قياس صفات محصول الحبوب وعدد الأيام من الزراعة حتى ظهور ٥٠% من الحرابر وارتفاعى النبات والكوز ومتوسط طول الكوز بالاضافه الى وزن ١٠٠ حبه .

أوضحت النتائج ما يلى:

- وجود فروق معنوية راجعه الى اضافة السماد العضوى لصفتى محصول الحبوب وارتفاع النبات ووزن ١٠٠ حبه. وقد أدت اضافة كلا من ١٠ و ٢٠ م^3 للفدان من السماد العضوى الى زياده محصول الحبوب فى الجميزه حوالى ٣٠.٢ ، ٣٠.٥ موسم ٢٠١٣ بينما كان محصول الحبوب حوالى ٢٤.٧ و ٢٦.٧ أردب للفدان موسم ٢٠١٤ ، بينما بلغ محصول الحبوب حوالى ٣٠.٨ و ٣٣.٦ أردب للفدان فى النوباريه موسم ٢٠١٤ .
- أيضا أدت اضافة السماد العضوى بمقدار ٢٠ م^3 الى زياده وزن ١٠٠ حبه حيث بلغت ٣٩.٧جم مقابل ٣٧.١ جم لاضافة ١٠م^3 من الماده العضويه للفدان.
- أدت اضافة السماد العضوى الى زياده معنويه فى ارتفاع النبات وطول الكوز.
- كما تلاحظ وجود فروق معنويه فى محصول الحبوب راجعه الى اضافة الكبريت.

- أدت اضافة ٢٠٠ كجم للفدان من الكبريت الى زياده معنويه فى محصول الحبوب حيث بلغت حوالى ٣٢.٢ أردب للفدان فى الجميزه موسم ٢٠١٣ بينما كانت حوالى ٢٦.٢ أردب للفدان موسم ٢٠١٤ فى حين بلغ متوسط محصول الحبوب حوالى ٣٣.٦ أردب للفدان فى النوباريه موسم ٢٠١٤.
- أعطت اضافه ٢٠٠ كجم كبريت موسم ٢٠١٤ متوسط محصول حبوب يقدر بحوالى ٢٦.٢ و٣٣.٦ أردب للفدان فى الجميزه والنوباريه على التوالى.
- أيضا ادت اضافه ٢٠٠ كجم كبريت الى زياده فى طول الكوز حيث بلغ متوسط طول الكوز حوالى ٢٢.٢ سم مقارنه بمتوسط حوالى ٢١.٢ و٢١.٧ عند اضافه ١٠٠ كجم وعدم اضافه الكبريت على التوالى فى النوباريه موسم ٢٠١٤.
- أدت اضافة ٢٠٠ كجم من الكبريت الى زياده فى ارتفاع النباتات حيث بلغ متوسط ارتفاع النبات حوالى ٢٢٥سم موسم ٢٠١٤ بالجميزه وحوالى ٢٢٠.٢ سم فى النوباريه.
- كان لتفاعل السماد العضوى مع الكبريت تأثيرا معنويا على زياده وزن ١٠٠ حبه فى الجميزه موسمى ٢٠١٣ و٢٠١٤ بالاضافه الى صفات طول الكوز وارتفاع النبات فى النوباريه موسم ٢٠١٤.
- عموما أدت اضافة السماد العضوى والكبريت الى زياده معنويه فى وزن ١٠٠ حبه فى النوباريه خلال موسمى التقييم حيث أدت اضافة ٢٠ م^{3} من السماد العضوى مع ٢٠٠ كجم من الكبريت الى زياده معنويه فى طول الكوز فى موقع النوباريه.

Response of Some Sugarcane Cultivars to Nitrogenous Fertilization and Micronutrients on Productivity and Quality

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ABSTRACT: Two filed experiments were carried out in the experiment farm of Faculty of Agriculture Aswan Egypt, during 2014 and 2015 growing seasons. The objective of this study was to investigate the response of some sugarcane cultivars to nitrogenous fertilization and micronutrient on productivity and quality. Experimental design was spilt spilt plot with three replicates. The results could be summarized as follows: Giza 9 variety at the four sampling dates had higher cane length, number of tillers/plant, number of internode/plant, leaf area index and cane diameter, also, cane girth, sugar cane, Brix (TSS%), sucrose (%), purity (%) and commercial cane sugar % (CCS%). Addition, nitrogen fertilizer at rate of 200 kg N/fed, resulted in a significant increment in growth characters, yield and quality of sugarcane plants in both seasons. Significant variations were recorded between the tested foliar micronutrient treatments for growth characters, yield and sugarcane quality. The effective treatments for growth characters, yield and quality were obtained for Giza 9 variety and adding 200 kg N/fed in both seasons. The highest values of all growth characters, yield and quality were obtained by Giza 9 variety with using the application of 200 kg N/fed and mixture of Zn +Fe treatment.

Keywords: sugarcane cultivars, nitrogenous fertilizer, micronutrient, growth, yield and quality.

INTRODUCTION

Sugarcane (*Saccharum officinarum* L.) is a commercial crop grown in tropical and sub-tropical regions for sugar production in climates ranging from hot dry environment near sea level to cool and moist environment at high elevations (Plaut *et al.,* 2000). Apart from the main product, sugar, it produces many valuable co-products such as alcohol used by pharmaceutical industry and as fuel, bagasse for paper and chip board and press mud as a rich source of organic nutrients for crop production (Kumar *et al.,* 1996 and Legendre *et al.,* 2000).Thrives best a temperature above 20℃ and requires a period of about 8 to 24 months to reach maturity (Nazir, 2000). Sugarcane is a major cash crop in Egypt, which not only provides man stay to sugar industry but also, row materials to many allied industries for alcohol and chip broad manufacturing (Naqvi, 2005).

Nitrogen is essential for vigorous vegetative growth and development, yield and quality in sugarcane. It is a constituent of plant cell components e.g. amino acids and nucleic acids and its deficiency inhibits plant growth, reduction in leaf area, thus causes a decrease in photosynthesis hence suppressing yield and quality (Taiz and Zeiger, 2002 and Sreewarome *et al.,* 2007). Application of N fertilization is mandatory in intensive sugarcane cultivation which requires a high amount of nitrogen as a nutrient to produce high biomass (Thornburn *et al*., 2005). Excess N and low N uptake cause retarded growth phase and decreases photosynthetic capacity of leaves thus causing shorter internodes (Martin, 1994). For many locations the depletion of plant available soil N over time justifies the need for split application of yearly total N rate (Wiedenfeld, 1995).

Micronutrients can be applied directly into the soil or by foliar application. Foliar application has many advantages such as less application rate, even distribution of nutrients and immediate response of plant to applied material. It also, performs better where; soil alkalinity and permeability are more which leads to leaching of nutrients. Foliar application of nutrients is useful where the nutrients are fixed up to in the soil and thereby not available for absorption by the roots. Foliar application of zinc sulphate and iron sulphate increases cane yield (Chandra, 2005 and Boklar and Sakurai, 2005). The aim of this study was to examine the response of some sugarcane cultivars to nitrogenous fertilization and micronutrients on productivity and quality.

MATERIALS AND METHODS

The present study was carried out at the experimental farm Kom-Omb-Aswan, Egypt, sugarcane is grown in the belt 32°N and 24°S, during the two successive growth seasons of 2014 and 2015 seasons to study the response of some sugarcane cultivars to nitrogenous fertilization and micronutrients on productivity and quality. The main physical and chemical properties of cultivated soil before planting and also, its content of some macro and micronutrients were determined according to the methods described by Page *et al.* (1982) as shown in Table (1)

Table (1). Some Physical and chemical properties of the experimental soil in 2014 and 2015 seasons.

Parameter	Value		
	2014	2015	Unit
Mechanical Analysis			
Sand	52.12	53.00	%
Silt	22.00	23.00	%
Clay	22.88	24.00	%
Textural class	**Sandy Clay Loam**		
pH (1:2)	7.92	7.84	-
Ca Co_3	2.1	2.3	%
EC(1:2, water extract)	0.417	0.412	dS/m
O.M	1.65	1.55	%
Soluble cations			
Ca^{2+}	2.04	2.02	meq/l
Mg^{2+}	3.06	2.99	meq/l
Na^{+}	1.41	1.42	meq/l
K^{+}	0.71	0.70	meq/l
Soluble anions			
$HCO3^{-}$	5.4	5.2	meq/l
Cl^{-}	7.82	7.85	meq/l
SO_4^{2-}	0.79	0.77	meq/l
Available nutrients			
Nitrogen (N)	189.5	188.4	mg/kg
Phosphorus (P)	46.75	45.80	mg/kg
Potassium (K)	1000	1001	mg/kg

A split split plot design with three replicates was used in both seasons. Three cultivars (Giza 9 (V1), Giza 47 (V2) and Giza 49 (V3) were randomly assigned to the main plots, three nitrogen fertilizer levels (120, 160 and 200 kg N/fed) were allocated to sub plots and three micronutrients treatments (Zn, Fe and Zn +Fe) were randomly distributed in sub sub plots.

The experiment was laid out as split split plot with three replicates Net plot size was 4.5m x 8.0 m for 75 cm spaced trenches.

Fertilization

Fertilizers were applied at the rate of 115 kg P_2O_5/ha and 115 kg/ha K_2O, respectively. Phosphorus (single super phosphate 15.5% was applied at the time of sowing and SOP (sulphate Potash, 48 %K_2O). The amount of Zn and Fe was applied at 2kg Zn and 2kg Fe/fed. The foliar spray of 1/3rd dose of Zn and Fe and mixture Zn + Fe were applied 50 days after sowing and the remaining 2/3 was applied in two equal splits in 20 days intervals after the 1st spray. The sources of Zn and Fe were Zn SO_4-H_2O (35% Zn) and $FeSO_4$ - $7H_2O$ (19.5 % Fe), respectively.

Recorded data

A. Growth attributes

- Cane length (cm)
- Cane diameter (cm)
- Number of tillers/plant
- Number of internods/plant
- Leaf area index

B. Yield

- Cane girth
- Sugar yield (ton/ha) was determined by the following formula:

$$\text{Sugar yield (t/ha)} = \frac{Cane\ yield\ (t/ha)\ \text{X}\ CCS\%}{100}$$

C. Qualitative traits

- Brix %

  Ten cane randomly selected from every plot were crushed through a cane crusher and the juice was collected in glass jars. The reading brix (%) was recoded with brix hydrometer. Temperature of the juice was noted. These brix reading were corrected with the help of Schmitz table (Spancer and Meade, 1963).
- Sucrose in juice %

  With the help of parameter, pol reading of extracted juice of every treatment was recorded. Sucrose contents of cane juice were calculated with the help of Schmitz table (Spancer and Meade, 1963).
- Cane juice purity %

  Cane juice purity was determined at described by (Spancer and Meade, 1963).

$$\text{Cane juice purity (\%)} = \frac{Pol\ \%\ juice}{Brix\ \%\ Juice}\text{X}\,100$$

- P=Pol % in juice
- B= Brix % in juice
- F=Fiber % in juice (12.5%)
- Commerical cane sugar (CCS %) was determined by as per the method described by Meady and Chen (1997).

$$CCS\ \% = 3/2\ (1-\frac{F+S}{100})\ -1/2\ B(1-\frac{F+3}{100})$$

Where S = Sucrose percent in juice
All the data collected were subjected to statistical analysis of Varian ANOVA and (L.S.D.) values to test the differences among the standard treatments means according to Gomez and Gomez (1984).

RESULTS AND DISCUSSION

A. Growth attributes

All the studied growth characters were greatly increased by all treatments with significant differences in most cases.

Regarding sugarcane varieties effect on cane length at all sampling dates and number of tillers/plant, number of internode/plant, leaf area index and cane diameter in both seasons, data in Table (2) show highly significant difference among sugarcane varieties for growth attributes. The Giza 9 variety produced the greatest values of all traits in the two seasons of study. This superiority can be mainly attributes to the increase in their number of tillers/plant and leaf area index and consequently increased photosynthesis by plant. These results are in agreement with those obtained by Nazir (2000) and Naqvi (2005).

Results recorded in Tables (3 and 4) revealed that cane length at four sampling dates, also, number of tillers/plant, number of internode/plant, leaf area index and cane diameter (cm) significantly increased by increasing the rate of nitrogen fertilizer (200 kg N/fed) in both growing seasons. The highest increases in these growth characters were obtained by application of 200 kg N/fed. However, the lowest values were recorded by using 120 kg N/fed. It is evident that each increase in the rate of nitrogen fertilizer from 120 to 200 kg N/fed was accompanied by highly significant increased in all growth characters. Similar results were found by Wiedenfeld (1995) and Thorburn *et al.* (2005).

Different dates of nutrients show significant effect of all growth attributes during both seasons. However, the application of Zn +Fe produced the highest all growth attributes in both seasons. The findings of Khan *et al*. (1997) and Tunio *et al*. (2004) are in contrast with these results they reported that of the most micronutrient exhibited a positive of all growth attributes.

Tables (3 and 4) indicated that growth characters of sugarcane plants significantly affected by the nitrogenous fertilizer and micronutrients, as well as, their interactions.

Concerning the interaction effect, data in Tables (3 and 4) indicated that Giza 9 variety and application of 200 kg N/fed produced the highest cane length, number of tillers/plant, number of internode/plant, leaf area index and cane diameter (cm) in both seasons.

The results reported in Tables (3 and 4) indicated that the effective treatments for cane length of four sampling dates and number of tillers/plant, number of internode/plant, leaf area index and cane diameter were obtained from Giza 9 with foliar application of Zn +Fe treatment in both seasons.

Regarding the effect of interaction among sugarcane varieties, nitrogen fertilizer levels and micronutrients on all growth attributes characters in both seasons.

Table (2). Number of tillers/plant, Number of internode/plant, Leaf area index and Cane diameter as affected by three varieties, nitrogen fertilizer and some micronutrients in 2014 and 2015 seasons.

Treatments	Number of tillers/plant		Number of internode/plant		Leaf area index		Cane diameter (cm)	
	2014	2015	2014	2015	2014	2015	2014	2015
A)Varieties								
Giza 9	4.76a	5.45a	20.30a	21.91a	8.53a	9.48a	2.47a	2.74a
Giza 47	4.20b	4.43b	18.36b	20.39b	8.07b	8.97b	2.38b	2.64b
Giza 49	3.46c	3.84c	16.24c	18.04c	7.25c	8.86c	2.26c	2.58c
LSD (0.05)	**0.42**	**0.48**	**1.02**	**1.04**	**0.40**	**0.45**	**0.05**	**0.04**
B)Nitrogen levels								
120	3.64c	4.01c	16.10c	17.88c	7.73c	8.53c	2.26c	2.51c
160	4.24b	4.70b	18.24b	20.28b	7.98b	8.87b	2.34b	2.62b
200	4.74a	5.28a	20.57a	22.18a	8.21a	9.11a	2.47a	2.75a
LSD (0.05)	**0.45**	**0.50**	**1.12**	**1.20**	**0.20**	**0.21**	**0.06**	**0.07**
C)Micronutrient								
Zn	3.68c	4.10c	15.71c	16.80c	7.13c	7.98c	2.21c	2.46c
Fe	4.17b	4.60b	18.12b	20.14b	7.92b	8.88b	2.34b	2.61b
Zn+Fe	4.67a	5.30a	21.06a	23.42a	8.88a	9.78a	2.60a	2.81a
LSD (0.05)	**0.45**	**0.48**	**1.15**	**1.30**	**0.60**	**0.70**	**0.09**	**0.11**
Interaction								
AxB	*	*	*	*	*	*	*	*
AxC	*	*	*	*	*	*	*	*
BxC	*	*	*	*	*	*	*	*
AxBxC	*	*	*	*	*	*	*	*

Means in the same column followed by the same letter are statistically equalled according to LSD (0.05) probability level.

*: Significant at (0.05) probability level

Table (3). Cane length (cm) as affected by three varieties, nitrogen fertilizer and some micronutrients in 2014 and 2015 seasons.

Treatments	2014				2015			
	July	Aug.	Sept.	Oct.	July	Aug.	Sept.	Oct.
A)Varieties								
Giza 9	179.97a	200.13a	223.35a	247.17a	180.39a	210.70a	222.91a	241.04a
Giza 47	136.37c	151.16c	168.70c	186.86c	138.52c	173.35c	168.36c	187.08c
Giza 49	147.79b	165.07b	183.82b	203.78b	149.23b	187.09b	183.31b	203.41b
LSD (0.05)	**5.40**	**6.10**	**8.10**	**9.70**	**6.10**	**6.40**	**7.10**	**9.30**
B)Nitrogen levels								
120	140.24c	155.51c	173.08c	192.09c	141.15c	157.04c	173.39c	186.25c
160	155.97b	175.03b	192.92b	214.17b	156.79b	173.40b	192.30b	214.17b
200	169.31a	188.27a	209.41a	232.30a	170.29a	184.79a	208.10a	231.68a
LSD (0.05)	**4.70**	**5.20**	**7.10**	**10.20**	**5.01**	**5.60**	**6.80**	**9.80**
C)Micronutrient								
Zn	142.95c	158.84c	176.46c	195.99c	143.63c	158.82c	176.82c	189.73c
Fe	154.37b	172.57b	191.63b	213.12b	155.67b	171.28b	190.40b	211.82b
Zn+Fe	166.32a	186.40a	206.43a	250.69a	169.38a	186.60a	206.88a	230.47a
LSD (0.05)	**5.10**	**6.30**	**7.50**	**10.4**	**5.18**	**6.50**	**7.20**	**10.20**
Interaction								
AxB	*	*	*	*	*	*	*	*
AxC	*	*	*	*	*	*	*	*
BxC	*	*	*	*	*	*	*	*
AxBxC	**ns**	**ns**	**ns**	**ns**	**ns**	**ns**	**ns**	**ns**

Means in the same column followed by the same letter are statistically equalled according to LSD (0.05) probability level.
*: Significant at (0.05) probability level
ns: not significant

Table (4). Interaction between three cultivars and N-levels on cane length (cm) at three sampling dates in 2014 and 2015 seasons.

Treatments		2014				2015			
Varieties	N-levels KgN/fed	July	Aug.	Sept.	Oct.	July	Aug.	Sept.	Oct.
Giza 9	120	169.13	191.56	216.15	236.59	191.56	212.85	217.65	262.50
	160	180.60	203.14	226.13	250.80	202.72	226.70	250.67	285.55
	200	197.42	205.67	230.77	255.37	206.23	229.88	254.67	284.89
Giza 47	120	120.64	134.97	149.87	166.23	135.28	149.59	166.20	184.69
	160	138.37	152.45	169.14	188.83	152.46	167.70	186.03	209.44
	200	151.14	168.07	186.75	207.50	168.88	186.13	207.75	230.54
Giza 49	120	10.86	141.66	157.59	174.41	144.26	157.42	174.90	194.31
	160	148.34	148.50	183.16	203.53	164.82	182.78	203.50	226.11
	200	167.62	188.72	209.70	232.69	187.74	209.72	232.94	258.70
LSD (0.05)		**5.50**	**6.30**	**8.30**	**10.50**	**6.30**	**6.50**	**7.60**	**10.10**

B. Yield and Qualitative characters

Data in Tables (5 and 6) showed that Giza 9 variety was significantly superior in yield and Qualitative characters i.e. cane girth, cane yield, Brix percentage of TSS%, sucrose %, purity % and commercial sugar (CCS%) than the other two sugarcane varieties Giza 47, Giza 49 varieties. Differences in these traits among sugarcane varieties under study may be due to differences in their genetic make and to response to environmental factors affecting development processe and ability to uptake the available nutrients. These results are in harmony with those obtained by Sharma *et al.* (2002) and Wilson

and Leslie (1997).The obtained results given in Tables (5 and 6) showed, clearly, that nitrogen fertilizer levels exhibited significant effect on all estimated traits during the two cropping seasons of the study. Notably increasing nitrogen fertilizer level resulted in a significant increase in cane girth, cane yield (ton/ha), Birx percentage (TSS %), sucrose %, purity % and CCS%. These findings might be attributed to more adsorption of nutrition which reflect more growth substance more cell division and enlargement more tissues and organs and plant elongation. Also, the nitrogen fertilizer may increase the synthesis of endogenous phytohormones which cause the formation of big active root system which allow more nutrients uptake. The previous results agreed more or less with the findings obtained by Yadava (1991), Wiedenfeld (1995) and Pratop *et al.* (1996). Effect of Fe + Zn treatments on sugarcane are presented in Tables (5 and 6). Data cleared that application of all treatments caused marked increases in yield and qualitative characters. The highest values of cane girth, cane yield (ton/ha), Brix percentage (TSS %), sucrose %, Purity % and CCS % by foliar application of mixture Zn +Fe in both seasons. Similary, Dhanascharan and Bhuvaneswari (2004), noticed that Zinc and iron or in combination significantly increased Purity (%) of cane juice, sucrose (%) and Brix (TSS %). Similar results were obtained by Sharma *et al.* (2002) and Raskar and Bhai (2004).All first and second order interaction on yield and quality were significant in both seasons, Tables (5 and 6). Generally, Giza 9 variety with application of 200 kg N/fed and mixture of Zn +Fe treatment gave the best growth characters, yield and quality for sugarcane under Aswan conditions.

Table (5). Cane girth and cane yield (ton/ha) as affected by three varieties, nitrogen levels and micronutrients during 2014 and 2015 seasons.

Treatments	Cane girth (cm)		Cane yield (ton/ha)	
	2014	2015	2014	2015
A)Varieties				
Giza 9	2.35a	2.61a	163.32a	180.95a
Giza 47	2.15b	2.39b	151.46b	167.74b
Giza 49	2.09c	2.32c	137.15c	153.12c
LSD (0.05)	**0.04**	**0.06**	**9.40**	**9.60**
B)Nitrogen levels				
120	2.12c	2.29c	141.54c	153.59c
160	2.25b	2.44b	148.56b	165.96b
200	2.35a	2.60a	165.97a	187.11a
LSD (0.05)	**0.06**	**0.08**	**6.70**	**7.90**
C)Micronutrient				
Zn	2.10c	2.32c	138.22c	153.53c
Fe	2.19b	2.42b	149.54b	166.12b
Zn+Fe	2.32a	2.58a	164.84a	179.77a
LSD (0.05)	**0.07**	**0.08**	**8.90**	**8.50**
Interaction				
AxB	*	*	*	*
AxC	*	*	*	*
BxC	*	*	*	*
AxBxC	*	*	*	*

Means in the same column followed by the same letter are statistically equalled according to LSD (0.05) probability level.

*: Significant at (0.05) probability level

Table (6). Total soluble solids (TSS), Sucrose content and juice Purity (%) and Commercial cane sugar (CCS%) as affected by three varieties, nitrogen fertilizer and some micronutrients in 2014 and 2015 seasons.

Treatments	Brix (TSS %)		Sucrose (%)		Purity (%)		Commerical cane sugar (CCS %)	
	2014	2015	2014	2015	2014	2015	2014	2015
A)Varieties								
Giza 9	20.14a	22.39a	13.70a	15.15a	77.62a	86.61a	12.25a	13.56a
Giza 47	18.13b	20.14b	13.44b	14.93b	60.56b	69.91b	11.89b	12.27b
Giza 49	16.29c	18.12c	12.73c	14.23c	52.30c	58.13c	9.62c	10.75c
LSD (0.05)	**1.02**	**1.10**	**0.50**	**0.45**	**7.10**	**9.50**	**0.50**	**0.60**
B)Nitrogen levels								
120	17.39c	19.33c	12.75c	14.17c	59.99c	66.26c	10.48c	11.59c
160	18.36b	20.45b	13.37b	14.82b	62.30b	71.27b	10.95b	12.23b
200	18.86a	20.98a	13.86a	15.33a	69.46a	76.27a	11.45a	12.77a
LSD (0.05)	**0.45**	**0.48**	**0.47**	**0.45**	**6.10**	**5.50**	**0.45**	**0.48**
C)Micronutrient								
Zn	17.88c	19.85c	12.39c	13.77c	65.51c	66.47c	10.52c	11.13c
Fe	18.20b	20.20b	13.23b	14.70b	63.91b	71.26b	10.96b	12.23b
Zn+Fe	18.54a	20.60a	14.39a	15.90a	66.56a	76.40a	11.97a	13.39a
LSD (0.05)	**ns**	**ns**	**0.70**	**0.80**	**ns**	**5.10**	**0.55**	**0.60**
Interaction								
AxB	*	*	*	*	*	*	*	*
AxC	ns	ns	*	*	*	*	*	*
BxC	ns	ns	*	*	*	*	*	*
AxBxC	*	*	*	*	*	*	*	*

Means in the same column followed by the same letter are statistically equalled according to LSD (0.05) probability level.
*: Significant at (0.05) probability level
ns: not significant

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الملخص العربي

إستجابة بعض أصناف القصب للتسميد النتروجيني والعناصر الصغري علي الإنتاجية والجودة

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أجريت تجربتان في بالمزرعة البحثية بكلية الزراعة جامعة أسوان= مصر، خلال موسمي ٢٠١٤، ٢٠١٥ لدراسة إستجابة بعض أصناف قصب السكر للتسميد النيروجيني والعناصر الصغري علي الإنتاجية والجودة، صممت التجربة بإستحدام القطع المنشقة مرتين في ثلاث مكرارت.

ويمكن تلخيص النتائج المتحصل عليها فيما يلي:

١. أعطي الصف جيزة ٩ عند ٤ عينات أعلي طول لنبات القصب فقط وعدد الأفرع /نبات، عدد العقد/نبات، دليل المساحة الورقية، قطر قطر العود أيضاً، مصول العود(طن)، المواد الكلية الكلية، السكروز، النقاوة، القيمة الأقتصادية للسكر.

٢. إضافة التسميد النيتروجين عند معدل ٢٠٠ كجم نيتروجين/فدان أنتج معنوية لصفات الخضرية والمصول وجودة نباتات قصب السكر في كلا الموسمين.

٣. سجلت لأختلافات معنوية بين إضافة العناصر الصغري المختبرة للصفات الخضرية والمحصول وجودة قصب السكر.

٤. المعاملات المتأثرة لصفات الخضرية ، المحصول والجودة تحصل عليها من الصنف جيزة ٩ مع إضافة ٢٠٠ كجم نتروجين/فدان في كلا الموسمين.

٥. أعلي قيم لجميع الصفات لجميع الصفات الخضرية والمحصول والجودة تحصل عليها بواسطة أفضل نباتات قصب السكر جيزة ٩ مع إستخدام إضافة ٢٠٠ كجم نيتروجين/فدان وخليط من معاملات Zn +Fe.

Effect of Cobalt Application and Mycorrhizal Fungi Inoculation on Growth and Some Nutrients Content of Barley and Egyptian Clover Plants Grown in Calcareous Soil

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ABSTRACT: Two pot experiments were carried out at the green-house of Faculty of agriculture (Saba Bash), Alexandria University to study the effect of cobalt applied with seeds through soaking in relation to mycorrhiza inoculation on growth and quality of barely and clover as forage crops under calcareous soil conditions during 2012-2013 and 2013-2014 growing seasons, respectively. The seeds of barley and clover were soaked in continuously aerated solution of different cobalt concentrations (0.0, 0.3, 0.6, 0.9, 1.2, and 1.5 mg/l) using cobalt sulphate salt and inoculated with two mycorrhizal spices (*G. intraradiaces* and *G. macrocarpium*) separately before sowing.The obtained results showed that soaking seeds of barley and clover (forage crops) in cobalt solutions and mycorrhizal inoculation had significant effects on all growth parameters and the tested nutrients content in the plants of the two crops.The Co significantly increased the contents of N, P, K, and Co in shoot and root of the tested plants. It was found that *G. intraradiaces* was more effective than *G. macrocarpium* for the studied traits. Also, the recommended cobalt concentration for barley crops was lower (0.6 mg/l) than that for E.Clover (1.2mg/l). However, Co concentration above 0.6 and 1.2 mg/l for barley and E. Clove, respectively, reduced growth of plants.

Key wards: Seeds soaking, cobalt, Mycorrhiza, Barley, E. Clover, growth parameters, macronutrients.

INTRODUCTION

Barley (*Hordeum vugare* L.) is the major cereal crops in many dry areas of the Middle East, North Africa and west Asia (Ceccerelli *et al*., 1987). Its distribution is worldwide and is of considerable economic importance for animal feed and human consumption. Throughout the world around, 80% of the grown barley is used to feed animals (Amri *et al.* 2005).

Berseem or Egyptian clover (*Trifolium alexandrinum* L.) is an annual legume that is a vine with climbing growth habit, great productivity due to its high growth rate and good fodder recovery after cutting, and high levels of crude protein. It is well adapted to a range of environments and is usually grown in the Mediterranean, central European, and Southeast Asian Countries for forage production (El-Bably, 2002; De Santis *et al*., 2004).

Cobalt is required by Rhizobia for nitrogen fixation and indirectly by leguminous and other plants (Riley and Dillwarth, 1985). On the other hand, low concentrations of cobalt can have a favorable effect on plant growth of non-leguminous crops (Walser *et al*., 1996). Cobalt affects metabolism and plant

growth and is an essential component of several enzymes and co-enzymes (Palit *et al.,* 1994). Its beneficial effects include retardation of leaf senescence, inhibition of ethylene biosynthesis, and stimulation of alkaloid biosynthesis (Palit *et al.,* 1994).

There are three main methods of adding micronutrients to crops: soil fertilization، foliar sprays and seed treatment. Atta-Aly (1998) found that soaking summer squash (*Cucurbita pepo cv. Esksandarany*) seed in continuously aerated solution of 0.25, 0.50, and 1.00 ppm Co^{2+} for 48 h before sowing strongly increased plant growth, femaleness, and fruit yield compared with those of water- (control) or 0.5 mM amino Oxyacetic acid soaked seed. In the same line, Atta-Aly (2003) reported that soaking Galia melon (*Cucumis melo* var. reticulatus, c.v. Royal) seed in continuously aerated solution of 1.00 ppm Co^{2+} for 48 h before sowing significantly increased ethylene (C_2H_4) level, plant growth and fruit yield compared with those of water- soaked seeds.

Arbuscular mycorrhizal fungi (AMF) play an important role in vegetation restoration because of symbiosis with plant root; they can facilitate mineral absorption by host plant, stability and improve soil structure, affect the population structure and preserve species diversity (Bothe *et al*., 2010).

Gad *et al*., (2012) studied the effect of cobalt and mycorrhizae (*Gigaspora gigantean*) on growth and yield of corn as monocots and soybean as dicots. The seedling (at the third truly leaf) were irrigated with cobalt sulphate once, with 0, 4, 8, 10, 12, 16 and 20 ppm cobalt. They found that the cobalt with mycorrhizae inoculation under low phosphorus level enhanced the growth, yield quantity and quality in both corn and soybean, but this positive impact was more significant in the dicot plants compared to monocot.The aim of this research was to study the effect of cobalt application using soaking seed method and mycorrhizal fungi inoculation on growth and nutrients content of barley (non-legumes) and Egyptian Clover (legumes) grown on calcareous soil.

MATERIALS AND METHODS

Soil

Surface calcareous soil sample (0-15cm) was collected from Al-Hamam region at the northern western coast of Egypt. The soil sample was air dried ground to pass 2 mm sieve and thoroughly mixed before using. The characteristics of this soil are presented in Table (1). Practical size distribution was determined by the hydrometer method according to Black (1965). Field capacity was measured by saturated the soil samples through capillary rise then pull the gravitational water from the samples and drying at 105^{o}C for 24 hours as reported by Black *et al*. (1965). Soil organic matter was determined by Walkley and Black method according to Jackson (1973). The water soluble Ca^{2+}, Mg^{2+}, HCO^{-}_{3}, Cl^{-}, pH and EC in the soil were measured according to Jackson (1967). The calcimeter method was used to determine the total carbonates volumetrically (Black, 1965). The

amounts of available nitrogen and potassium were determined according to Jackson (1967), that of phosphorus was determined as described by Murphy and Riley (1962), and that of cobalt was determined using the methods of Lindsay and Norvell (1978).

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

Soil property	Particle size distribution				Soil moisture content			
Physical	Sand %	Silt%	Clay%	Texture	F.C % (w:w)			
	73	14	13	Silty loam	20			
Chemical	pH (1:1)		EC(dSm^{-1}) (1:1)		$CaCO_3$,%		O.M (%)	
	8.0		2.14		19.95		1.06	
	Water soluble cation (meq/l)				Water soluble anion (meq/l)			
	Ca^{2+}	Mg^{2+}	K^+	Na^+	HCO_3^-	CO_3^-	SO_4^{2-}	Cl^-
	7.0	2.5	0.87	13.1	4.00	-	5.08	14.00
	Available nutrients (mg/kg soil)							
	N		P	K	DTPA-Co			
	60		7	185	0.196			

Seed soaking in cobalt solutions

The seeds of barley or clover were soaked for 48 h at room temperature in continuously aerated solutions of 0.00 (distilled water), 0.3, 0.6. 0.9, 1.2 and 1.5 mg L^{-1} Co^{2+} using cobalt sulphate salts as described by Atta-Aly (1998). By the end of soaking, the seeds were radicated with a ridacle length of 1-1.5 mm and were directly sown.

Experimental procedures

Two pot experiments were carried out at the green-house of Faculty of agriculture (Saba Basha), Alexandria University to study the effect of cobalt applied with seeds through soaking in relation to mycorrhiza inoculation (*Glomus macrocarpium* (G.M) or *Glomus intraradiaces* (G.I)) on the growth and quality of barely crop (*Hordeum vulgare,L.*) during 2012-2013 growing season and on Egyptian Clover (*Trifolum alexandarinum,L.*) during 2013-2014 growing season under calcareous soil conditions. Plastic pots (12.5 cm diameter and 11.5 cm depth) were filled with 1 kg calcareous soil for each pot. The barley and E. Clover were fertilized by recommended dose of super phosphate (15% P_2O_5), which was added and mixed with soil in each pot during the preparation of the experimental soil at the rate of (90 and 200 kg P_2O_5/fed) respectively, while N fertilizer was added in the form of (NH_4NO_3, 33% N) at the rate of (100 and 50 kg N/fed) in three equal dose, and K fertilizer was added in the form of K_2SO_4 (K_2O 50%), at the rate of (50 and 100 kg/fed) for barley and clover, respectively. Five grams of mycorrhiza (about 500 spores) inoculate (mycorrhiza spores with sand) was applied in a hole under the seeds before planting. Ten seeds bed of barely or clover were sown in each pot in holes and the seedlings were thinned to six plants per pot after three weeks from sowing. The seeds of Egyptian clover (*Balady* 1) were inoculated prior sowing with the specific strain of *rhizobium leguminosarum*. Soil moisture content

was monitored at 80% of field capacity daily by distilled water. The cobalt (the main plot) and arbuscular-mycorrhizal (AM) species (the sub plot) treatments for the experiment were distributed in complete randomized block design with three replicates. At the harvest time (50, 47 days after planting of barley and clover, respectively), the plant height and number of leaves were measured. Also, samples of soil were collected from each pot and available cobalt was determined (Lindsay and Norvell, 1978).

Morphological root parameters

Plant roots were removed from each pot and separated from soil by washing under a jet of tap water on a 0.5 mm sieve. Excess moisture was blotted from the cleaned roots by wrapping up the roots in layers of paper towel for 3 min (Schenk and Barber, 1979). For each pot three samples of 0.3 g fresh weight were used for the determination of root length by the line intersect method of Tannant (1975).

- **Root length (Tennant, 1975)**

$$RL = \frac{11}{14} \times N \times G$$

Where:
RL= root length, N = sum of horizontal and vertical crossing,
G= length of the grid unit (2cm or 1cm).

- **Root Surface Area (Barber, 1995)**

Surface area of a 1cm root cylinder (SAC) was calculated as follows:

$$SAC = 2\pi \times r_0$$

Where SAC = surface area of the root cylinder and r_0 = root radius

- **Root radius**

Estimation of root radius (r_0) (cm) was based on the assumption that the specific weight of root is almost equal to that of water,1 g cm^{-1}(Barber 1995).

$$r_0 = \sqrt{\frac{RFW}{\pi \ RL}}$$

Where RFW = root fresh weight (g) and RL = root length (cm) and r_0 = root radius

- **Mean half distance between roots (r_1)**

Mean half distance between neighbouring roots (r1) was calculated according to (Schenk and Barber, 1979):

$$r_1 = \sqrt{\frac{V}{\pi \ RL}}$$

Where V = volume of the soil in the pot (cm^3) and RL= root length per pot

Plant analyses

Samples of shoots were measured from each pot and weighed, washed with running tap water and then with distilled water .The samples were air dried for few hours, and weight was measured, then oven dried at 65^{o}C for 48 hours and grounded after recording the oven-dry weight of shoots. After dryness, the plant samples were ground by mill well and 0.5g of oven-dried plant materials were digested with H_2SO_4-H_2O_2 digest (Lowther, 1980) and the digested solutions, were analysed for total nitrogen, phosphorus, potassium and cobalt. Total N was determined colorimetrically by Nessler method (Chapman and Pratt, 1961). The vanado molydate colorimetric method was used to measure P in the digested plant samples (Jackson, 1967) using spectrophotometer at 480 nm wave length. Cobalt concentration was determined in the digested solution (Jackson, 1967) using the atomic absorption spectrophotometer (Model SpectrAA-200).

The obtained data were statistically analyzed according to the technique of analysis of variance (ANOVA) and the least significant difference (L.S.D) method was calculated to test the difference between the treatment means, as described by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

1. Barley and E. Clover growth parameters

A. Shoot growth

The results presented in Table (2) revealed that soaking barley and E. clover seeds in cobalt solutions and mycorrhizal inoculation had significant effects on shoot height, shoot fresh and dry weights and number of leaves.

Increasing cobalt concentration up to 0.6 mg/l in soaking solution for barley shoot growth parameters produced the highest plant length (48.33cm), shoot fresh and dry weights (2.23 and 0.77g), and number of leaves/ plant (10.4). Conversely, increasing cobalt concentration up to 1.5ppm in soaking solution showed the lowest values (45.5, 6.92, 1.38 g and 0.58 g) for shoot height, number of leaves, shoot fresh and dry weights of barley, respectively. Cobalt promotes many developmental processes including stem and coleoptiles elongation, opening of hypocotyls hooks, leaf disc expansion and feet development (Ibrahim *et. al.*, 1989). It is clear from Table (2) that there were highly significant positive interaction effects between cobalt concentrations and mycorrhizal species on shoot height, shoot fresh and dry weight of barley and E. Clover plants.

Table (2). The main effects of cobalt concentrations and Mycorrhizae on shoot growth parameters of barley and E. Clover plants

Treatments	Shoot height (cm/ plant)		No.of leaves/ plant		Shoot fresh weight (g/plant)		Shoot dry weight (g/plant)	
	Barley	E. Clover	Barley	E. Clover	Barley	E. Clover	Barley	E. Clover
Cobalt concentration, mg/l (A)								
Control	46.92d	50.50e	8.01ab	55.55b	1.59d	2.11c	0.63d	0.514d
0.3	47.56c	53.14d	9.04b	58.5ab	1.79c	2.18bc	0.72c	0.615c
0.6	48.33a	53.30cd	10.36a	59.23ab	2.23a	2.19bc	0.77a	0.618c
0.9	48.06ab	54.30ab	9.55a	61.75ab	2.01b	2.83a	0.75ab	0.684b
1.2	47.61bc	54.78a	9.32ab	62.19a	1.8c	2.87a	0.73bc	0.713a
1.5	45.5e	53.96bc	6.92b	59.25ab	1.38e	2.26b	0.58e	0.675b
Mycorrhizal inoculation (B)								
Control	45.64c	51.37c	7.14b	52.16c	1.34c	1.6c	0.59c	0.581c
G.M	47.52b	53.95b	7.66b	59.55b	1.67b	2.7b	0.64b	0.639b
G.I	48.83a	54.66a	11.8a	66.51a	2.39a	2.92a	0.86a	0.689a
$L.S.D_{0.05}$								
A	**0.35**	**0.54**	**ns**	**4.64**	**0.04**	**0.10**	**0.02**	**0.008**
B	**0.50**	**0.77**	**2.41**	**6.56**	**0.05**	**0.144**	**0.03**	**0.012**
AxB	**0.85**	**1.34**	**ns**	**ns**	**0.092**	**0.25**	**0.046**	**0.021**

*The values in each column followed by the same letter are not significant at 0.05 probability level

These results are in accordance with those obtained by Abd-Elgawad *et al*. (2014) and Gad and Abdel- Moez (2015). Previous studied have shown that cobalt also promotes the growth of seedlings and alleviates the senescence of aged tissues as it inhibits the activities of ACC oxidase and reduced ethylene production (Lau and Yang, 1976). On the other hand, increasing cobalt concentration for E. Clover shoot growth parameters, in soaking solution up to 1.2 mg/l, produced the highest shoot (54.78 cm); massive shoot fresh weight (2.87g) and heaviest shoot dry weight (0.713g). Also, this concentration showed the highest number of leaves/plant (62.19), but without significant difference with other concentrations (Atta-Aly *et al.,* 1998). On the other hand, soaked E. Clover seeds in solution without cobalt gave the shortest shoot (50.50 cm), lowest number of leaves/plant (55.55) and lightest shoot dry weight (0.514g). It is obvious that Co is an essential element for legumes because of its use by microorganisms in fixing atmospheric nitrogen (Evan and Kliwer, 1964). These results are in accordance with those obtained b Abdul Jaleel *et al.* (2009); and Gad and El-Metwally (2015).

Regarding mycorrhizal effect on barley and E. Clover shoot growth parameters, the results in Table (2) showed that treated barley and E. Clover seeds with mycorrhizae, significantly increased all the studied growth parameters as compared with the (control). It has been recognized that Arbuscular mycorrhizal (AM) fungi plays an essential role for nutrient uptake of the majority of plants, including many important crop species. The extraradical mycelium of the fungus takes up nutrients from the soil, transfers these nutrients to the intraradical mycelium within the host root, and exchanges the nutrients against carbon from the host across a specialized plant-fungal interface (Bücking and Kafle 2015). These

results agreed with those reported by Bano and Ashfag (2013) and Abou Elseoud (2008). On the other hand, *G. intraradiaces* was more efficient than *G. macrocarpium* for the studied growth parameters of barley and E. Clover plants. Similar results were reported by Banni and Faituri (2013) who reported that plants treated with *G. intraradiaces* had higher mycorrhizal colonization rate and was more effective than *G. macrocarpium*–treated plants.

B. Root growth parameter

The main treatment effects, including cobalt concentration in soaking solution and inoculated barley and E. Clover seeds has exhibited significant trend on all root growth parameters, Table (3). The data also showed that treated barley seeds with 0.6 mg/L cobalt produced the heaviest root fresh and dry weights (2.40 and 0.52g), longest roots length (1069.39cm) and highest root surface (187.61 cm^2). Additional data revealed that soaking barley seeds in solutions contained the highest studied cobalt concentration (1.5 mg/L) showed maximum root radius (0.028cm) and longest distance between roots (0.572cm). These results are generally confirmed with those reported by Helmy and Gad (2002), and Gad and El-Metwally (2015). However, Atta-Aly *et al*. (1989) found that supplementing the nutrient solution with a concentration of 0.5 mg/L Co^{2+} or less significantly induced ethylene production and adventitious root formation of tomato and squash cuttings. On the other hand, the results in Table (3) pointed out that the heaviest root fresh weight (1.18 g), dry weight (0.61g), longest root length (875.25 cm) and highest root surface area (113.06 cm^2) of E. Clover plants was due to treatment by 1.2mg/L Co^{2+}. Besides, the thickest root (0.23cm) and widest distance between roots (0.61cm) resulted from applied 0.6 mg/L cobalt and without cobalt application to soaking solution, respectively. However, soaking seeds of E. Clover seeds in solution without cobalt showed the lowest root fresh weight (0.81) and dry weight (0.184), shortest root (619.30cm) and lowest root surface (79.65cm^2). Occonner (1992) showed that soybean grown without cobalt exhibited severe nitrogen deficiency, leading the death in about one of four plants. These results are in accordance with those obtained by Atta-Aly (2003). As shown in Table (3) there were highly significant positive interaction effect between cobalt concentration and mycorrhizal species on root fresh weight, root dry weight, root length, root radius and root surface for both two plants.

Table (3). The main effect of cobalt concentrations and Mycorrhizae on root growth parameters of barley and E. Clover plants

Treatments	Root fresh weight (g/plant)		Root dry weight (g/plant)		Root length (cm/plant)		Root radius (cm)		Mean half distance between roots (cm)		Root surface (cm^2/ plant)	
	Barley	E.Clover	Barley	E.Clover	Barley	E.Clover	Barley	E.Clover	Barley	E.Clover	Barley	E.Clover
Cobalt concentration, mg/l (A)												
Control	1.89c	0.81d	0.42c	0.18d	1004.29b	6.19.30e	0.0248b	0.02bc	0.497b	0.61a	153.67c	79.65e
0.3	2.24b	1.01c	0.43c	0.41c	1011.97b	677.29d	0.0264ab	0.21b	0.491b	0.57b	168.38bc	92.69d
0.6	2.4a	1.04b	0.52a	0.42c	1069.39a	737.15c	0.0254ab	0.23a	0.4451b	0.55c	187.61a	104.02c
0.9	2.3b	1.17ab	0.51a	0.53b	1053.58b	851.45a	0.0265ab	0.02b	0.469bc	0.51de	174.85ab	109.35ab
1.2	2.3b	1.18a	0.46b	0.61a	1042.67b	875.25a	0.0260ab	0.019c	0.472bc	0.51e	170.89abc	113.06a
1.5	1.66d	1.16ab	0.38d	0.52b	739.4c	808.05b	0.0275a	0.029b	0.572a	0.53d	122.96d	107.67bc
Mycorrhizal inoculation (B)												
Control	1.7c	0.95c	0.37c	0.196c	775.35c	685.47c	0.0268a	0.020b	0.554a	0.58a	127.88c	92.73c
G.M	1.83b	1.07b	0.42b	0.528b	938.63b	759.12b	0.0251a	0.021ab	0.499b	0.55b	146.38b	101.09b
G.I	2.87a	1.21a	0.57a	0.623a	1296.68a	839.66a	0.0264a	0.021a	0.422c	0.52c	214.91a	109.4a
$L.S.D_{0.05}$												
A	**0.07**	**0.03**	**0.02**	**0.019**	**98.4**	**36.67**	**0.003**	**8.55**	**0.035**	**0.01**	**18.82**	**3.79**
B	**0.05**	**0.02**	**0.01**	**0.013**	**69.61**	**25.93**	**0.002**	**6.04**	**0.025**	**0.01**	**13.3**	**2.68**
AxB	**0.12**	**0.06**	**0.013**	**0.033**	**170.52**	**63.5**	**0.004**	**0.001**	**ns**	**0.026**	**32.58**	**6.57**

*The values in each column followed by the same letter are not significant at 0.05 probability level

As shown in Table (3), inoculated seeds barley and E. Clover with mycorrhizae generally increased significantly all the studied root parameters except root radius and mean half distance between roots compared to the other plants without mycorrhizal inoculation (control). Inoculation barley and E. Clover with *G. intraradiaces* (G.I) produced the heaviest root fresh and dry weights (2.87 and 0.57g), tallest root length (1296.68cm) and largest root surface (214.91 cm^2) compared with the other mycorrhizal species (*G. macrocarpium*). Abou Elseoud (2005) and Puttaradder and Lakshman (2015) reported similar results. They found that mycorrhizal inoculation greatly influenced plant growth, root length, fresh and dry weight of shoots and roots. Also, Abou Elseoud (2008) showed that plants inoculation by mycorrhizal fungi significantly increased root length and root surface area compared to the control.

2. Barley and E. Clover macronutrients content

Considering cobalt concentrations and mycorrhizal inoculation effects on nitrogen, phosphorus and potassium contents and uptake by barley and E. Clover plants, results presented in Table (4) revealed that both studied factors had significant effects on the studied traits. With respect to cobalt concentrations in soaking solutions of barley plants, results showed that low concentration level (0.6 mg/L) produced the highest N, P and K plant contents (18.17, 10.05 and 45.43mg/ g d.m.) and uptake (16.9, 8.43 and 19.81 mg/ plant), respectively. Conversely, the highest cobalt concentration (1.5 mg/L) showed the lowest N, P and K contents in barley plant (9.38, 3.85 and 32.65 mg/ g d.m) and uptake (4.35, 2.07 and 18.3mg/ plant), respectively. Gad and Azize (2011) and Atiia *et al.* (2016) reported similar results. On the other hand, results in Table (4) pointed out that applied 1.2mg cobalt /L to soaking solution produced the highest N, P and K content in E. clover plants (24.89, 11.75 and 28.96 mg/g d.m.) and uptake (16.9, 8.43 and 19.81 mg/plant), respectively. However, the lowest values due to soaking solution without cobalt the (control). Cobalt had positive effect due to several induced effects in hormonal synthesis (auxin and gibberellin contents) and metabolic activity resulted in maximum growth and yield of tomato, and increase the activity of some enzymes i.e. peroxidase and catalase in plant and hence increasing the catabolism rather than anabolism (Gad, 2005). As shown in Table (4) there were highly significant interaction effect between cobalt concentrations and mycorrhizal species on N, P, and K content and uptake of both two plants.

Table (4). The main effects of cobalt concentrations and Mycorrhizae on N, P and K content and uptake of barley and E. Clover plants

Treatments	N content (g/kg d.m)		P content (mg/g d.m)		K content (mg/g d.m)		N uptake (mg/plant)		P uptake (mg/plant)		K uptake (mg/plant)	
	Barley	E.Clover	Barley	E.Clover	Barley	E.Clover	Barley	E.Clover	Barley	E.Clover	Barley	E.Clover
Cobalt concentration, mg/l (A)												
Control	10.4e	15.95d	4.94d	2.53e	34.39d	23.16d	5.18e	5.70d	3.0e	1.10d	19.85e	9.59d
0.3	11.99d	19.24c	5.23d	4.02d	35.25d	24.35cd	7.23d	9.93c	3.61d	2.26cd	21.49d	13.49c
0.6	18.17a	21.86b	10.05a	4.82cd	45.43a	24.81c	13.51a	11.64c	8.13a	2.84c	33.09a	14.10c
0.9	14.83b	23.96a	7.88b	6.46b	42.64b	27.55b	10.3b	15.07ab	6.17b	4.39b	30.26b	17.95b
1.2	13.55c	24.89a	6.45c	11.75a	39.42c	28.96a	9.3c	16.9a	4.42c	8.43a	27.67c	19.81a
1.5	9.38f	22.57b	3.85e	5.49c	32.65e	26.55b	4.35f	13.69b	2.07f	3.57bc	18.30f	16.77b
Mycorrhizal inoculation (B)												
Control	8.03c	17.97c	2.76c	3.30c	30.83c	23.46c	3.57c	6.83c	1.45c	1.54c	16.91c	10.83c
G.M	11.34b	21.66b	5.17b	5.89b	35.92b	25.54b	5.87b	13.01b	3.0b	3.77b	20.95b	15.63b
G.I	19.60a	24.61	11.27a	8.36a	48.15a	28.68a	15.48a	16.63a	9.24a	5.99a	37.68a	19.41a
$LSD_{.05}$												
A	0.57	1.31	0.36	0.94	1.34	1.32	0.39	1.91	0.22	1.40	1.21	1.32
B	0.4	0.92	0.26	0.66	0.95	0.94	0.28	1.35	0.15	0.99	0.85	0.94
AxB	0.98	2.27	0.062	1.63	2.33	2.30	0.68	3.31	0.37	2.42	2.08	2.30

*The values in each column followed by the same letter are not significant at 0.05 probability level

Results presented in Table (4) showed that uninoculated barley and E. Clover seeds with mycorrhizae showed the lowest N, P, and K plant content and uptake respectively. However, inoculated seeds with *G.intraradiaces* showed a significant highest N, P and K content and uptake compared to the other plants inoculated with *G. macrocarpium*. Mycorrhizal plants roots hyphae can increase the branching of root system in rhizosphere so that mycorrhizal plants roots have more absorption efficiency compared to non-mycorrhizal ones. These results are in agreement with those found by Nourinia *et al.* (2007) and Robinson *et al*. (2014).

3. Cobalt contents in barley and E. Clover plants

Table (5) indicated that cobalt contents in shoot, root and whole barley and E. Clover plants were significantly affected by cobalt concentrations in soaking solution and mycorrhizal inoculation.

The results, showed that, applied 1.5 mg / L cobalt to soaking solution produced the highest amount of available cobalt in soil (0.17 and 0.21 mg/ kg soil); and in total shoot cobalt contents (4.99 and 1.81 mg/g d.m); root cobalt contents (7.51 and 17.81 mg/g d.m) and total plant cobalt contents (12.51 and 19.62 mg/g d.m) for barley and E. Clover plants, respectively.

Conversely, the control treatment produced the lowest cobalt in shoot, root and plant content. Similarly, Gad and Abdel-Moez (2015) reported that cobalt content in fenugreek grains significantly increased with increasing cobalt concentration in plant growing in media as compared to the control.

Concerning mycorrhizal effect, results presented in Table (5) revealed that inoculation both barley seeds and E. Clover seeds with *G. intraradiaces* showed the highest amount of available cobalt (0.17 and 0.25 mg/ kg soil); shoot cobalt contents (3.88 and 2.03 mg/g d.m), root cobalt contents (7.16 and 14.99 mg/g d.m) and total plant cobalt contents (11.05 and 17.01 mg/g d.m.) for the two plants, respectively as compared to the other mycorrhizal species (*G. macrocarpium*).

However, the lowest cobalt content resulted from unicoculated seeds. It can be seen from Table (5) that there were highly significant positive interaction effect between cobalt concentrations and mycorrhizal species on available Co^{2+} in soil, shoot Co^{2+}, root $Co^{2+}$and plant cobalt content for both barley and E. Clover plants.

Table (5). The main effects of cobalt concentrations and Mycorrhizae on available cobalt in soil and cobalt content of barley and E. Clover plants

Treatments	Available Co^{2+} (mg/ kg soil)		Shoot Co^{2+}content (mg/ kg d.m)		Root Co^{2+} content (mg/ kg d.m)		Plant Co^{+2} content (mg/ kg d.m)	
	Barley	E.Clover	Barley	E.Clover	Barley	E.Clover	Barley	E.Clover
Cobalt concentration, mg/l (A)								
Control	0.135c	0.02e	0.22e	0.11d	0.43d	0.74e	0.65d	0.85e
0.3	0.15bc	0.02e	0.23d	0.14c	0.45cd	0.93d	0.68d	1.07d
0.6	0.15abc	0.03d	0.25c	0.16b	0.51bc	1.11c	0.76c	1.28c
0.9	0.16ab	0.11c	0.25c	0.17ab	0.55b	1.23b	0.81bc	1.40b
1.2	0.16ab	0.18b	0.31b	0.17ab	0.56b	1.27b	0.88b	144b
1.5	0.17a	0.21a	0.49a	0.18a	0.75a	1.78a	1.25a	1.96a
Mycorrhizal inoculation (B)								
Control	0.13c	0.01c	0.20c	0.09c	0.37c	0.93c	0.57c	1.02c
G.M	0.15b	0.03b	0.29b	0.17b	0.55b	1.11b	0.84b	1.29b
G.I	0.17a	0.25a	0.38a	0.20a	0.71a	1.49a	1.11a	1.70a
$LSD_{.05}$								
A	**0.01**	**0.006**	**0.009**	**0.01**	**0.07**	**0.045**	**0.075**	**0.04**
B	**0.015**	**0.004**	**0.006**	**0.009**	**0.05**	**0.031**	**0.053**	**0.03**
AxB	**0.025**	**0.009**	**0.016**	**0.023**	**0.12**	**0.078**	**0.13**	**0.08**

*The values in each column followed by the same letter are not significant at 0.05 probability level

CONCLUSION

It can be concluded that soaking seeds of barley and E. Clover in cobalt solution and mycorrhizal inoculation had significant effects on all growth parameters of the two plants. Moreover, the interaction was highly positive between cobalt concentrations and mycorrhizae species with both crops forge. Under the same experimental conditions, it can be recommended that *G. intraradiaces* was more effective than *G. macrocarpium* for the studied traits. Also, the recommended cobalt concentration for barley crops was lower (0.6 mg/l) than that for E. Clover (1.2mg/l) since legume plants needs cobalt supply for enhancing nitrogen fixation in all Rhizobium species and hence promotes legume growth.

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الملخص العربي

تأثير إضافة الكوبالت والتلقيح بفطر الميكورايزا على نمو ومحتوى بعض العناصر الغذائية لنباتي الشعير والبرسيم المصري النامية في أرض جيرية

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اجريت هذه الدراسة في الصوبة الزجاجية بكلية الزراعة ساباباشا جامعة الاسكندرية لدراسة تاثير اضافة الكوبالت بنقع البذور وعلاقة ذلك بتلقيحها بالميكورايزا وتاثيره على نمو ومحتوى العناصر الغذائية في نباتي الشعير والبرسيم المصري كمحصولي علف تحت ظروف التربة الجيرية خلال موسمي النمو ٢٠١٢–٢٠١٣ و ٢٠١٣–٢٠١٤ على التوالي. وقد نقعت بذور الشعير والبرسيم المصري في محلول دائم التهوية لمدة ٤٨ ساعة في تركيزات مختلفة من الكوبالت (٠.٠، ٠.٣، ٠.٦، ٠.٩، ١.٢ و ١.٥ملجم/لتر) باستخدام ملح كبريتات الكوبالت كما تم استخدام نوعين من الميكورايزا ادى نقع بذور الشعير والبرسيم المصري (كعلف حيواني) في محلول الكوبالت عند تركيزاته المختلفه وتلقيحها بالميكورايزا الى زيادة معنوية في كل صفات النمو ومحتوى العناصر الغذائية المختبرة في المجموع الخضري والجذري. أدت اضافة الكوبالت الى زيادة محتوى N، P ، K والكوبالت في النباتات المختبرة . وكانت الميكورايزا (*G. intraradiaces*) اكثر فاعلية من النوع (*G. macrocarpium*.). وكان التركيز الامثل للكوبالت هو التركيز (٠.٦ ملجم/لتر) لنبات الشعير، و التركيز (١.٢ ملجم/لتر) لنبات البرسيم المصري.

1017.6, 1001.7 and 0.992 pounds for crops of wheat, rice, summer maize and nile maize respectively. The Egyptian agriculture level they lead to increased production, equivalent to a horizontal agricultural expansion by 338.7, 176.2, 294.5 and 43.2 thousand fedan of crops of wheat, rice, summer maize and Nile maize respectively. As well as achieving savings of irrigation water use at 0.61, 0.92, 1.33 and 0.17 billion cubic meters respectively. The study recommended in the light of the findings, the importance of implementing programs for the development of cereal crops including contents of the provision and improvement of production inputs (fertilizer, improved varieties, pest resistance, irrigation), and provide extension support to farmers and to provide credit to farmers and other incentives, to increase production efficiency and economic benefits vertical grain crops development.

Estimation of The Technical Efficiency for Production of The Most Important Grain Crops in Egyptian Governorates

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ABSTRACT: There is many difficulties in front of horizontal Agricultural development such as the rarity of agricultural resources, particularly land and water, in addition to the largeness of the required investment, which makes the vertical agricultural development through increase unit production of resources target seeks agricultural policy to achieve it, in setting the research problem this research target study all the development of area and the production of the most important cereal crop in the Egyptian agriculture represented in wheat, rice, maize, estimate some of the productivity and economic indicators for those cereal crops, estimate the technical efficiency of the production of wheat, rice and maize in governorates of Egypt, estimate the economic effects of achieving technical efficiency in the production of grain crops at the government level and the Egyptian agriculture. To reach the research goals its adopted on the descriptive method of economic analysis to measure and quantify the measurement of productivity and some economic indicators related to the production the most important grain crops, simple regression, descriptive and quantitative method of Data Envelopment Analysis (DEA) to measure the technical efficiency of the most important grain crops. The results show that there is statistical significance for growth rate in cultivated area for crops of wheat ,summer maize, Nile maize amounted to about 2.2%, 1.6% and 10.2% each respectively, than the annual average during the study period of about 2859.4, 1852.4 and 281.3 thousand fedan for each of them respectively. While the annual growth of the total production rate of about 2.4%, 13% and 21.7% respectively, at a time when statistical morale did not prove to the rate of growth of the area and production of rice crop because the specific area by irrigation and agriculture ministries. Elbehera governorate has achieved maximum return per fedan for wheat valued about 5125 pounds, and maximum return fedan wheat crop of about 1.37 pounds in Aswan, while the province of Dakahlia achieved maximum return fedan crops of rice, summer maize and nile maize indigo value of 4808.5601 and 4443 pounds for the three crops respectively. The results of estimating the technical efficiency of grain crops under study that the average coefficient of technical efficiency about 0.89, 0.87, 0.86 and 0.82 for crops of wheat, rice, summer maize and nile maize, respectively, and technical efficiency in a production of the wheat crop has been achieved in six governorates Elbehera, Dakahlia, Damietta, Menoufia, Giza, Aswan, and in the production of rice crop achieved full technical efficiency in the governorates of Dakahlia, Ismailia, and for the summer maize have technical competence in full production achieved in Beheira, Dakahlia, Aswan. Finally full technical efficiency achieved at nile maize in governorates of Dakahlia, Elsharkia, Fayoum.The economic implications of achieving the technical efficiency of the most important gain crops at the farm level in the increase the net return pre fedan by 826.1,

أردب، تبلغ قيمتها حوالي ٩٩٢ جنيه تمثل زيادة في كل من إجمالي العائد الفداني وصافي العائد الفداني لأن زيادة الإنتاجية تتحقق دون زيادة مدخلات الإنتاج. أما على المستوى القومي فإن تحقيق الكفاءة الفنية يؤدي إلى زيادة الإنتاج الكلي من محصول الذرة الشامية النيلي بمقدار يبلغ حوالي ٠,٨١ مليون أردب، هذه الكمية يمكن إنتاجها من مساحة تعادل حوالي ٤٣,٢ ألف فدان توسع أفقي، كما يبلغ مقدار الوفر المتحقق في مياه الري والذي يمكن أن يستخدم لري تلك المساحة بحوالي ٠,١٧ مليار متر مكعب، جدول رقم (١٢).

توصي الدراسة في ضوء ما توصلت إليه من نتائج، بأهمية تنفيذ برامج لتنمية محاصيل الحبوب بما تضمنه من توفير وتحسين مستلزمات الإنتاج (الأسمدة، الأصناف المحسنة، مقاومة الآفات، مياه الري)، وتقديم الدعم الإرشادي للمزارعين، توفير الائتمان للمزارعين والحوافز الأخرى، لرفع الكفاءة الإنتاجية وتحقيق المنافع الاقتصادية للتنمية الرأسية لمحاصيل الحبوب.

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محصول الذرة الشامية الصيفي: تشير النتائج الواردة بالجدول رقم (١١) إلى أن الكفاءة الفنية لمحصول الذرة الشامية الصيفي قدرت بنحو ٠,٨٦ أي أن هناك إمكانية لزيادة الإنتاجية الفدانية بنسبة تقدر بنحو ١٤% وهي تعادل حوالي ٣,١٦ أردب، تبلغ قيمتها حوالي ١٠٠٢ جنيه تمثل زيادة في كل من إجمالي العائد الفداني وصافي العائد الفداني لأن زيادة الإنتاجية تتحقق دون زيادة مدخلات الإنتاج. أما على المستوى القومي فإن تحقيق الكفاءة الفنية يؤدي إلى زيادة الإنتاج الكلي من محصول الذرة الشامية الصيفي بمقدار يبلغ حوالي ٦,٧ مليون أردب، هذه الكمية يمكن إنتاجها من مساحة تعادل حوالي ٢٩٥ ألف فدان توسع أفقي، كما يبلغ مقدار الوفر المتحقق في مياه الري والذي يمكن أن يستخدم لري تلك المساحة بحوالي ١,٣٣ مليار متر مكعب، جدول رقم (١٢) .

جدول رقم (١١).الآثار الاقتصادية لتحقيق الكفاءة الفنية في عملية إنتاج أهم محاصيل الحبوب في الزراعة المصرية على مستوى المزرعة للموسم الزراعي (٢٠١٣/٢٠١٤)

المحصول	الكفاءة الفنية	الإنتاجية الفدانية			سعر الأردب	الزيادة في العائد الفداني
		فعلية	مستهدفة	الزيادة		
	%	أردب	أردب	أردب	جنيه	جنيه
القمح	٠,٨٩	١٨,٣	٢٠,٣١	٢,٠١	٤١١	٨٢٦,١
الأرز	٠,٨٧	٢٤,٥	٢٧,٦٧	٣,١٨	٣٢٠	١٠١٧,٦
الذرة الشامية الصيفي	٠,٨٦	٢٢,٦	٢٥,٧٦	٣,١٦	٣١٧	١٠٠١,٧
الذرة الشامية النيلي	٠,٨٢	١٨,٧	٢٢,٠٤	٣,٣٤	٢٩٧	٩٩٢

المصدر: جمعت وحسبت من: وزارة الزراعة واستصلاح الأراضي، قطاع الشئون الاقتصادية، نشرة إحصاءات التكاليف وصافي العائد، ٢٠١٤، نتائج تحليل الكفاءة باستخدام برنامج DEAP v.2.1.

جدول رقم (١٢).الآثار الاقتصادية لتحقيق الكفاءة الفنية في عملية إنتاج أهم محاصيل الحبوب في الزراعة المصرية على مستوى الزراعة المصرية للموسم الزراعي (٢٠١٣/٢٠١٤)

المحصول	الكفاءة الفنية	الإنتاجية الفدانية			المساحة المنزرعة	الزيادة الممكنة في إجمالي الإنتاج	المساحة المقابلة بالتوسع الأفقي	المقنن المائي للفدان	الوفر المتحقق في مياه الري
		فعلية	مستهدفة	الزيادة					
	%	أردب	أردب	أردب	ألف فدان	ألف أردب	ألف فدان	م٣/فدان	مليار متر مكعب
القمح	٠,٨٩	١٨,٣	٢٠,٣١	٢,٠١	٣٠٨٣,٩	٦١٩٨,٧	٣٣٨,٧	١٨٠٠	٠,٦١
الأرز	٠,٨٧	٢٤,٥	٢٧,٦٧	٣,١٨	١٣٥٧,٣	٤٣١٦,٤	١٧٦,٢	٥٢٠٠	٠,٩٢
الذرة الشامية الصيفي	٠,٨٦	٢٢,٦	٢٥,٧٦	٣,١٦	٢١٠٦,٦	٦٦٥٦,٩	٢٩٤,٥	٤٥٠٠	١,٣٣
الذرة الشامية النيلي	٠,٨٢	١٨,٧	٢٢,٠٤	٣,٣٤	٢٤١,٩	٨٠٨,٢	٤٣,٢	٣٩٠٠	٠,١٧

المصدر: جمعت وحسبت من:

- وزارة الزراعة واستصلاح الأراضي، قطاع الشئون الاقتصادية، نشرة الإحصاءات الزراعية ٢٠١٤.
- الجهاز المركزي للتعبئة العامة والإحصاء، النشرة السنوية لإحصاءات الري والموارد المائية، أكتوبر ٢٠١٤.
- نتائج تحليل الكفاءة باستخدام برنامج DEAP v.2.1.

محصول الذرة الشامية النيلي: تشير النتائج الواردة بالجدول رقم (١١) إلى أن الكفاءة الفنية لمحصول الذرة الشامية النيلي قدرت بنحو ٠,٨٢ أي أن هناك إمكانية لزيادة الإنتاجية الفدانية بنسبة تقدر بنحو ١٨% وهي تعادل حوالي ٣,٣٤

محصول القمح: تشير النتائج الواردة بالجدول رقم (١١) إلى أن الكفاءة الفنية لمحصول القمح قدرت بنحو ٠,٨٩ وهو ما يعني أن هناك إمكانية لزيادة الإنتاجية الفدانية بنسبة تقدر بنحو ١١% وهي تعادل حوالي ٢,٠١ أردب، تبلغ قيمتها حوالي ٨٢٦,١ جنيه تمثل زيادة في كل من إجمالي العائد الفداني وصافي العائد الفداني لأن زيادة الإنتاجية تتحقق دون زيادة مدخلات الإنتاج. أما على المستوى القومي فإن تحقيق الكفاءة الفنية يؤدي إلى زيادة الإنتاج الكلي من محصول القمح بمقدار يبلغ حوالي ٦,٢ مليون أردب، هذه الكمية يمكن إنتاجها من مساحة تعادل حوالي ٣٣٨,٧ ألف فدان توسع أفقي، كما يبلغ مقدار الوفر المتحقق في مياه الري والذي يمكن أن يستخدم لري تلك المساحة بحوالي ٠,٦١ مليار متر مكعب، جدول رقم (١٢).

جدول رقم (١٠). تقدير الكفاءة الفنية لمحافظات الجمهورية في إنتاج محصول الذرة الشامية النيلي للموسم الزراعي (٢٠١٣/٢٠١٤)

المحافظات	المدخلات		المخرجات	الكفاءة الفنية		كفاءة السعة	فوائض المدخلات	
	رأس المال جنيه	العمل البشري جنيه	الإنتاجية أردب	CRS %	VRS %	SE %	طبيعة العائد للسعة	رأس المال بالجنيه	العمل البشري بالجنيه
الإسكندرية	٢٠٨٤	١٧١٥	١٨,٧٩	٠,٥٥٢	٠,٥٧	٠,٩٦	drs	٠	٠
البحيرة	٢١٧٠	١٠٣٥	٢٠,٣٤	٠,٨٦٤	٠,٨٧	٠,٩٩	drs	٠	٠
الغربية	٢٢٩٤	١٤٤١	٢٠,١٤	٠,٦٥٣	٠,٦٨	٠,٩٦	drs	٠	٠
الدقهلية	١٧١٣	١٦٥٠	٢٩,٠٤	١,٠٠٠	١,٠٠	١,٠٠	-	٠	٠
الشرقية	٢١٤٨	٩٥٠	٢٢,٠٤	١,٠٠٠	١,٠٠	١,٠٠	-	٠	٠
الاسماعيلية	١٩٣٥	١٤٠٠	١٨,٤٩	٠,٦٣٣	٠,٦٦	٠,٩٦	drs	٠	٠
الجيزة	٢٢٨٨	١٥٦٢	٢٥,١	٠,٧٦٤	٠,٨٢	٠,٩٣	drs	٠	٠
بنى سويف	١٤٢٧	١٠٢٠	١٨,٢٧	٠,٨٥٨	٠,٩٠	٠,٩٦	drs	٠	٠
الفيوم	٧٩٢	٦٢٥	١٢,٨٢	١,٠٠٠	١,٠٠	١,٠٠	-	٠	٠
قنا	١١٤٣	٦٤٥	٩,٠٣	٠,٦٤٠	٠,٩٧	٠,٦٦	irs	٠	٠
الأقصر	١٤٥١	١٢٨٥	١١,٤٨	٠,٥٧٦	٠,٥٥	٠,٨٧	irs	٣١٥,٦	٠
المتوسط	**١٧٦٧,٧**	**١٢١١,٦**	**١٨,٧**	**٠,٧٦٧**	**٠,٨٢**	**٠,٩٤**			

المصدر: جمعت وحسبت من: وزارة الزراعة واستصلاح الأراضي، قطاع الشئون الاقتصادية، نشرة إحصاءات التكاليف وصافي العائد، ٢٠١٤، نتائج تحليل الكفاءة باستخدام برنامج DEAP v.2.1.

محصول الأرز الصيفي: تشير النتائج الواردة بالجدول رقم (١١) إلى أن الكفاءة الفنية لمحصول الأرز قدرت بنحو ٠,٨٧ أي أن هناك إمكانية لزيادة الإنتاجية الفدانية بنسبة تقدر بنحو ١٣% وهي تعادل حوالي ٣,١٨ أردب، تبلغ قيمتها حوالي ١٠١٨ جنيه تمثل زيادة في كل من إجمالي العائد الفداني وصافي العائد الفداني لأن زيادة الإنتاجية تتحقق دون زيادة مدخلات الإنتاج. أما على المستوى القومي فإن تحقيق الكفاءة الفنية يؤدي إلى زيادة الإنتاج الكلي من محصول الأرز بمقدار يبلغ حوالي ٤,٣ مليون أردب، هذه الكمية يمكن إنتاجها من مساحة تعادل حوالي ١٧٦,٢ ألف فدان توسع أفقي، كما يبلغ مقدار الوفر المتحقق في مياه الري والذي يمكن أن يستخدم لري تلك المساحة بحوالي ٠,٩٢ مليار متر مكعب، جدول رقم (١٢) .

وبتقدير فوائض المدخلات والتي تعبر عن القدر من المدخلات الذي يمكن خفضه دون أن يتأثر مستوى الإنتاج، تبين وجود فوائض في رأس المال بمحافظة الأقصر فقط بمقدار بلغ حوالي ٣١٥,٦ جنيهاً، بينما لم يظهر فوائض في استخدام عنصري العمل ورأس المال في باقي محافظات الجمهورية.

جدول رقم (٩). تقدير الكفاءة الفنية لمحافظات الجمهورية في إنتاج محصول الذرة الشامية الصيفي للموسم الزراعي (٢٠١٣/٢٠١٤)

المحافظات	المدخلات		المخرجات	الكفاءة الفنية		كفاءة السعة		فوائض المدخلات	
	رأس المال جنيه	العمل البشري جنيه	الإنتاجية أردب	CRS %	VRS %	SE %	طبيعة العائد للسعة	رأس المال بالجنيه	العمل البشري بالجنيه
الإسكندرية	٢٠٤٥	١٧٧٥	٢٣,٨٤	٠,٦٨٢	٠,٧٢	٠,٩٥	irs	٠	١١,٠٣
البحيرة	٢١٨١	١٣٤٥	٢٦,٦٦	١,٠٠٠	١,٠٠	١,٠٠	-	٠	٠
الغربية	٢٠٩٤	١٤١٠	٢٥,٥٢	٠,٩٥١	٠,٩٣	٠,٩٩	irs	٠	٠
كفر الشيخ	٢٢٠١	١٥٦٠	٢٦,٤٩	٠,٨٥٩	٠,٨٧	٠,٩٩	irs	٠	٠
الدقهلية	١٦٦٠	١٤٤٠	٢٨,٣٦	١,٠٠٠	١,٠٠	١,٠٠	-	٠	٠
دمياط	٢٢٣٩	١٩٢٥	٢٥,٠٥	٠,٦٦١	٠,٦٨	٠,٩٧	irs	٠	٠
الشرقية	٢١١٩	١٦٢٥	٢٤,٧١	٠,٧٧٠	٠,٧٩	٠,٩٧	irs	٠	٠
الاسماعيلية	١٤٤٩	١٦٢٥	١٧,٣	٠,٦٩٩	٠,٨١	٠,٨٦	irs	٠	٣٢٣,٩
المنوفية	٢٠٥٦	١٦٥٠	٢٦,١٧	٠,٨٠٤	٠,٨٢	٠,٩٨	irs	٠	٠
القليوبية	١٩٧٧	١٤٠٠	٢٣,٤٣	٠,٨٤٧	٠,٨٨	٠,٩٦	irs	٠	٠
الجيزة	٢٣٩٢	١٥٦٣	٢٦,٠٩	٠,٨٤٣	٠,٨٥	٠,٩٩	irs	٠	٠
بنى سويف	١٨٥٧	١٢٦٠	٢٠,١	٠,٨٠٦	٠,٨٧	٠,٩٢	irs	١٠٦,٢٤	٠
الفيوم	١٥٣٠	١٣٧٥	١٩,٥٦	٠,٧٤٨	٠,٨٣	٠,٨٩	irs	٠	٥٩,٩
المنيا	١٦٤١	١٣١٥	٢٢,٩١	٠,٨٨٣	٠,٩٣	٠,٩٥	irs	٠	٠
أسيوط	٢١٤٩	١٥٩٠	٢٣,٢٩	٠,٧٤٢	٠,٧٧	٠,٩٦	irs	٠	٠
سوهاج	١٦٩٥	١٧٦٠	٢٣,٠٤	٠,٧٩٦	٠,٨٤	٠,٩٥	irs	٠	٢٥٦,٠
قنا	١٥١٨	١٢٨٠	١٥,٩٨	٠,٦٣٤	٠,٧٥	٠,٨٥	irs	٠,٥٠	٠
الأقصر	١٢٤٤	٩٨٥	١٤,٣٨	٠,٧٤٠	٠,٩٨	٠,٧٦	irs	٧٤,٤٣	٠
أسوان	١١٣٨	٩٦٠	١٦,٤٣	٠,٨٦٩	١,٠٠	٠,٨٧	irs	٠	٠
المتوسط	**١٨٥١,٨**	**١٤٦٥,٤**	**٢٢,٦**	**٠,٨٠٥**	**٠,٨٦**	**٠,٩٤**			

المصدر: جمعت وحسبت من: وزارة الزراعة واستصلاح الأراضي، قطاع الشئون الاقتصادية، نشرة إحصاءات التكاليف وصافي العائد، ٢٠١٤، نتائج تحليل الكفاءة باستخدام برنامج DEAP v.2.1.

رابعاً: تقدير الآثار الاقتصادية المترتبة على تحقيق الكفاءة الفنية لأهم محاصيل الحبوب خلال الموسم الزراعي (٢٠١٣/٢٠١٤)

يمكن تناول الآثار الاقتصادية المترتبة على تحقيق الكفاءة الفنية لإنتاج أهم محاصيل الحبوب على مستويين، الأول مستوى المزرعة خاصة المتعلقة بزيادة إجمالي العوائد الفدانية، الأمر الذي ينعكس على زيادة صافي العائد الفداني للمزارع، الثاني مستوى الزراعة المصرية وبصفة خاصة الآثار المتعلقة بأكثر الموارد الزراعية ندرة وهي الأرض والمياه.

محصول الذرة الشامية الصيفي: تشير نتائج التحليل الواردة بجدول رقم (٩) إلى أن الكفاءة الفنية التامة وفقاً لفرضية العائد المتغير للسعة في إنتاج محصول الذرة الشامية الصيفي تحققت في ثلاثة محافظات فقط وهى البحيرة، الدقهلية، أسوان بينما المحافظات الأقل كفاءة فنية تمثلت في قنا، الإسكندرية، دمياط بمعامل كفاءة بلغ ٠,٧٢، ٠,٧٥، ٠,٦٨ لكل منهم على الترتيب، وبلغ متوسط معامل الكفاءة الفنية لمحافظات الجمهورية في إنتاج الذرة الشامية الصيفي حوالى ٠,٨٦، الأمر الذى يشير إلى إمكانية زيادة الإنتاجية الفدانية لمحصول الذرة الشامية الصيفي (٢٢,٦ أردب) بنسبة ١٤% باستخدام نفس القدر من الموارد تمثل حوالي ٣,١٦ أردب للفدان. كما تشير نتائج كفاءة السعة لمحافظات الجمهورية في إنتاج الذرة الشامية الصيفي أنها تراوحت بين حد أدنى بلغ نحو ٠,٧٦ في محافظة الأقصر، بينما بلغت الواحد الصحيح في كل من محافظتي البحيرة والدقهلية، بمتوسط بلغ نحو ٠,٩٤، أي أن محافظات الجمهورية تعمل عند سعة إنتاجية تقل عن السعة الإنتاجية المثلى بنحو ٦% وتشير نتائج طبيعة العائد للسعة أن جميع محافظات الجمهورية تخضع لتزايد العائد للسعة باستثناء محافظتي البحيرة والدقهلية حيث تتسما ثبات العائد للسعة.

وبتقدير فوائض المدخلات والتي تعبر عن القدر من المدخلات الذي يمكن خفضه دون أن يتأثر مستوى الإنتاج، تبين وجود فوائض في رأس المال بمحافظات بني سويف، الأقصر، قنا بمقدار بلغ حوالي ١٠٦,٢٤، ٧٤,٤٣، ٠,٥ جنيه لكل منهما على الترتيب، بينما اتسمت محافظات الإسماعيلية، سوهاج، الفيوم، الإسكندرية بوجود فوائض في عنصر العمل بلغت حوالي ٣٢٣,٩، ٢٥٦، ٥٩,٩، ١١,٠٣ جنيه لكل منهم على الترتيب.

محصول الذرة الشامية النيلي: تشير نتائج التحليل الواردة بجدول رقم (١٠) إلى أن الكفاءة الفنية التامة وفقاً لفرضية العائد المتغير للسعة في إنتاج محصول الذرة الشامية النيلي قد تحققت في ثلاثة محافظات وهى الدقهلية، الشرقية، الفيوم بينما المحافظات الأقل كفاءة فنية تمثلت في كل من الإسماعيلية، الإسكندرية، الأقصر بمعامل كفاءة بلغ حوالي ٠,٦٦، ٠,٥٧، ٠,٥٥ لكل منهم على الترتيب، وبلغ متوسط معامل الكفاءة الفنية لمحافظات الجمهورية في إنتاج الذرة الشامية النيلي حوالي ٠,٨٢ الأمر الذى يشير إلى إمكانية زيادة الإنتاجية الفدانية (١٨,٦ أردب) بنسبة ١٨% باستخدام نفس القدر من الموارد تقدر بحوالي ٣,٣٤ أردب للفدان.

كما تشير نتائج كفاءة السعة لمحافظات الجمهورية في إنتاج الذرة الشامية النيلي أنها تراوحت بين حد أدنى بلغ نحو ٠,٦٦ في محافظة قنا وحد أقصى بلغ واحد صحيح في محافظات الدقهلية، الشرقية، الفيوم بمتوسط بلغ نحو ٠,٩٤، أي أن محافظات الجمهورية تعمل عند سعة إنتاجية تقل عن السعة الإنتاجية المثلى بنحو ٦%، وتشير نتائج طبيعة العائد للسعة أن جميع محافظات الجمهورية تخضع لتناقص العائد للسعة باستثناء محافظتي قنا والأقصر حيث تميزتا بتزايد العائد للسعة، بينما تميزت محافظات الدقهلية، الشرقية، الفيوم بثبات العائد للسعة.

محصول الأرز الصيفي: تشير نتائج التحليل الواردة بجدول رقم (٨) إلى أن الكفاءة الفنية التامة وفقاً لفرضية العائد المتغير للسعة في إنتاج محصول الأرز الصيفي تحققت في كل من محافظتي الدقهلية، الإسماعيلية، بينما تمثلت المحافظات الأقل كفاءة فنية في كل من الإسكندرية، كفر الشيخ، بورسعيد بمعامل كفاءة بلغ ٠,٧٢، ٠,٧١، ٠,٧٠ لكل منهم على الترتيب، وبلغ متوسط معامل الكفاءة لمحافظات الجمهورية في إنتاج الأرز حوالى ٠,٨٧، الأمر الذى يشير إلى إمكانية زيادة الإنتاجية الفدانية لمحصول الأرز (٣,٦٧ طن) بنسبة تبلغ نحو ١٣% باستخدام نفس القدر من الموارد تمثل حوالي ٠,٤٧٧ طن للفدان. كما تشير نتائج كفاءة السعة لمحافظات الجمهورية في إنتاج الأرز الصيفي أنها تراوحت بين حد أقصى بلغ واحد صحيح في محافظة الدقهلية، وحد أدنى في محافظتي المنوفية، الإسماعيلية قدر بحوالي ٠,٧٨، ٠,٧٥ بمتوسط بلغ نحو ٠,٨٨، أي أن محافظات الجمهورية تعمل عند سعة إنتاجية تقل عن السعة الإنتاجية المثلى بنحو 12%، وتشير نتائج طبيعة العائد للسعة أن جميع محافظات الجمهورية تخضع لتزايد العائد للسعة باستثناء محافظة الدقهلية والتي تميزت بثبات العائد للسعة. وبتقدير فوائض المدخلات والتي تعبر عن القدر من المدخلات الذي يمكن خفضه دون أن يتأثر مستوى الإنتاج، تبين وجود فوائض في استخدام عنصر العمل بلغت أقصاها في محافظة الغربية بقيمة بلغت ٨٩٨,٠٦ جنيه، يليها في ذلك محافظات الشرقية، البحيرة، المنوفية بحوالي بقيمة بلغت حوالي ٥٥٩,٨٢، ٣٨٤,٥٤، ١٣,٤٦ جنيه لكل منهم على الترتيب، بينما لم تظهر نتائج التحليل وجود فوائض في استخدام عنصر رأس المال في جميع محافظات الجمهورية.

جدول رقم (٨). تقدير الكفاءة الفنية لمحافظات الجمهورية في إنتاج محصول الأرز للموسم الزراعي (٢٠١٣/٢٠١٤)

المحافظات	المدخلات		المخرجات	الكفاءة الفنية		كفاءة السعة		فوائض المدخلات	
	رأس المال جنيه	العمل البشري جنيه	الإنتاجية طن	CRS %	VRS %	SE %	طبيعة العائد للسعة	رأس المال بالجنيه	العمل البشري بالجنيه
الإسكندرية	٢٣٥٢	١٦٧٠	٣,٦	٠,٦٢٠	٠,٧٢٤	٠,٨٥٦	irs	٠	٠
البحيرة	١٩١٤	١٦٥٠	٤,٠٤٩	٠,٨٥٦	٠,٨٩٨	٠,٩٥٣	irs	٠	٣٨١,٥٤
الغربية	١٨٠٣	٢١٧٠	٣,٩	٠,٨٧٦	٠,٩٤٤	٠,٩٢٨	irs	٠	٨٣٨,٠٦
كفر الشيخ	٢٤١١	١٦٠٠	٣,٩٤٢	٠,٦٦٢	٠,٧١١	٠,٩٣١	irs	٠	٠
الدقهلية	١٧٥٣	٨٩٤	٤,٣٣١	١,٠٠٠	١,٠٠٠	١,٠٠٠	-	٠	٠
دمياط	١٧٨٣	١٥٨٠	٣,٤٥١	٠,٧٨٣	٠,٩٣١	٠,٨٤٢	irs	٠	٠
الشرقية	١٨٥٩	٢٠٢٢	٣,٨٠٦	٠,٨٢٩	٠,٩٠٩	٠,٩١١	irs	٠	٥٥٩,٨٢
الاسماعيلية	١٥٨٥	١٩٢٥	٢,٩٢٤	٠,٧٤٧	١,٠٠٠	٠,٧٤٧	irs	٠	٠
بورسعيد	٢٣٩٧	١٨٠٠	٣,٩	٠,٦٠٨	٠,٧٠٦	٠,٨٦١	irs	٠	٠
المنوفية	١٨٧٩	٢١١٠	٣,١٠٧	٠,٦٦٩	٠,٨٥٥	٠,٧٨٣	irs	٠	١٣,٤٩
القليوبية	٢٢٣٣	١٨٦٠	٣,٦١٣	٠,٦٥٥	٠,٧٤٩	٠,٨٧٥	irs	٠	٠
المتوسط	**١٩٩٧,٢**	**١٧٥٢,٨**	**٣,٦٧**	**٠,٧٦٧**	**٠,٨٦٩**	**٠,٨٥٦**			

irs: increasing returns to scale

المصدر: جمعت وحسبت من: وزارة الزراعة واستصلاح الأراضي، قطاع الشئون الاقتصادية، نشرة إحصاءات التكاليف وصافي العائد، ٢٠١٤، نتائج تحليل الكفاءة باستخدام برنامج DEAP v.2.1.

يمكن خفضه دون أن يتأثر مستوى الإنتاج، تبين وجود فوائض في رأس المال بمحافظة الشرقية والإسكندرية فقط بمقدار بلغ حوالي ٢٧١,٧، ١٥٢,٤ جنيه لكل منهما على الترتيب، بينما اتسمت معظم المحافظات بوجود فوائض في عنصر العمل بلغت اقصاها في محافظة سوهاج بحوالي ٥٥٥,٤ جنيه تليها كل من الأقصر، أسيوط والمنيا بقيمة بلغت حوالى ٢١٦,٥، ١٧٨,١، ١٧٢,٧جنيه كل منهم على الترتيب، وبلغت أدناها في محافظتي الغربية، القليوبية بقيمة بلغت حوالى ٢٦,٦، ٤٦,٥ جنيه لكل منهما على الترتيب، الأمر الذي يشير إلى الإسراف في استخدام عنصر العمل في عملية إنتاج القمح في غالبية محافظات الجمهورية وبصفة خاصة محافظات الوجه القبلي.

جدول رقم (٧). تقدير الكفاءة الفنية لمحافظات الجمهورية في إنتاج محصول القمح للموسم الزراعي (٢٠١٣/٢٠١٤)

المحافظات	المدخلات		المخرجات	الكفاءة الفنية TE		كفاءة السعة		فوائض المدخلات	
	رأس المال جنيه	العمل البشري جنيه	الإنتاجية أردب	CRS %	VRS %	SE %	طبيعة العائد للسعة	رأس المال بالجنيه	العمل البشري بالجنيه
الإسكندرية	٢٣٤٥	١٠١٠	١٧,٦٦	٠,٨١	٠,٨١	٠,٩٩	drs	١٥٢,٤	٠
البحيرة	١٩٠٤	١٢١٥	١٩,٦٢	٠,٩٥	١,٠٠	٠,٩٤	drs	٠	٠
الغربية	٢٠٤٠	١٣٦٥	١٩,٠٨	٠,٨٦	٠,٩٠	٠,٩٥	drs	٠	٢٦,٦
كفر الشيخ	١٧٤٧	١٣٠٠	١٧,٨٢	٠,٩٤	٠,٩٥	٠,٩٨	drs	٠	٧٥,٤
الدقهلية	١٨٥٩	١٠٣٥	١٩,٠٠	٠,٩٤	١,٠٠	٠,٩٤	drs	٠	٠
دمياط	١٦٤٥	١١٥٥	١٧,٧٣	٠,٩٩	١,٠٠	٠,٩٩	drs	٠	٠
الشرقية	٢٢٧٧	٩٣٥	١٧,٢٨	٠,٨٦	٠,٨٦	٠,٩٩	drs	٢٧١,٧	٠
الاسماعيلية	٢٥١٣	١٢٥٥	١٧,٧٣	٠,٦٥	٠,٦٩	٠,٩٥	drs	٠	٠
المنوفية	٢٢٣٢	١٥٨٢	٢١,٣٦	٠,٨٨	١,٠٠	٠,٨٨	drs	٠	٠
القليوبية	١٧٥٨	١٢٤٥	١٨,٢٩	٠,٩٦	٠,٩٨	٠,٩٧	drs	٠	٤٦,٥
الجيزة	٢٢٦٣	٩٥٥	٢٠,٣٤	٠,٩٩	١,٠٠	٠,٩٨	drs	٠	٠
بنى سويف	٢٠٩٥	١٥٦٠	١٨,٠٩	٠,٨٠	٠,٨١	٠,٩٨	drs	٠	٩٥,٢
الفيوم	٢١٨٦	١٥١٠	١٨,٠٠	٠,٧٦	٠,٧٧	٠,٩٨	drs	٠	٠
المنيا	٢٠٠٨	١٤٩٠	١٩,٢٦	٠,٨٨	٠,٩٢	٠,٩٥	drs	٠	١٧٢,٧
أسيوط	٢٢٥٦	١٧٧٠	١٨,٢٩	٠,٧٥	٠,٧٦	٠,٩٧	drs	٠	١٧٨,١
سوهاج	١٩١٣	١٩٧٠	١٧,٨٨	٠,٨٦	٠,٨٧	٠,٩٩	drs	٠	٥٥٥,٤
قنا	٢٠٤٦	١٤٨٤	١٧,٣١	٠,٧٨	٠,٧٨	٠,٩٩	drs	٠	١٢٤,٧
الأقصر	٢٠٢٠	١٣٩٣	١٦,٦٠	٠,٧٦	٠,٧٥	٠,٩٩	drs	٠	٢١٦,٥
أسوان	١٥٠٠	٧٥٥	١٦,٣٠	١,٠٠	١,٠٠	١,٠٠	-	٠	٠
المتوسط	**٢٠٣٢**	**١٣١٥**	**١٨,٣٠**	**٠,٨٦**	**٠,٨٩**	**٠,٩٧**			

Technical Efficiency :TE
Constant Returns to Scale :CRS
Variable Returns to Scale, :VRS
Scale Efficiency :SE
decreasing returns to scale :drs

المصدر: جمعت وحسبت من: وزارة الزراعة واستصلاح الأراضي، قطاع الشئون الاقتصادية، نشرة إحصاءات التكاليف وصافي العائد، ٢٠١٤، نتائج تحليل الكفاءة باستخدام برنامج DEAP v.2.1.

ثالثاً: تقدير الكفاءة الفنية لإنتاج أهم محاصيل الحبوب خلال الموسم الزراعي (٢٠١٣/٢٠١٤)

تم تقدير الكفاءة باستخدام أسلوب تحليل مغلف البيانات وتمثلت مدخلات الإنتاج في مدخلين فقط هما العمل معبراً عنه بقيمته النقدية بالجنيه، ورأس المال ليمثل قيمة مستلزمات الإنتاج معبراً عنه بالجنيه، في حين تمثلت المخرجات في الإنتاجية الفدانية معبراً عنها بالأردب، وتم إجراء التحليل وفقاً لفرضيتي ثبات العائد للسعة (CRS)، العائد المتغير للسعة (VRS) حتى يمكن فصل كفاءة السعة عن الكفاءة الفنية، كذلك تم التحليل وفقاً لمفهوم مدخلات الإنتاج input orientated وهو ما يتناسب مع طبيعة الإنتاج الزراعي.

جـدول رقم (٦). المؤشرات الإنتاجية والاقتصادية لمحصول الذرة الشامية النيلي بمحافظات الجمهورية خلال الموسـم الزراعي (٢٠١٣/٢٠١٤)

المحافظات	صافي العائد بالجنيه/فدان	القيمة المضافة بالجنيه/فدان	الأربحية النسبية %	نسبة الإيرادات إلى التكاليف %	معدل العائد على الجنيه المستثمر بالجنيه
الإسكندرية	٧٧٥	٤٧٢٤	٢٠,٤٠	١,١٥	٠,١٥
البحيرة	٢١٠٥	٤٩٤٠	٦٥,٦٨	١,٥٠	٠,٥٠
الغربية	١٤١٤,٤٤	٤٧٦٤,٤٤	٣٧,٨٧	١,٢٩	٠,٢٩
الدقهلية	٤٤٤٢,٩٨	٧٨٧٦,٩٨	١٣٢,١٥	٢,٠٢	١,٠٢
الشرقية	٢٤٥٧	٥٤٩٣	٧٩,٣١	١,٥٧	٠,٥٧
الإسماعيلية	١٢٧٨,٥٥	٤٧٠٨,٥٥	٣٨,٣٤	١,٢٨	٠,٢٨
الجيزة	٢٩٢٤,٦١	٦١١٤,٦١	٧٥,٩٦	١,٦٠	٠,٦٠
بنى سويف	٢٢٣٠,٨٣	٥٠٠٢,٨٣	٩١,١٧	١,٦٥	٠,٦٥
الفيوم	١٦٧٧,٥٤	٣٨١٩,٥٤	١١٨,٣٩	١,٦٩	٠,٦٩
قنا	٣١٥,٢٧	٢٤٧٨,٢٧	١٧,٦٣	١,١٢	٠,١٢
الاقصر	١٨٦,٣٣	٣١٢٢,٣٣	٦,٨١	١,٠٥	٠,٠٥
المتوسط	١٨٠٠,٦٨	٤٨٢٢,٢٣	*٤٦,١٢	*١,٤٢	*٠,٣٣
الانحراف القياسي	١٢٣٥,١	١٤٤٦,١	٤١,٦	٠,٣	٠,٣

المصدر: جمعت وحسبت من: وزارة الزراعة واستصلاح الأراضي، قطاع الشئون الاقتصادية، نشرة إحصاءات التكاليف وصافي العائد، ٢٠١٤.

محصول القمح : تشير نتائج التحليل الواردة بجدول رقم (٧) إلى أن الكفاءة الفنية التامة وفقاً لفرضية العائد المتغير للسعة في إنتاج محصول القمح تحققت في ٦ محافظات وهى البحيرة، الدقهلية، دمياط، المنوفية، الجيزة، أسوان بينما المحافظات الأقل كفاءة تمثلت في قنا، الفيوم، الاقصر، أسيوط والاسماعيلية بمعامل كفاءة بلغ ٠,٧٨، ٠,٧٧، ٠,٧٦، ٠,٧٥، ٠,٦٩ لكل منهم على الترتيب، وبلغ متوسط معامل الكفاءة الفنية لمحافظات الجمهورية في إنتاج القمح حوالى ٠,٨٩، الأمر الذى يشير إلى إمكانية زيادة الإنتاجية الفدانية لمحصول القمح (١٨,٣ أردب) بنسبة تبلغ نحو ١١% باستخدام نفس القدر من الموارد تمثل حوالي ٢,٠١ أردب للفدان. كما تشير نتائج كفاءة السعة لمحافظات الجمهورية في إنتاج القمح أنها تراوحت بين حد أدنى بلغ نحو ٠,٨٨ في محافظة المنوفية وحد أقصى بلغ واحد صحيح في محافظة أسوان، بمتوسط بلغ نحو ٠,٩٧، أي أن محافظات الجمهورية تعمل عند سعة إنتاجية تقل عن السعة الإنتاجية المثلى بنحو 3%، وتشير نتائج طبيعة العائد للسعة أن جميع محافظات الجمهورية تخضع لتناقص العائد للسعة باستثناء محافظة أسوان والتي تميزت بثبات العائد للسعة. وبتقدير فوائض المدخلات والتي تعبر عن القدر من المدخلات الذي

وتشير النتائج إلى أن الربحية النسبية لمحصول الذرة الشامية النيلي بلغت أقصاها في محافظة الدقهلية حيث قدرت بنحو ١٣٢,١٥% بينما حققت محافظة الأقصر أقل ربحية نسبية وقدرت بنحو ٦,٨١% بمتوسط بلغ نحو ٤٦,١٢% وانحراف قياسي بلغ حوالي ٤١,٦%، في حين تبين أن نسبة الايرادات إلى التكاليف بلغت أقصاها في محافظة الدقهلية حيث بلغت نحو ٢,٠٢% بينما اقل نسبة كانت في محافظة الأقصر وبلغت نحو ١,٠٥% بمتوسط بلغ نحو ١,٤٢% ومعامل انحراف قياسي بلغ حوالي ٠,٣%، أما ما يتعلق بمعدل العائد على الجنيه المستثمر فقد حقق اقصى قيمة للعائد في محافظة الدقهلية بحوالي ١,٠٢ جنيه وحقق اقل قيمة للعائد في محافظة الأقصر بحوالي ٠,٠٥ جنيه بمتوسط بلغ حوالي ٠,٣٣ جنيه للمحافظات المنتجة بمعامل انحراف القياسي بلغ حوالي ٠,٣ جنيه.

جـــدول رقم (٥). المؤشـرات الإنتـاجية والاقتـصـادية لمحـصـول الذرة الشامية الصيفي بمحافظات الجمهورية خلال الموســـــم الزراعي (٢٠١٣/٢٠١٤)

المحافظات	صافي العائد بالجنيه/فدان	القيمة المضافة بالجنيه/فدان	الأربحية النسبية %	نسبة الإيرادات إلى التكاليف %	معدل العائد على الجنيه المستثمر بالجنيه
الإسكندرية	٣١٧٢,٢٨	٦٨٥٢,٢٨	٨٣,٠٤	١,٦٣	٠,٦٣
البحيرة	٤٢٨١,١٠	٧٤٦٢,١٠	١٢١,٤٢	١,٩٥	٠,٩٥
الغربية	٣١٤٦,٠٠	٧٣٠٠,٠٠	٨٩,٧٨	١,٥٧	٠,٥٧
كفر الشيخ	٣٢٢١,٨٧	٧٦٨٢,٨٧	٨٥,٦٧	١,٥٦	٠,٥٦
الدقهلية	٥٦٠١,١٢	٨٨٥٧,١٢	١٨٠,٦٨	٢,٣٧	١,٣٧
دمياط	٢٢١٧,٩٠	٦٩١١,٩٠	٥٣,٢٦	١,٣٧	٠,٣٧
الشرقية	٣٠٤٦,٩٤	٧٠١٠,٩٤	٨١,٣٨	١,٥٨	٠,٥٨
الإسماعيلية	١٨٢٢,٠٠	٥٥١١,٠٠	٥٩,٢٧	١,٤٣	٠,٤٣
المنوفية	٣١٣٣,٧٢	٧٣٧١,٧٢	٨٤,٥٦	١,٥٧	٠,٥٧
القليوبية	٢٨٩٣,١٧	٦٥٩٠,١٧	٨٥,٦٧	١,٥٨	٠,٥٨
الجيزة	٣٣٩٩,٢٩	٧١١٩,٢٩	٨٥,٩٥	١,٦٢	٠,٦٢
بنى سويف	١٩٦٧,٧٠	٥٨٣٩,٧٠	٦٣,١٣	١,٤١	٠,٤١
الفيوم	٢٣٣٧,٩٨	٥٦٤٢,٩٨	٨٠,٤٨	١,٥٣	٠,٥٣
المنيا	٣٤١٥,٠٠	٦٧٠٦,٠٠	١١٥,٥٣	١,٨٤	٠,٨٤
اسيوط	٢٣٥١,٩٨	٦٦٥٠,٩٨	٦٢,٩٠	١,٤٤	٠,٤٤
سوهاج	٢٦١٦,٧٨	٦٨٧١,٧٨	٧٥,٧٤	١,٥٣	٠,٥٣
قنا	١٤٦٧,٥٦	٤٨٤٠,٥٦	٥٢,٤٥	١,٣٧	٠,٣٧
الاقصر	١٧٦٧,٢٢	٤٣٥١,٢٢	٧٩,٢٨	١,٥٦	٠,٥٦
أسوان	٢٥٢٦,٧٥	٤٩٧٩,٧٥	١٢٠,٤٤	١,٨٢	٠,٨٢
المتوسط	٢٨٦٢,٤٤	٦٥٥٥,٣٨	* ٨٣,٣٥	* ١,٦٠	* ٠,٥٨
الانحراف القياسي	٩٦٢,٤٣	١١١٠,٦	٣٠,٢	٠,٢٤	٠,٢٤

المصدر: جمعت وحسبت من: وزارة الزراعة واستصلاح الأراضي، قطاع الشئون الاقتصادية، نشرة إحصاءات التكاليف وصافي العائد، ٢٠١٤.

٨٣,٣٥% وانحراف قياسي بلغ حوالي ٣٠,٢%، كما تبين أن نسبة الايرادات إلى التكاليف بلغت أقصاها في محافظة الدقهلية حيث بلغت نحو ٢,٣٧% بينما اقل نسبة كانت في محافظتي قنا ودمياط وبلغت نحو ١,٣٧% بمتوسط بلغ نحو ١,٦٠% ومعامل انحراف قياسي بلغ حوالي ٠,٢٤%، أما ما يتعلق بمعدل العائد على الجنيه المستثمر فقد حقق اقصى قيمة للعائد في محافظة الدقهلية بحوالي ١,٣٧ جنيه وحقق اقل قيمة للعائد في محافظة قنا ودمياط بحوالي ٠,٣٧ جنيه بمتوسط بلغ حوالي ٠,٥٨ جنيه للمحافظات المنتجة بمعامل انحراف القياسي بلغ حوالي ٠,٢٤ جنيه.

جـدول رقم (٤). المؤشرات الإنتاجية والاقتصادية لمحصول الأرز بمحافظات الجمهورية خلال الموسم الزراعي (٢٠١٣/٢٠١٤)

المحافظات	صافي العائد بالجنيه/فدان	القيمة المضافة بالجنيه/فدان	الأربحية النسبية %	نسبة الإيرادات إلى التكاليف %	معدل العائد على الجنيه المستثمر بالجنيه
الإسكندرية	٣٠٢٦,٢٥	٧٠٦٨,٢٥	٧٥,٢٤	١,٥٨	٠,٥٨
البحيرة	٣٣٥٤,٠٧	٨٢٤٣,٠٧	٩٤,١١	١,٦٠	٠,٦٠
الغربية	٢١٨٣,٥٠	٧٧٢٦,٥٠	٥٤,٩٦	١,٣٤	٠,٣٤
كفر الشيخ	٢٥٩٧,٦٤	٧٣٢٧,٦٤	٦٤,٧٦	١,٤٣	٠,٤٣
الدقهلية	٤٨٠٧,٥٦	٨٧٢٠,٥٦	١٨١,٦٢	٢,٠٣	١,٠٣
دمياط	٢٨٦٠,٤١	٧٠٠٨,٤١	٨٥,٠٦	١,٥٩	٠,٥٩
الشرقية	٢٨٠٥,٩٠	٧٥٦٠,٩٠	٧٢,٣٠	١,٤٩	٠,٤٩
الإسماعيلية	١٦٩٢,٨٠	٦٠٤٧,٨٠	٤٨,٢٣	١,٣٤	٠,٣٤
بورسعيد	٢٣٣٣,٥٠	٧٢٩٠,٥٠	٥٥,٦٠	١,٤١	٠,٤١
المنوفية	١٠٣٢,٢٦	٦١٦١,٢٦	٢٥,٨٨	١,٧١	٠,٧١
القليوبية	٢٤٦٢,٧٨	٦٩٠٠,٧٧	٦٠,١٧	١,٤٣	٠,٤٣
المتوسط	٢٦٥٠,٦١	٧٢٧٧,٧٩	* ٦٦,٧٧	* ١,٥٣	* ٠,٥١
الانحراف القياسي	٩٦١,٧٦	٧٩٥	٤٠,١	٠,٢	٠,٢

* متوسط هندسي

المصدر: جمعت وحسبت من: وزارة الزراعة واستصلاح الأراضي، قطاع الشئون الاقتصادية، نشرة إحصاءات التكاليف وصافي العائد، ٢٠١٤.

محصول الذرة الشامية النيلي: تبين من النتائج الواردة بالجدول رقم (٦) أن محافظة الدقهلية جاءت في المرتبة الأولى لمؤشر صافى العائد الفداني بقيمة بلغت حوالي ٤٤٤٢,٩٨ جنيه، بينما جاءت في المرتبة الأخيرة محافظة الاقصر محققة أقل صافي عائد فداني بلغ حوالي ١٨٦,٣٣ جنيه بمتوسط بلغ حوالى ١٨٠٠,٦٨ جنيه لأهم المحافظات المنتجة وانحراف قياسي بلغ حوالي ١٢٣٥,١ جنيه، كما تبين أن أعلى قيمة مضافة قد تحققت في محافظة الدقهلية حيث بلغت حوالى ٧٨٧٦,٩٨ جنيه يليها محافظتي الجيزة وبني سويف بقيمة بلغت ٦١١٤,٦١، ٥٠٠٣,٨٣ جنيه لكل منهما على الترتيب، بينما اقل قيمة مضافة تحققت في محافظة قنا وبلغت حوالي ٢٤٧٨,٢٧ جنيه بمتوسط بلغ حوالي ٤٨٢٢,٢٣ جنيه بانحراف قياسي بلغ حوالي ١٤٤٦,١ جنيه.

وانحراف قياسي بلغ حوالي ٣١,٩%، كما تبين أن نسبة الايرادات إلى التكاليف بلغت أقصاها في محافظة اسوان حيث بلغت نحو ٢,٣٧ % بينما اقل نسبة كانت في محافظة الفيوم وبلغت نحو ١,٥٧% بمتوسط بلغ نحو ١,٨١% ومعامل انحراف قياسي بلغ حوالي ٠,٢%، بينما حقق معدل العائد على الجنيه المستثمر اقصى قيمة للعائد في محافظة اسوان بحوالي ١,٣٧ جنيه وحقق اقل قيمة للعائد في محافظة الفيوم بحوالي ٠,٥٧ جنيه بمتوسط بلغ حوالي ٠,٨٠ جنيه للمحافظات المنتجة بمعامل انحراف القياسي بلغ حوالي ٠,٢ جنيه.

محصول الأرز الصيفي: تبين من النتائج الواردة بالجدول رقم (٤) أن محافظة الدقهلية جاءت في المرتبة الأولى لمؤشر صافى العائد الفداني بقيمة بلغت حوالي ٤٨٠٧,٥٦ جنيه، بينما جاءت في المرتبة الأخيرة محافظة المنوفية محققة أقل صافي عائد فداني بلغ حوالي ١٠٣٢,٢٦ جنيه بمتوسط بلغ حوالى ٢٦٥٠,٦١ جنيه لأهم المحافظات المنتجة وانحراف قياسي بلغ حوالي ٩٦١,٧٦ جنيه، كما تبين أن أعلى قيمة مضافة قد تحققت في محافظة الدقهلية حيث بلغت حوالى ٨٧٢٠,٥٦ جنيه يليها محافظتي البحيرة والغربية بقيمة بلغت ٨٢٤٣,٠٧، ٧٧٢٦,٥ جنيه لكل منهما على الترتيب، بينما اقل قيمة مضافة تحققت في محافظة الإسماعيلية وبلغت حوالي ٦٠٤٧,٨ جنيه بمتوسط بلغ حوالي ٧٢٧٧,٧٩ جنيه بانحراف قياسي بلغ حوالي ٧٩٥ جنيه.

وتشير النتائج إلى أن الربحية النسبية لمحصول الأرز بلغت أقصاها في محافظة الدقهلية حيث قدرت بنحو ١٨١,٦٢% بينما حققت محافظة المنوفية أقل ربحية نسبية وقدرت بنحو ٢٥,٨٨ % بمتوسط بلغ نحو ٦٦,٧٧%، وانحراف قياسي بلغ حوالي ٤٠,١%، كما تبين أن نسبة الايرادات إلى التكاليف بلغت أقصاها في محافظة الدقهلية حيث بلغت نحو ٢,٠٣% بينما اقل نسبة كانت في محافظتي الغربية والإسماعيلية وبلغت نحو ١,٣٤% لكل منهما، بمتوسط بلغ نحو ١,٥٣% وانحراف قياسي بلغ حوالي ٠,٢%، أما ما يتعلق بمعدل العائد على الجنيه المستثمر فقد حقق اقصى قيمة في محافظة الدقهلية بحوالي ١,٠٣ جنيه وحقق اقل قيمة للعائد في محافظتي الغربية والإسماعيلية بحوالي ٠,٣٤ جنيه بمتوسط بلغ حوالي ٠,٥١ جنيه للمحافظات المنتجة بمعامل انحراف القياسي بلغ حوالي ٠,٢ جنيه.

محصول الذرة الشامية الصيفي: تبين من النتائج الواردة بالجدول رقم (٥) أن محافظة الدقهلية جاءت في المرتبة الأولى لمؤشر صافى العائد الفداني بقيمة بلغت حوالي ٥٦٠١,١٢ جنيه، بينما جاءت في المرتبة الأخيرة محافظة قنا محققة أقل صافي عائد فداني بلغ حوالي ١٤٦٧,٥٦ جنيه بمتوسط بلغ حوالى ٢٨٦٢,٤٤ جنيه لأهم المحافظات المنتجة وانحراف قياسي بلغ حوالي ٩٦٢,٤٣ جنيه، كما تبين أن أعلى قيمة مضافة قد تحققت في محافظة الدقهلية حيث بلغت حوالى ٨٨٥٧,١٢ جنيه يليها محافظتي كفر الشيخ والبحيرة بقيمة بلغت ٧٦٨٢,٨٧، ٧٤٦٢,١ جنيه لكل منهما على الترتيب، بينما اقل قيمة مضافة تحققت في محافظة الأقصر وبلغت حوالي ٤٣٥١,٢٢ جنيه بمتوسط بلغ حوالي ٦٥٥٥,٣٨ جنيه بانحراف قياسي بلغ حوالي ١١١٠,٦ جنيه.

وتشير النتائج إلى أن الربحية النسبية لمحصول الذرة الشامية الصيفي بلغت أقصاها في محافظة الدقهلية حيث قدرت بنحو ١٨٠,٦٨% بينما حققت محافظة قنا أقل ربحية نسبية وقدرت بنحو ٥٢,٤٥% بمتوسط بلغ نحو

جدول رقم (٣). المؤشرات الإنتاجية والاقتصادية لمحصول القمح بمحافظات الجمهورية خلال الموسم الزراعي (٢٠١٤/٢٠١٣)

المحافظات	صافي العائد بالجنيه/فدان	القيمة المضافة بالجنيه/فدان	الاربحية النسبية %	نسبة الإيرادات إلى التكاليف %	معدل العائد على الجنيه المستثمر بالجنيه
الإسكندرية	٤٢٨٢,٢	٧٥٧٧,٢	١٢٧,٦٤	١,٩٢	٠,٩٢
البحيرة	٥١٢٥,٢	٨٨٤٤,٢	١٦٤,٣٢	٢,١١	١,١١
الغربية	٤٢٨٧,٧	٨٦١٢,٧	١٢٥,٩٢	١,٧٩	٠,٧٩
كفر الشيخ	٣٣٤٤,٨	٨١٤١,٨	١٠٩,٧٧	١,٦٠	٠,٦٠
الدقهلية	٤٥٣٦,٠	٨٥٠٢,٠	١٥٦,٧٤	١,٩٣	٠,٩٣
دمياط	٤٧٦٦,٦	٨٣٤٦,٦	١٧٠,٢٤	٢,١١	١,١١
الشرقية	٣٥٦٠,٠	٧٥٦٢,٠	١١٠,٨٣	١,٦٨	٠,٦٨
الإسماعيلية	٣٦٢٦,٦	٧٤٢٩,٦	٩٦,٢٥	١,٧٢	٠,٧٢
المنوفية	٤٨٣٠,٤	٩٨٤٩,٤	١٢٦,٦٥	١,٧٩	٠,٧٩
القليوبية	٤٣٣٨,٨	٨٧٨٦,٨	١٤٤,٤٨	١,٨٣	٠,٨٣
الجيزة	٤٨٢٤,٨	٨٧٢٢,٨	١٤٩,٩٣	١,٩٢	٠,٩٢
بنى سويف	٣٢٦١,٩	٨١٣٣,٩	٨٩,٢٤	١,٥٨	٠,٥٨
الفيوم	٣٥٠١,٥	٨٤٠٧,٥	٩٤,٧٤	١,٥٧	٠,٥٧
المنيا	٣٧٩٤,٩	٨٥٤٢,٩	١٠٨,٤٩	١,٦٧	٠,٦٧
أسيوط	٤٠٦٠,٤	٨٥٢٦,٤	١٠٠,٨٥	١,٧٥	٠,٧٥
سوهاج	٣٦٧٦,٧	٨١٠٩,٧	٩٤,٦٩	١,٦٨	٠,٦٨
قنا	٣٩٨٢,١	٨٢٤٧,١	١١٢,٨١	١,٧٨	٠,٧٨
الأقصر	٣٦٩٠,٢	٧٤٥٣,٢	١٠٨,١٢	١,٨٠	٠,٨٠
أسوان	٤٧٢٢,٢	٧٣٤٢,٢	٢٠٩,٤١	٢,٣٧	١,٣٧
المتوسط	**٤١١٦,٥**	**٨٢٧٠,٤**	***١٢٢,٩٥**	***١,٨١**	***٠,٨٠**
الانحراف القياسي	**٥٧٠,٣**	**٦١٩,٦**	**٣١,٩**	**٠,٢**	**٠,٢**

حيث أن: * المتوسط الهندسي

صافي العائد = إجمالي الإيرادات – إجمالي التكاليف

القيمة المُضافة = قيمة الانتاج – قيمة مستلزمات الإنتاج

الربحية النسبية = (صافى العائد / التكاليف المتغيرة) ×١٠٠

نسبة الايرادات للتكاليف = (الايرادات / التكاليف) × ١٠٠

معدل العائد على الجنيه المستثمر = صافى العائد / إجمالي التكاليف الكلية

المصدر: جمعت وحسبت من: وزارة الزراعة واستصلاح الأراضي، قطاع الشئون الاقتصادية، نشرة إحصاءات التكاليف وصافي العائد، ٢٠١٤.

حيث بلغت حوالى ٩,٨٥ الف جنيه يليها محافظتي البحيرة والغربية بقيمة بلغت حوالي ٨,٨٤، ٨,٦١ ألف جنيه لكل منهما على الترتيب، بينما اقل قيمة مضافة تحققت في محافظة أسوان وبلغت حوالي ٧,٣٤ الف جنيه بمتوسط بلغ حوالي ٨,٢٧ ألف جنيه بانحراف قياسي بلغ حوالي ٦١٩,٦ جنيه.

وتشير النتائج إلى أن الربحية النسبية لمحصول القمح بلغت أقصاها في محافظة اسوان حيث قدرت بنحو ٢٠٩,٤% في حين حققت محافظة بنى سويف أقل ربحية نسبية وقدرت بنحو ٨٩,٢٤% بمتوسط بلغ نحو ١٢٢,٩%

في حين تراوح إنتاج محصول الذرة الشامية الصيفي بين حد أقصى بلغ حوالي ٧,٢١ مليون طن عام ٢٠١٢، وحد أدنى بلغ حوالي ٥,٦٥ مليون طن عام ٢٠٠٠، وبتقدير معادلة الاتجاه الزمني العام تبين معنوية الزيادة السنوية في إنتاج محصول الذرة الشامية الصيفي، حيث قدرت الزيادة السنوية بحوالي ٨١٥,٦ ألف طن بمعدل نمو سنوي قدر بنحو ١٣% من متوسط الفترة والبالغ حوالي ٦,٢٧ مليون طن.

محصول الذرة الشامية النيلي: تراوحت المساحة المنزرعة بمحصول الذرة الشامية النيلي بين حد أقصى بلغ حوالي ٣٦٨,٨ ألف فدان عام ٢٠٠٨، وحد أدنى بلغ حوالي ٣٠,٤٨ ألف فدان عام ٢٠٠١، وبتقدير معادلة الاتجاه الزمني العام تبين معنوية الزيادة السنوية في المساحة المنزرعة بمحصول الذرة الشامية النيلي، حيث قدرت الزيادة السنوية بحوالي ٢٨,٧ ألف فدان بمعدل نمو سنوي قدر بنحو ١٠,٢% من متوسط الفترة والبالغ حوالي ٢٨١,٣ ألف فدان.

في حين تراوح إنتاج محصول الذرة الشامية النيلي بين حد أقصى بلغ حوالي ١,٠٩ مليون طن عام ٢٠٠٨، وحد أدنى بلغ حوالي ٧,٤٩ ألف طن عام ٢٠٠١، وبتقدير معادلة الاتجاه الزمني العام تبين معنوية الزيادة السنوية في إنتاج محصول الذرة الشامية النيلي، حيث قدرت الزيادة السنوية بحوالي ١٦٣,٤٥ ألف طن بمعدل نمو سنوي قدر بنحو ٢١,٧% من متوسط الفترة والبالغ حوالي ٧٥٣,٢٢ ألف طن.

ثانيا: المؤشرات الإنتاجية والاقتصادية لإنتاج أهم محاصيل الحبوب خلال الموسم الزراعي(٢٠١٣/٢٠١٤)

محصول القمح : تبين من النتائج الواردة بالجدول رقم (٣) أن محافظة البحيرة جاءت في المرتبة الأولى لمؤشر صافى العائد الفداني بقيمة بلغت حوالي ٥,١٣ الف جنيه، بينما جاءت في المرتبة الأخيرة محافظة بنى سويف محققة أقل صافي عائد فداني بلغ حوالي ٣,٢٦ الف جنيه بمتوسط عام بلغ حوالى ٤,١٢ الف جنيه لأهم المحافظات المنتجة وانحراف قياسي بلغ حوالي ٥٧٠,٣ جنيه، كما تبين أن أعلى قيمة مضافة قد تحققت في محافظة المنوفية.

جدول رقم (٢). تقدير معادلات الاتجاه الزمني العام لمساحة وإنتاج أهم حاصلات الحبوب في الزراعة المصرية خلال الفترة (٢٠٠٠-٢٠١٤)

المحصول	البيان	المعادلة	ف	ر^{٢}	معدل النمو
القمح	المساحة	لو ص$^{\wedge}$ = ٧,٧٧ + ٠,٠٢٢ س (٦,٨٢)**	٤٦,٦**	٠,٧٨	٢,٢
	الإنتاج	لو ص$^{\wedge}$ = ٨,٧٦ + ٠,٠٢٤ س (٥,٨٤)**	٣٤,١٣**	٠,٧٢	٢,٤
الذرة الشامية الصيفي	المساحة	لو ص$^{\wedge}$ = ٧,٤ + ٠,٠١٦ س (٤,٩)**	٢٣,٩**	٠,٦٥	١,٦
	الإنتاج	لو ص$^{\wedge}$ = ٨,٦ + ٠,٠١٣ س (٣,٧)**	١٣,٩**	٠,٥٢	١,٣
الذرة الشامية النيلي	المساحة	لو ص$^{\wedge}$ = ٤,٦ + ٠,١٠٢ س (٢,٤)*	٥,٨*	٠,٣١	١٠,٢
	الإنتاج	لو ص$^{\wedge}$ = ٤,٤ + ٠,٢١٧ س (٢,٦)*	٥,٨*	٠,٣٤	٢١,٧

**معنوية عند المستوى الاحتمالي ١% *معنوية عند المستوى الاحتمالي ٥%

المصدر: جمعت وحسبت من تحليل البيانات الواردة بجدول رقم (١).

محصول الأرز: تراوحت المساحة المنزرعة بمحصول الأرز بين حد أقصى بلغ حوالي ١,٧٧ مليون فدان عام ٢٠٠٨، وحد أدنى بلغ حوالي ١,٠٩ مليون فدان عام ٢٠١٠، بمتوسط بلغ حوالي ١,٤٨ مليون فدان خلال فترة الدراسة، في حين تراوح إنتاج محصول الأرز بين حد أقصى بلغ حوالي ٧,٢٤ مليون طن عام ٢٠٠٨، وحد أدنى بلغ حوالي ٤,٣٢ مليون طن عام ٢٠١٠، بمتوسط بلغ حوالي ٥,٩٦ مليون طن خلال فترة الدراسة.

وبتقدير معادلة الاتجاه الزمني العام لكل من المساحة المنزرعة وكمية الإنتاج لمحصول الأرز في صورها الرياضية المختلفة، لم تثبت المعنوية الإحصائية للدالة المقدرة نظراً لتحديد المساحة المنزرعة بمحصول الأرز من قبل وزارتي الري والزراعة المصرية في حدود ١,٢ مليون فدان سنوياً.

محصول الذرة الشامية الصيفي : تراوحت المساحة المنزرعة بمحصول الذرة الشامية الصيفي بين حد أقصى بلغ حوالي ٢,١٦ مليون فدان عام ٢٠١٢، وحد أدنى بلغ حوالي ١,٦٦ مليون فدان عام ٢٠٠٣، وبتقدير معادلة الاتجاه الزمني العام تبين معنوية الزيادة السنوية في المســـاحة المنزرعة بمحصول الذرة الشامية الصيفي، حيث قدرت الزيادة الزيادة السنوية بحوالي ٢٩,٦ ألف فدان بمعدل نمو سنوي قدر بنحو ١,٦% من متوسط الفترة والبالغ حوالي ١,٨٥ مليون فدان.

النتائج البحثية

أولا تطور المساحة والإنتاج لأهم محاصيل الحبوب خلال الفترة (٢٠٠٠-٢٠١٤)

باستعراض البيانات الواردة بالجدول رقم (١) ونتائج التحليل الإحصائي الواردة بالجدول رقم (٢) تبين ما يلي:

محصول القمح : تراوحت المساحة المنزرعة بمحصول القمح بين حد أقصى بلغ حوالي ٣,٣٨ مليون فدان عام ٢٠١٣، وحد أدنى بلغ حوالي ٢,٣٤ مليون فدان عام ٢٠٠١، وبتقدير معادلة الاتجاه الزمني العام تبين معنوية الزيادة السنوية في المساحة المنزرعة بمحصول القمح، حيث قدرت الزيادة السنوية بحوالي ٦٢,٩ ألف فدان بمعدل نمو سنوي قدر بنحو ٢,٢% من متوسط الفترة والبالغ حوالي ٢,٨٦ مليون فدان.

في حين تراوح إنتاج محصول القمح بين حد أقصى بلغ حوالي ٩,٤٦ مليون طن عام ٢٠١٣، وحد أدنى بلغ حوالي ٦,٢٦ مليون طن عام ٢٠٠١، وبتقدير معادلة الاتجاه الزمني العام تبين معنوية الزيادة السنوية في إنتاج محصول القمح، حيث قدرت الزيادة السنوية بحوالي ١٨٥,٧٦ ألف طن بمعدل نمو سنوي قدر بنحو ٢,٤% من متوسط الفترة والبالغ حوالي ٧,٧٤ مليون طن.

جدول رقم (١). تطور مساحة وإنتاج أهم محاصيل الحبوب في الزراعة المصرية خلال الفترة (٢٠٠٠-٢٠١٤)

السنة	القمح		الأرز الصيفي		الذرة الشامية الصيفي		الذرة الشامية النيلي	
	المساحة ألف فدان	الإنتاج ألف طن	المساحة ألف فدان	الإنتاج ألف طن	المساحة ألف فدان	الإنتاج ألف طن	المساحة ألف فدان	الإنتاج ألف طن
٢٠٠٠	٢٤٦٤,٠	٦٥٦٤,٠	١٥٦٩,٠	٦٠٠٠,٠	١٦٧٩,٠	٥٦٥٠,٤	٣٢,٧	٨,٢
٢٠٠١	٢٣٤٢,٠	٦٢٥٥,٠	١٣٤١,٠	٥٢٣٩,٠	١٧٧٣,٤	٦٠٩٣,٦	٣٠,٥	٧,٥
٢٠٠٢	٢٤٥١,٠	٦٦٢٥,٠	١٥٤٧,٠	٦١٠٥,٠	١٦٦٨,٥	٥٦٧٦,٥	٣٠٢,٥	٧٥٤,٥
٢٠٠٣	٢٥٠٧,٠	٦٨٤٥,٠	١٥٠٨,٠	٦١٧٤,٠	١٦٥٧,٨	٥٦٨١,٨	٣٢٧,٤	٨٤٨,٦
٢٠٠٤	٢٦٠٦,٠	٧١٧٨,٠	١٤٣٧,٠	٦٣٥١,٠	١٦٨٤,٩	٥٨٣٩,٩	٣٤٨,٢	٨٨٨,١
٢٠٠٥	٣٠٠٥,٠	٨١٤١,٠	١٤٥٩,٠	٦١٢٤,٠	١٩٤٠,٣	٦٨٦٦,٥	٣١٧,١	٨٣١,٥
٢٠٠٦	٣٠٦٤,٠	٨٢٧٤,٠	١٥٩٣,٠	٦٧٤٤,٠	١٧٠٨,٠	٦١٤٩,٦	٢٨٢,٢	٧٥٩,٠
٢٠٠٧	٢٧١٢,٠	٧٤٢٠,٠	١٦٧٣,٠	٦٨٦٨,٠	١٧٨١,٠	٦١٤٠,٩	٢٨٧,٠	٧٨٨,٦
٢٠٠٨	٢٩٢٠,٠	٧٩٧٧,٠	١٧٧٠,٠	٧٢٤١,٠	١٨٦٠,٠	٦٣٠٦,١	٣٦٨,٨	١٠٩٥,٤
٢٠٠٩	٣١٤٧,٠	٨٥٢٣,٠	١٣٦٩,٠	٥٥١٨,١	١٩٧٧,٦	٦٦٤٤,٥	٣٦٣,١	١٠٤١,٦
٢٠١٠	٣٠٠١,٠	٧١٦٩,٠	١٠٩٣,٠	٤٣٢٧,١	١٩٩٨,٣	٦٢٧٥,٩	٣٥٩,٨	١٠١٦,٢
٢٠١١	٣٠٤٨,٦	٨٣٧٠,٥	١٤٠٩,٠	٥٦٦٥,٤	١٧٥٨,٦	٥٨٨٥,٧	٣٥٦,٥	٩٩٠,٨
٢٠١٢	٣١٦٠,٧	٨٧٩٥,٥	١٤٧٢,٠	٥٨٩٦,٦	٢١٥٧,١	٧٢٠٥,٥	٣٢٢,٣	٨٨٨,١
٢٠١٣	٣٣٧٧,٩	٩٤٦٠,٢	١٤١٩,٠	٥٧١٧,١	٢٠٣٤,٢	٦٧٢٦,٨	٢٧٩,٦	٧٢٨,٠
٢٠١٤	٣٠٨٣,٩	٨٥٢٠,٩	١٣٥٧,٠	٥٤٢٩,٤	٢١٠٦,٦	٦٩٦٩,١	٢٤٢,٠	٦٥٢,٢
المتوسط	**٢٨٥٩,٤**	**٧٧٤١,٢**	**١٤٦٧,٧**	**٥٩٦٠,٠**	**١٨٥٢,٤**	**٦٢٧٤,٢**	**٢٨١,٣**	**٧٥٣,٢**

المصدر: جمعت وحسبت من وزارة الزراعة واستصلاح الأراضي، قطاع الشئون الاقتصادية، نشرة الاقتصاد الزراعي، أعداد متفرقة.

$$\text{Max}_{u,v}\ (u'y_i)$$

$$\text{St} \quad v'x_i = 1,$$

$$u'y_j - ux'_j \leq 0, \quad j= 1,2, \ldots\ldots,N$$

$$U,v \geq 0,$$

وتستخدم عادة الصورة الثنائية Dual في التقدير وليست صورة المضاعف Multiplier سابقة الذكر وتكون على الصورة التالية (Charnes etal.,1995):

$$\text{Min}_{\theta,\lambda}\ \theta$$

$$\text{St} \quad -y_i + Y\lambda \geq 0$$

$$\theta x_i - X\lambda \geq 0$$

$$\lambda \geq 0$$

حيث λ متجه $(N\times1)$ تمثل أوزان المفردات، θ قيمة مؤشر الكفاءة الفنية وتتراوح قيمته من الصفر إلى الواحد الصحيح، ولكن التحليل وفقاً لفرضية ثبات العائد للسعة يفترض أن جميع الوحدات تعمل عند السعة المثلى، أي أن منحنى متوسط التكاليف في المدى الطويل أفقياً، وهذا لا يتفق مع الواقع، لذلك تم تطوير النموذج السابق بواسطة (Banker *et al.,* 1984) للتعبير عن فرضية العائد المتغير للسعة (VRS) وبهذا أمكن فصل كفاءة السعة عن الكفاءة الفنية بإضافة قيد التحدب $(N1'\lambda = 1)$ حيث N1 يرمز إلى متجه الوحدة $(N\times1)$، ويكون النموذج على الصورة التالية:

$$\text{Min}_{\theta,\lambda}\ \theta$$

$$\text{St} \quad -y_i + Y\lambda \geq 0$$

$$\theta x_i - X\lambda \geq 0$$

$$N1'\lambda = 1$$

$$\lambda \geq 0$$

وتكون كفاءة السعة هي النسبة بين النموذجين السابقين أي تساوي CRS/VRS (Coelli, 1996).

واعتمد البحث في تحقيق أهدافه على البيانات الثانوية المنشورة والتي تصدرها وزارة الزراعة واستصلاح الأراضي المصرية من خلال قطاع الشئون الاقتصادية ، كنشرات الاقتصاد الزراعي ونشرات الإحصاءات الزراعية، نشرة إحصاءات التجارة الخارجية للصادرات والواردات الزراعية، بالإضافة إلى بعض البحوث والدراسات الاقتصادية ذات الصلة بموضوع البحث.

المشكلة البحثية

تواجه التنمية الزراعية الأفقية العديد من الصعوبات المتمثلة في ندرة الموارد الزراعية وبصفة خاصة الأرض والمياه، إلى جانب ضخامة الاستثمارات اللازمة، الأمر الذي يجعل من التنمية الزراعية الرأسية من خلال زيادة إنتاجية الوحدة من الموارد هدفاً تسعى السياسة الزراعية لتحقيقه، ونظراً للأهمية الاقتصادية لمحاصيل الحبوب فقد استهدفت استراتيجية وزارة الزراعة ٢٠٣٠ (وزارة الزراعة واستصلاح الأراضي، ٢٠٠٩) الارتقاء بالإنتاجية الفدانية لمحاصيل القمح والأرز والذرة الشامية لتصل لنحو ٣,٦، ٥,٢، ٥ طن لكل منهم على الترتيب، مما يستلزم الإجابة عن التساؤلات التالية: كم نبعد عن الحد الأقصى الممكن للإنتاج؟ وكيف يمكن تحقيقه؟ وما هي الآثار الاقتصادية المترتبة على تحقيق الكفاءة الإنتاجية لعملية إنتاج تلك المحاصيل؟

الأهداف البحثية

في إطار المشكلة البحثية استهدف هذا البحث دراسة ما يلي:

١-تطور مساحة وإنتاج أهم محاصيل الحبوب في الزراعة المصرية (القمح، الأرز، الذرة الشامية).

٢-تقدير بعض المؤشرات الانتاجية والاقتصادية لمحاصيل الحبوب موضع الدراسة.

٣- تقدير الكفاءة الفنية لمحافظات الجمهورية في إنتاج محاصيل القمح والأرز والذرة الشامية.

٤- تقدير الآثار الاقتصادية المترتبة على تحقيق الكفاءة في إنتاج محاصيل الحبوب على مستوى المزرعة وعلى المستوى القومي.

الأسلوب البحثي ومصادر البيانات

اعتمد البحث في تحقيق أهدافه على استخدام أسلوب التحليل الاقتصادي الوصفي، لقياس بعض المؤشرات الإنتاجية والاقتصادية المرتبطة بإنتاج أهم محاصيل الحبوب موضع البحث، كما تم الاستعانة بأسلوب التحليل الكمي متمثل في تحليل الانحدار البسيط، وتقدير الكفاءة باستخدام تحليل مغلف البيانات Data Envelopment Analysis (DEA)، وهو أسلوب رياضي غير معلمي Non-Parametric لا يأخذ في الاعتبار الخطأ العشوائي في التقدير، يعتمد على استخدام البرمجة الخطية، ويستند في تقييم الكفاءة لمجموعة من الوحدات الإنتاجية على الأوزان المثلى للمدخلات والمخرجات (شافعي، ٢٠١٠)، ويكون نموذج البرمجة المستخدم في ظل فرضية ثبات العائد للسعة (CRS) على الصورة التالية (Ali, Seiford,1993):

$$\text{Max}_{u,v} \ (u'y_i/v'x_i)$$

$$\text{St} \quad u'y_j/v'x_i \leq 1 \qquad j= 1,2, \ldots\ldots,N$$

$$U,v \geq 0$$

حيث u تمثل متجه أوزان المخرجات (M×1) ، V تمثل متجه أوزان المدخلات (K×1) ، ولكن هذه الطريقة تعطي العديد من الحلول ولذلك تم وضع القيد $v'xi=1$ ليصبح النموذج على الصورة التالية:

وأن الكفاءة الفنية التامة في إنتاج محصول القمح قد تحققت في ٦ محافظات هي البحيرة، الدقهلية، دمياط، المنوفية، الجيزة، أسوان، وفي إنتاج محصول الأرز تحققت الكفاءة الفنية التامة بمحافظتي الدقهلية، الاسماعيلية، وبالنسبة لمحصول الذرة الشامية الصيفي فقد تحققت الكفاءة الفنية التامة في إنتاجها في محافظات البحيرة، الدقهلية، أسوان، وأخيراً تحققت الكفاءة الفنية التامة لمحصول الذرة الشامية النيلي بمحافظات الدقهلية، الشرقية، الفيوم.

وتمثلت الآثار الاقتصادية المترتبة على تحقيق الكفاءة الفنية لأهم محاصيل الحبوب على مستوى المزرعة في زيادة صافي العائد الفداني بمقدار ٨٢٦,١، ١٠١٧,٦، ١٠٠١,٧، ٩٩٢ جنيه لمحاصيل القمح، الأرز، الذرة الشامية الصيفي والذرة الشامية النيلي على الترتيب، أما على مستوى الزراعة المصرية فإنها تؤدي إلى زيادة الإنتاج بما يعادل توسع زراعي أفقي تقدر مساحته بحوالي ٣٣٨,٧، ١٧٦,٢، ٢٩٤,٥ و٤٣,٢ ألف فدان لمحاصيل القمح، الأرز، الذرة الشامية الصيفي والذرة الشامية النيلي على الترتيب، فضلاً عن تحقيق وفر في استخدام مياه الري يقدر بنحو ٠,٦١، ٠,٩٢، ١,٣٣، ٠,١٧ مليار متر مكعب بنفس الترتيب.

توصي الدراسة في ضوء ما توصلت إليه من نتائج، بأهمية تنفيذ برامج لتنمية محاصيل الحبوب بما تضمنه من توفير وتحسين مستلزمات الإنتاج (الأسمدة، الأصناف المحسنة، مقاومة الآفات، مياه الري)، وتقديم الدعم الإرشادي للمزارعين، توفير الائتمان للمزارعين والحوافز الأخرى، لرفع الكفاءة الإنتاجية وتحقيق المنافع الاقتصادية للتنمية الرأسية لمحاصيل الحبوب.

المقدمة

تعد دراسة محاصيل الحبوب من الدراسات الهامة سواء من الناحية الغذائية أومن الناحية الاقتصادية، فمحصول القمح هو المكون الرئيسي لرغيف الخبز، كما أن الأرز يعتبر من أهم المكونات الغذائية في النمط الغذائي للأسرة المصرية، في حين تعتبر الذرة الشامية مكون أساسي في إنتاج أعلاف الماشية والدواجن. كما تؤثر محاصيل الحبوب في الميزان التجاري الزراعي المصري بصورة كبيرة فالقمح والذرة الشامية من أهم الواردات الزراعية بنسبة بلغت نحو ١٩,٩%، ١٢,٣% من إجمالي الواردات الزراعية والبالغة حوالي ١١٥ مليار جنيه عام ٢٠١٤، في حين يعد الأرز محصول تصديري هام وإن كانت تلك الأهمية قد تراجعت بعد تحديد مساحته في الآونة الأخيرة، وتمثل المساحة المزروعة بتلك المحاصيل نسبة كبيرة من المساحة المحصولية حيث بلغت نسبة المساحة المزروعة بكل من القمح، الأرز الصيفي، الذرة الشامية الصيفي والنيلي حوالى ١٨,٥%، ٩,٥%، ١١,٩%، ١,٨% لكل منهم على الترتيب من المساحة المحصولية والبالغة حوالى ١٥,٥ مليون فدان عام ٢٠١٤ (وزارة الزراعة واستصلاح الأراضي، ٢٠٠٠-٢٠١٤).

تقدير الكفاءة الفنية للمحافظات المصرية في إنتاج أهم محاصيل الحبوب

غادة صالح حسن صالح و أشرف السيد مصطفي العمري

معهد بحوث الاقتصاد الزراعي– مركز البحوث الزراعية

الملخص: تواجه التنمية الزراعية الأفقية العديد من الصعوبات المتمثلة في ندرة الموارد الزراعية وبصفة خاصة الأرض والمياه، بالإضافة إلى ضخامة الاستثمارات اللازمة، الأمر الذي يجعل من التنمية الزراعية الرأسية بزيادة إنتاجية الوحدة من الموارد هدفاً تسعى السياسة الزراعية لتحقيقه، وفي إطار المشكلة البحثية استهدف هذا البحث دراسة كل من تطور مساحة وإنتاج أهم محاصيل الحبوب في الزراعة المصرية متمثلة في القمح، الأرز، الذرة الشامية، تقدير بعض المؤشرات الانتاجية والاقتصادية لمحاصيل الحبوب موضع البحث، تقدير الكفاءة الفنية لمحافظات الجمهورية في إنتاج محاصيل القمح والأرز والذرة الشامية، تقدير الآثار الاقتصادية المترتبة على تحقيق الكفاءة الفنية في إنتاج محاصيل الحبوب على مستوى المزرعة والزراعة المصرية.

اعتمد البحث في تحقيق أهدافه على استخدام أسلوب التحليل الاقتصادي الوصفي لقياس والكمي لقياس بعض مؤشرات الإنتاجية والاقتصادية المرتبطة بإنتاج أهم محاصيل الحبوب، كما تم الاستعانة بأسلوب تحليل الانحدار البسيط والتحليل مغلف البيانات لتقدير الكفاءة الفنية لأهم محاصيل الحبوب.

تبين من النتائج أن هناك معدل نمو سنوي معنوي إحصائياً للمساحة المنزرعة بمحاصيل القمح، والذرة الشامية الصيفي، والذرة الشامية النيلي بلغ نحو ٢,٢%، ١,٦%، ١٠,٢% لكل منهم على الترتيب من المتوسط السنوي خلال فترة الدراسة والبالغ حوالي ٢٨٥٩,٤، ١٨٥٢,٤، ٢٨١,٣ ألف فدان لكل منهم وبنفس الترتيب. في حين بلغ معدل النمو السنوي لإجمالي الإنتاج نحو ٢,٤%، ١٣%، ٢١,٧% وبنفس الترتيب، في الوقت الذي لم تثبت فيه المعنوية الإحصائية لمعدل نمو المساحة والإنتاج لمحصول الأرز نظراً لأن مساحته محددة من قبل وزارتي الري والزراعة.

حققت محافظة البحيرة أقصى عائد فداني لمحصول القمح بقيمة بلغت حوالي ٥١٢٥ جنيه، كما بلغ أقصى عائد فداني لمحصول القمح حوالي ١,٣٧ جنيه بمحافظة أسوان، في حين حققت محافظة الدقهلية أقصى عائد فداني لمحاصيل الأرز، الذرة الشامية الصيفي والذرة الشامية النيلي بقيمة بلغت ٤٨٠٨، ٥٦٠١، ٤٤٤٣ جنيه للمحاصيل الثلاثة على الترتيب.

أشارت نتائج تقدير الكفاءة الفنية لمحاصيل الحبوب موضع الدراسة إلى أن متوسط معامل الكفاءة الفنية بلغ حوالي ٠,٨٩، ٠,٨٧، ٠,٨٦، ٠,٨٢ لمحاصيل القمح، الأرز، الذرة الشامية الصيفي والذرة الشامية النيلي على الترتيب،

المحتويات

هيئة التحرير

مجلـة

الجديد في البحوث الزراعية

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