



FACULTY OF AGRICULTURE

Minia J. of Agric. Res. & Develop.
Vol. (39), No. 1, pp. 161-174, 2019

RESPONSE OF WHEAT AND MAIZE PLANTS TO APPLICATION OF COMPOST AND INOCULATION WITH VESICULAR ARBUSCULAR MYCORRHIZAE

F .S. Ali; O. A. O. Saad and Yasmein S. Maisar

Agricultural Microbiology Department, Faculty of Agriculture,
Minia University, Minia, Egypt.

Received: 4 July (2019) Accepted: 15 July (2019)

ABSTRACT

A pot experiment was conducted to investigate the effect of application of three rates of compost (40, 60 and 80 g/pot) and inoculation with VA mycorrhizae on growth of wheat and maize plants grown in clay loam and sandy soils. VA mycorrhizal root colonization was also studied.

The results revealed that the increasing of organic fertilization resulted in increases in growth measurements of both plants, (*i.e.* plant height, root length, fresh weight, dry weight, percentage of infection with mycorrhizae and N and P percentage). Inoculation of wheat and maize plants with mycorrhizae led to high significant increases in the above-mentioned parameters as compared to uninoculated plants grown in the two soils. The highest values of above-mentioned measurements were recorded in plants which received 80 g compost /pot (*i.e.* 20 tons/ feddan), in the clay loam and sandy soils. The interaction effect between compost and inoculation with mycorrhizae was significant in the plant height, root length and N percentage of wheat in the sandy soil, as well as the interaction effect between compost and inoculation with mycorrhizae was significant in the percentage of mycorrhizal infection in the sandy soil. The interaction effect between application of compost and inoculation with mycorrhizae was significant in plant height, % mycorrhizal infection and % N of maize in the clay loam and sandy soils. The highest values of the above-mentioned parameters of wheat and maize were achieved with application of compost at the rate of 60 g/pot which represent 15 tons/ feddan combined with inoculation with mycorrhizae in both experimental soils.

INTRODUCTION

In fact, wheat crops represent a strategic element in the food of developing countries occupying 17% of the total cultivated land in the world (CIMMYT 2000). The importance of wheat as an important food commodity is due to its high nutritive value. The whole grain wheat is a rich source of various antioxidants, protein (gluten), vitamins, minerals and fibers (Sramkova et al., 2009). African countries are the world's biggest wheat importer with more than 45 million ton in 2013 where North African countries have the highest per capita wheat consumption.

Maize accounts for almost half of the calories and protein consumed in eastern and southern Africa (ESA), and one-fifth of the calories and protein consumed in West Africa. An estimated 208 million people in sub-Saharan Africa (SSA) depend on maize as a source of food security and economic wellbeing. Maize occupies more than 33 million ha of SSA's estimated 200 million ha of cultivated land. Considering the low average maize grain yields that are still pervasive in farmers' fields, meeting the projected increase demand for maize grain in Africa presents a challenge. Maize accounts for almost half of the calories and protein consumed in ESA, and one-fifth of the calories and protein consumed in West Africa. An estimated 208 million people in SSA depend on maize as a source of food security and economic wellbeing. Maize occupies more than 33 million ha of SSA's estimated 200 million ha of cultivated

land. Considering the low average maize grain yields that are still pervasive in farmers' fields, meeting the projected increase demand for maize grain in Africa presents a challenge. (Macauley, 2015)

Compost is increasingly used as an organic fertilizer (Cavagnaro, 2014), it can slowly release nutrients for plants and microorganisms and help maintaining a medium-high nutrient availability (Scotti et al., 2016; Yang et al., 2017), which may benefit *Arbuscular mycorrhizae* fungi. Although AM fungi are not saprotrophic fungi, some studies have shown that AM fungi can directly take advantage of organic matter (Hodge et al., 2001; Govindarajulu et al., 2005; Jin et al., 2005). In addition, compost addition usually promotes plant growth and enhances carbon allocation to soil fungi (Lee et al., 2004; Donn et al., 2014), thus can indirectly affect AM fungi. The effect of compost addition on AM can also be mediated through soil bacteria, which was reported to either directly enhance AM growth and germination or indirectly by influencing plant physiology (Saia et al., 2015a,b). Taken as a whole, the addition of compost mostly had beneficial effect on AM growth. A number of studies have reported that compost addition enhanced AM root colonization, spore production, and development of AM extraradical hyphae (Labidi et al., 2007; Valarini et al., 2009; Tanwar et al., 2013; Cavagnaro, 2015).

The object of the present study was to evaluate the interaction effect of application of compost and inoculation with mycorrhizae on

growth of wheat (Sids 12) and maize (Giza 2) plants grown in clay loam and sandy soils.

MATERIALS AND METHODS

This investigation was carried out in the laboratory of microbiology and the greenhouse of the faculty of Agriculture, Minia University, during 2015/2016 seasons to study the effect of application of compost and inoculation with VA- mycorrhizae on growth of wheat and maize plants grown in two types of soils (clay loam and sandy soils).

1-The soil used

Two types of soil were used in this study (clay loam and sandy soils). The clay loam soil was collected from the experimental farm of Faculty of Agriculture, Minia University. Whereas, the sandy soil was obtained from newly reclaimed sandy soil of Shosha Agriculture Research Center, Minia University. The physical and chemical properties of the used soils are presented in Table (1) as reported by Service Laboratory for soil, Plant and Water analysis of Minia University.

2- The compost used

Nile compost produced by Egyptain company for Agricultural Residues Utilization. EL-Minia industrial zone EL- Minia Egypt was used in this study. Some of the main characteristics of this compost are given in Table (2).

3-Vesicular-arbuscular mycorrhizae (VAM)

Two species of endomycorrhizal fungi (*Glomus fasciculatum* & *G. mosseas*), supplied by Agric. Microbiology Dept., Fac., Agric., Minia University, Egypt were used.

Preparation of inocula

For preparing VAM inoculum, fired clay pots of 30cm in diameter were filled with autoclaved sandy loam soil. The soil in each pot was inoculated with the two species of endomycorrhizal fungi. Five onion seedlings were transplanted in each pot as a host plant. At the end of the growth stage of onion, plants were unrooted. The soil of the used pots was mixed together and VAM spores were counted as described by (Gerdemann and Nicolson, 1963). The spores count was found to be 2.4 spores/g. soil. This soil containing mixture of VAM spores, mycelium and chopped roots, was kept to be used as VAM inoculum.

The experimental design and treatment

On the May and November experiment seasons, maize and wheat grains were sown in polyethylene bags 28x20 cm, each filled with 5 kg of clay loam or and sandy soils. These pots were subjected to the following compost treatments:

1-Control (without any treatment).

2-Nile compost at rates of 40, 60 and 80 g per pot (*i.e.* 10, 15 and 20 tons/Fed.).

3- VAM inoculum added at rate of 100g/bag (5 kg soil).

4- Nile compost at rates of 40, 60 and 80 g per pot (*i.e.* 10, 15 and 20 tons/Fed.) plus VAM inoculum added at rate of 100g/bag (5 kg soil) .

Table (1): Mechanical and chemical analysis of the used soils. Table (1): Mechanical and chemical analysis of the used soils.

Characteristics	Soil types	
	Soil I	Soil II
Physical analysis	26.44	92.40
Sandy %		
Silt %	31.17	4.04
Clay %	42.39	3.16
Texture grade	Clay loam	Sandy
Chemical analysis		
pH	8.01	8.30
E.C.mmhos/cm	0.65	3.22
CaCO ₃	1.82	13.85
Total N %	0.09	0.02
Available P (ppm)	12.62	2.41
Organic matter	1.69	0.06

Table (2): Chemical analysis of used compost

Characteristics	Value
pH	7.60
Ec	2.53
Total N (%)	0.69
NH ₄ ⁺ (ppm)	97.50
NO ₃ ⁻ (ppm)	43
Organic matter (%)	51.5
Organic carbon (%)	29.5
P(%)	0.43
K(%)	1.27
Fe (ppm)	1013
Mn (ppm)	108
Cu (ppm)	58
Zn (ppm)	2.53

Factorial design with three replicates and 2 plants/replicate was conducted. Maize and wheat plants grown in bags containing sandy or clay loam soil were carefully harvested at 60 days of growth. Then, the plants were thoroughly hand-washed to remove soil particles from the roots, then, heights of plants and root length, plant fresh weight and dry

weight were recoded. Percentage of mycorrhizal root colonization was assessed microscopically by the slide method (Phillips and Hayman, 1970) as described below. Nitrogen content of the shoots and roots was determined by microkjeldahl procedure (Eastin, 1978). Phosphorus contents had been colorimetrically determined according to Olsen *et al.*, (1954).

The obtained data were statistically analyzed (Clewer and Scarisbrick, 2001) and the Data collected were statistically analyzed by the analysis of variance using the general linear model (GLM) procedure of statistical analysis system (SAS,2006). The following statistical model Factorial design using the following models.

$$Y_{ijk} = \mu + F_i + I_j + FI_{ij} + E_{ijk}$$

where Y_{ijk} = The observation value of the concerned trait.

μ = The overall mean for the concerned trait.

F_i = The fixed effect to the fertilization (0, 50, 75, 100 %).

I_j = The fixed effect to inoculation (with, without).

$F_i I_j$ = The fixed effect due to the interaction ($F_i \times I_j$).

E_{ijk} = Arandom error.

Significant differences among treatments were sparated by Duncan,s multiple range tests (Duncan, 1955)at level 5% only when F-value were significantly different at level 5%. The differences were expressed as follow:

NS= Not significant ($p \geq 0.05$)

*= significant ($p \leq 0.05$)

** = Highly significant ($p \leq 0.01$)

RESULTS AND DISCUSSION

1- Effect of compost and inoculation with mycorrhizae on plant height, root length and fresh weight of wheat plant

Data in Table (3) show the mean values of plant height, root length and fresh weight of wheat plants. Data presented in Table (3) indicate that inoculation with mycorrhizae led to a high significant increase in the above parameters as compared to uninoculated treatment in the two types of soils. The superior estimated effect of VAM could be due to the great role played via mycorrhizae mycelia means, that they are more effective than plant root hairs in absorbing nutrient elements including phosphorus, nitrogen, potassium and some micronutrients. Similar results were reported by Rupam *et al.* (2001); Bhoopander *et al.* (2005); Pertot *et al.* (2006); Abd EL- Wahab (2007); Ali *et al.* (2009); Scotti *et al.* (2016) and Yang *et al.* (2017).

Above mentioned parameters significantly increased as a result of application of different levels of compost in the two types of soils. The highest values of plant height, root length and fresh weight were obtained when the compost was applied at the rate of 80 g/pot which represent 20 tons/ feddan in the clay loam and sandy soils. These results may be due to the role of compost in increasing the vegetative growth of the cultivated plants.

These results are in agreement with those obtained by Linderman and Davis (2001); Velasco *et al.* (2001); Caravaca *et al.* (2002); Osorio *et al.* (2002); Linderman and Davis

(2003); Nicole *et al.* (2003); Hakan *et al.* (2007); Tanwar *et al.* (2013); Cavagnaro (2015) and Saia *et al.* (2015a,b.) they found that the compost application enhance the vegetative growth of cultivated plants.

Also, data in Table (3) reveal that interaction effect between compost and inoculation with mycorrhizae was significant on the plant height and root length in the sandy soil. The interaction between compost and inoculation with mycorrhizae had no significant effect on plant height and root length in the clay loam soil.

The highest values of the above parameters were obtained when the compost was applied at the rate of 60 g/pot which represent 15 tons/ feddan with application of mycorrhizae in the clay loam and sandy soil.

2-Effect of compost and inoculation with mycorrhizae on plant height, root length and fresh weight of maize plant

Data presented in Table (4) indicate that inoculation with mycorrhizae led to a high significant increase in the above parameters as compared with uninoculated treatment in the two types of soils. The superior effect of VAM could be due to the great role played by mycorrhizae mycelia means, that they are more effective than plant root hairs at absorbing nutrient elements including phosphorus, nitrogen, potassium and some micronutrients. Similar results were reported by Rupam *et al.* (2001); Bhoopander *et al.* (2005); Pertot *et al.* (2006); Abd EL- Wahab (2007); Ali *et al.* (2009); Scotti *et al.* (2016) and Yang *et al.* (2017).

Table (3) Effect of compost and inoculation with mycorrhizae on plant height, root length and fresh weight of wheat plant during 2015/2016 season.

Treatments		Plant height		Root length		Fresh weight	
Soil Types		Clay loam	Sand	Clay loam	Sand	Clay loam	Sand
Compost	Co _w	*	***	*	***	*	**
	Control	57.17 ^b	45.66 ^b	12.83 ^c	8.76 ^c	2.07 ^c	1.29 ^b
	100%	83.33 ^a	75.66 ^a	18.16 ^{ab}	15.26 ^b	4.05 ^{ab}	1.90 ^a
	75%	80.66 ^a	73.33 ^a	17.50 ^a	12.76 ^a	3.02 ^a	1.83 ^a
	50%	60.00 ^b	52.66 ^b	14.83 ^{bc}	11.26 ^b	2.26 ^{bc}	1.09 ^b
	LSD	18.62	7.91	3.65	2.39	0.77	0.44
Inoculation	I	***	***	***	***	***	***
	With	83.17	74.66	18.83	14.33	3.14	1.91
	Without	57.41	49.00	12.83	9.50	2.06	1.15
	LSD	13.16	5.59	2.58	1.69	0.55	0.31
Compost x Inoculation	CO _w * I	Ns	**	Ns	**	Ns	Ns
	Control with	78.00	67.66	16.00	11.33	2.88	1.68
	Control without	36.33	23.66	9.66	6.00	1.27	0.90
	% 100 with	81.00	78.00	18.00	11.66	3.33	2.07
	% 100 without	80.00	69.33	16.33	12.66	2.78	1.60
	% 75 with	93.66	84.66	23.33	19.66	3.27	2.62
	% 75 without	73.00	66.00	13.66	11.66	2.77	1.18
	% 50 with	80.00	68.33	18.00	14.66	3.08	1.26
	% 50 without	40.00	37.00	11.66	7.66	1.44	0.92

In addition, data in Table (4) show the mean values of plant height, root length and fresh weight of wheat plants. These parameters significantly increased by levels of compost in the two soils. The highest values of plant height, root length and fresh weight were obtained when the compost was applied at the rate of 80 g/pot which represent 20 tons/ feddan in the clay loam and sandy soils. These results may be due to the role of compost in increasing the vegetative growth of the plants. These results are in accordance with those obtained by Linderman and Davis (2001); Velasco *et al.* (2001); Caravaca *et al.* (2002); Osorio *et al.* (2002); Linderman and Davis (2003); Nicole *et al.* (2003); Hakan *et al.* (2007); Tanwar *et al.*

(2013); Cavagnaro (2015) and Saia *et al.* (2015a,b).

Data in Table (4) reveal that interaction effect between compost and inoculation with mycorrhizae was significant on the plant height in the clay loam and sandy soils and also significant on the plant height in the sandy soil. The interaction between compost and inoculation with mycorrhizae had no significant effect on fresh weigh of plant in the sandy soil.

The highest values of the above parameters were obtained when compost was applied at the rate of 60 g/pot which represent 15 tons/ feddan and inoculation with mycorrhizae in the clay loam and sandy soil. This could be attributed to the synergistic

effect for VAM inoculation and compost application.

Table (4) Effect of compost and inoculation with mycorrhizae on plant height, root length and fresh weight in the maize plant during 2015/2016 season .

Treatments		Plant height		Root length		Fresh weight	
Soil Types		Clay loam	Sand	Clay loam	Sand	Clay loam	Sand
Compost	Coz	***	***	***	**	***	**
	Control	60.33 ^c	58.50 ^c	42.83 ^b	49.66 ^{bc}	41.87 ^c	30.54 ^b
	100%	101.16 ^a	98.00 ^{ab}	82.50 ^a	62.66 ^{ab}	87.73 ^{ab}	65.76 ^a
	75%	95.33 ^a	92.83 ^a	80.16 ^a	59.16 ^a	67.43 ^a	58.66 ^a
	50%	86.16 ^b	85.66 ^b	54.16 ^b	40.66 ^c	61.16 ^b	53.45 ^a
	LSD	12.008	8.298	13.914	11.42	18.93	19.22
Inoculation	I	***	***	***	***	***	***
	With	99.25	94.58	81.25	78.41	87.97	73.71
	Without	75.75	72.91	48.58	27.66	45.63	30.49
	LSD	8.490	5.867	9.838	8.07	13.385	13.59
Compost x Inoculation	COZ * I	**	**	ns	**	ns	ns
	Control with	84.00	75.33	61.00	85.66	64.63	49.66
	Control without	36.66	41.66	24.66	13.66	19.12	11.42
	% 100 with	101.00	92.66	91.33	73.33	90.56	74.10
	% 100 without	101.33	91.33	69.66	46.00	62.90	43.43
	% 75 with	118.00	114.00	97.00	87.66	108.16	95.73
	% 75 without	86.66	83.66	67.33	36.66	66.70	35.60
	% 50 with	94.00	96.33	75.66	67.00	88.53	75.36
% 50 without	78.33	75.00	32.66	14.33	33.80	31.53	

3-Effect of compost and inoculation with mycorrhizae on dry weight, infection %, nitrogen % and phosphorus % of wheat plant

Results in Table (5) indicate that dry weight, percentage of infection, percentage of nitrogen and percentage of phosphorus in wheat plants were significantly affected by inoculation with endomycorrhizae fungi in the two types of soils. This increase may be due to the principle mechanism that carried out by mycorrhizae to benefit the plant growth through production of some useful materials transfer to the plant root area creating

a direct effect on plant growth. These materials could be hormones, auxins, (GAS) and (CKS) that mycorrhizae release in the root zone and positively affect root growth and extension. The result could also attributed to more absorption of nutrients which reflect more growth activity, nitrogenous compound assimilation forming growth substances, more cell division and elongation. Similar results and explanation were obtained by Abd El Ati (2000); Grandcourt *et al.* (2004); Caglar and Bayram (2006); Ghazi *et al.* (2007); Ali *et al.* (2009); Scotti *et al.* (2016) and Yang *et al.* (2017).

Data presented in Table (5) showed that increasing compost levels resulted in increase of dry weight, percentage of infection, percentage of nitrogen and percentage of phosphorus in wheat plants growing in the two types of soils. The highest values were obtained when compost was applied at rate of 80 g/pot which represent 20 tons/ feddan in the clay loam and sandy soils. These results are in full agreement with those reported by Velasco *et al.* (2001); Osorio *et al.* (2002); Nicole *et al.* (2003); Hakan *et al.* (2007); Walsh and Ragupupathy (2007) and Saia *et al.* (2015a,b).

The interaction effect between inoculation with VAM and application of compost on percentage of nitrogen was highly significant on the clay loam and sandy soils where the dry weigh of wheat was significant in the clay loam soil. The highest values of the above parameters were obtained when the compost was applied at the rate of 60 g/pot which represent 15 tons/ feddan with mycorrhizal inoculation in the clay loam and sandy soil.

4-Effect of compost and inoculation with mycorrhizae on dry weight, infection%, nitrogen %and phosphorus% in maize plants

Results in Table (6) indicate that dry weight, percentage of infection, percentage of nitrogen and percentage of phosphorus in the maize plants were significantly affected by inoculation with endomycorrhizal fungi in the two soils. This increase may be due to the principle mechanism that carried out by

mycorrhizae to benefit the plant growth through production of some useful materials transferred to the plant root zone creating a direct effect on plant growth. These materials could be hormones, auxins, (GAS) and (CKS) that mycorrhizae release in the root zone and positively affect root growth and extension. The result could be attributed to more absorption of nutrients which reflect more growth activity, nitrogenous compound assimilation forming growth substances, more cell division and elongation. Similar results and explanation were reported by Abd El Ati (2000); Grandcourt *et al.* (2004); Caglar and Bayram (2006), Ghazi *et al.* (2007) and Ali *et al.* (2009).

Data reported in Table (6) show that increasing compost levels resulted in increase of dry weight, percentage of infection, percentage of nitrogen and percentage of phosphorus in maize plants growing in the two soils. The highest values were obtained when compost was applied at rate of 80 g/pot which represent 20 tons/ feddan in the clay loam and sandy soils. These results are in full agreement with those reported by Velasco *et al.* (2001); Osorio *et al.* (2002); Nicole *et al.* (2003); Hakan *et al.* (2007) ;Walsh and Ragupupathy (2007) and Saia *et al.* (2015a,b).

The interaction effect between VAM inoculation and compost application on percentage of infection, percentage of nitrogen was significant on the clay loam and sandy soils. The highest values of the above parameters were obtained when the compost was applied at the rate of

60 g/pot which represent 15 tons/ feddan in the clay loam and sandy soil with mycorrhizal inoculation

Table (5) Effect of compost and inoculation with mycorrhizae on dry weight, %infection, %nitrogen and %phosphorus in the wheat plant.

Treatments		Dry weight		% infection		%N		%P	
Soil Types		Clay loam	Sand	Clay loam	Sand	Clay loam	Sand	Clay loam	sand
	CO _w	*	Ns	*	Ns	***	***	***	*
Compost	Control	1.28 ^{bc}	0.66 ^a	36.83 ^c	29.66 ^a	7.71 ^c	6.60 ^d	0.27 ^b	0.26 ^b
	100%	2.85 ^{ab}	0.99 ^a	48.16 ^{ab}	37.83 ^a	29.63 ^a	24.60 ^b	0.36 ^a	0.31 ^a
	75%	1.93 ^a	0.85 ^a	44.50 ^a	31.33 ^a	25.11 ^a	19.13 ^a	0.35 ^a	0.31 ^a
	50%	1.14 ^c	0.62 ^a	39.50 ^{bc}	32.83 ^a	13.50 ^b	8.23 ^c	0.29 ^b	0.28 ^{ab}
	LSD	0.62	0.45	7.04	9.62	3.87	3.69	0.04	0.04
Inoculation	I	**	Ns	***	***	***	***	***	***
	With	1.94	0.89	51.08	39.83	27.91	20.47	0.36	0.32
	Without	1.16	0.66	33.41	26.00	10.06	6.30	0.27	0.25
	LSD	0.44	0.32	5.98	7.80	2.73	2.61	0.02	0.028
Compost x Inoculation	CO _w * I	Ns	Ns	*	Ns	***	***	Ns	Ns
	Control with	1.74	0.72	47.33	38.33	12.90	4.03	0.33	0.29
	Control without	0.83	0.59	16.33	11.00	6.53	6.16	0.20	0.21
	%100 with	2.12	0.94	51.00	40.00	29.96	22.90	0.36	0.32
	%100 without	1.58	1.04	36.00	21.66	21.30	16.30	0.34	0.30
	%75 with	2.32	0.99	59.33	43.00	35.00	29.73	0.41	0.36
	%75 without	1.55	0.70	19.00	13.66	13.23	8.53	0.30	0.25
	%50 with	1.60	0.91	46.66	38.00	23.80	15.23	0.31	0.32
	%50 without	0.68	0.32	22.33	17.66	3.20	1.23	0.14	0.13

Table (6) Effect of compost and inoculation with mycorrhizae on dry weight, %infection, %nitrogen and %phosphorus in the maize plant during 2015/2016 season.

Treatments	Dry weight		% infection		%N		%P		
	Clay loam	Sand	Clay loam	Sand	Clay loam	Sand	Clay loam	sand	
Soil Types	Coz	**	*	***	**	***	***	*	*
Compost	Control	16.28 ^b	10.60 ^c	34.00 ^c	28.83 ^b	9.66 ^c	3.11 ^b	0.16 ^b	0.11 ^{bc}
	100%	28.75 ^a	24.41 ^{ab}	50.83 ^b	44.33 ^b	40.15 ^a	32.76 ^a	0.22 ^a	0.18 ^a
	75%	27.96 ^a	19.63 ^a	46.66 ^a	32.50 ^a	31.18 ^a	21.33 ^a	0.21 ^a	0.16 ^{ab}
	50%	19.00 ^b	15.38 ^{bc}	38.33 ^c	33.16 ^b	30.73 ^b	11.11 ^b	0.16 ^b	0.10 ^c
	LSD	6.851	7.818	5.919	7.79	9.22	12.572	0.0479	0.0579
Inoculation	I	***	***	***	***	***	**	***	**
	With	29.75	24.04	53.83	44.66	32.28	29.67	0.25	0.17
	Without	16.24	10.97	32.58	24.75	23.58	14.49	0.13	0.11
	LSD	4.814	5.528	3.478	4.80	6.522	8.889	0.0339	0.040
Compost x Inoculation	COZ* I	ns	ns	**	**	*	*	ns	ns
	Control with	21.36	16.20	41.66	37.00	13.60	16.26	0.22	0.13
	Control without	11.20	5.01	16.33	10.66	10.73	9.96	0.09	0.09
	% 100 with	32.86	23.23	52.00	34.00	45.43	22.56	0.25	0.19
	% 100 without	22.00	15.60	31.66	20.00	36.86	20.96	0.20	0.18
	%75 with	35.93	31.73	67.33	61.00	46.43	41.83	0.30	0.23
	%75 without	22.00	17.53	30.00	18.00	26.93	22.83	0.12	0.09
	%50 with	28.86	25.00	54.33	46.66	26.66	18.03	0.22	0.14
	%50 without	9.13	5.76	12.33	9.66	14.80	14.20	0.10	0.06

REFERENCES

- Abd El Ati, Y.Y. (2000). Growth and yield of cowpea as affected by irrigation regime, phosphorus application and VA-mycorrhizae infection treatments. *Assiut-Journal-of-Agricultural-Sciences*. 31(2):21-38.
- Abd El-Wahab, A.M. (2007). Effect of some sodium azide and algae extract treatments on vegetative growth, yield and berried quality of early superior grapevine cv. M. Sc. Thesis Fac. Of Agric. Minia Univ. Egypt.
- Ali, F. S., Zayed, G., Saad O. A. and Abdul-Mohsen, E . (2009) Optimization of nitrogen fertilizer level for maximum colonization of mycorrhizae on root of *Coriander* plants. African Crop Science Conference, proceeding, Vol 117-122..
- Bhoopander,G.; Rupam,K. and Mukerji, K.G.(2005). Effect of the arbuscular mycorrhizae *Glomus fasciculatum* and *G.macrocarpum* on the growth and nutrient content of *Cassia siamea* in a semi-arid indian

- waste land soil. *New-Forests*. 29(1):63-73.
- Caglar, S. and Bayram, A. (2006). Effects of vesicular-arbuscular mycorrhizal (VAM) fungi on the leaf nutritional status of four grapevine rootstocks. *European-Journal-of-Horticultural-Science*. 71(3):109-113.
- Caravaca, F.; Barea, J.M.; Figuerola, D. and Roldan, A. (2002). Assessing the effectiveness of mycorrhizal inoculation and soil compost addition for enhancing reforestation with *Olea europaea* subsp. *Sylestris* through changes in soil biological and physical parameters. *Applied Soil Ecology*. 20(2):107-118.
- Cavagnaro, T. R. (2014). Impacts of compost application on the formation and functioning of arbuscular mycorrhizas. *Soil Biol. Biochem.* 78: 38–44.
- Cavagnaro, T. R. (2015). Biologically regulated nutrient supply systems: compost and arbuscular mycorrhizas-a review. *Adv. Agron.* 129: 293–321.
- CIMMYT (2000). Wheat in the developing world. Available at http://www.CIMMYT.Org/research/wheat/map/developing_world/index.htm.
- Clewer, I.M. and Scarisbrick, F.J. (2001). *Agricultural Experimentation, Design and analysis*. John Wiley & Sons. Inc., New York .
- Donn, S.; Wheatley R. E.; McKenzie B. M.; Loades K. W. and Hallett P. D. (2014). Improved soil fertility from compost amendment increases root growth and reinforcement of surface soil on slopes. *Ecol. Eng.* 71: 458–465.
- Duncan, D. B. (1955). Multiple Range and Multiple F Tests. *Biometrics* 11:1.
- Eastin, E.F. (1978). Total nitrogen determination for plant nutrient. *Analytical biochemistry*, 85:591-594.
- Gerdemann, J.W. and Nicolson, T.H. (1963). Spores of mycorrhizal endogene species extracted from soil by wet sieving and decanting. *Trans.Br. Mycol. Soc.*, 46:235-244.
- Ghazi, A.; Nehad A. and Yahia-Othman. (2007). Application of mycorrhizae fungi to improve drought tolerance in two onion cultivars. *African-Crop-Science-Society*. Vol.8.PP.1-5.
- Govindarajulu M.; Pfeffer P. E.; Jin H. R.; Abubaker J.; Douds D. D. and Allen J. W. (2005). Nitrogen transfer in the arbuscular mycorrhizal symbiosis. *Nature* 435: 819–823.
- Grandcourt, D.A.; Eprop, U.; Lou, D.; Montpiedinisanna, M. and Bereau, E.J. (2004) Resting responses of mycorrhizal inoculated phosphorus *Avicennia* seedlings of two tropical rain forest tree species. *New-Phytologist*. 161(3):865-875.
- Hakan, W.; Mongi, Z.; Hafedh, N. and Sonia, L. (2007). Effects of compost addition on extra radical growth of arbuscular mycorrhizal fungi in *Acacia tortilis* ssp. *Raddiana savanna* in

- a pre-saharan area. *Applied soil ecology*. 184-192.
- Hodge A.; Campbell C. D. and Fitter A. H. (2001). An arbuscular mycorrhizal fungus accelerates decomposition and acquires nitrogen directly from organic material. *Nature* 413: 297–299.
- Jin H.; Pfeffer P. E.; Douds D. D.; Piotrowski E.; Lammers P. J. and Shachar-Hill Y. (2005). The uptake, metabolism, transport and transfer of nitrogen in an arbuscular mycorrhizal symbiosis. *New Phytol.* 168: 687–696.
- Labidi S.; Nasr H.; Zouaghi M. and Wallander H. (2007). Effects of compost addition on extra-radical growth of arbuscular mycorrhizal fungi in *Acacia tortilis* ssp. *raddiana* savanna in a pre-Saharan area. *Appl. Soil Ecol.* 35: 184–192.
- Lee J. J.; Park R. D.; Kim Y. W.; Shim J. H.; Chae D. H. and Rim Y. S. (2004). Effect of food waste compost on microbial population, soil enzyme activity and lettuce growth. *Bioresour. Technol.* 93: 21–28.
- Linderman, R.G. and Davis, E.A. (2001). Vesicular-arbuscular mycorrhizae and plant growth response to soil amendment with composted grape pomace or its mater extract. *Hort Technology*. 11(3):446-450.
- Linderman, R.G. and Davis, E.A. (2003). Soil amendment with different peatmosses affects mycorrhizae of onion. *Hort Technology*. 13(2):285-289.
- Macauley, H. (2015). Cereal crops: Rice, Maize, Millet, Sorghum, Wheat. Feeding Africa background paper. United Nations economic commission for Africa. pp:1-36.
- Nicole, D. C.; Role, M. A. and Michael, K. (2003). Vermicompost stimulates mycorrhizal colonization of roots of sorghum bicolor at the expense of plant growth. *Pedobiologia* 47,85-89.
- Olsen, S.R.; Cole, C.V.; Watanabe, F.S. and Dean, L.A. (1954). Estimation of available phosphorus in soils by extraction with sodium bicarbonate. U.S. Dept. Agr.Cir. 939.19.P.
- Osorio, N.W.; Alzate, J.M. and Ramirez, G.A. (2002). Coffee seedlings growth as affected by micorrhizal inoculation and organic amendment. *Communications in soil science and plant analysis*. 33(9/10): 1425-1434.
- Pertot, I.; Luca, F. De.; Zassom R. and Zulini, L (2006). Influence on plant growth of *Glomus mosseae* BE G12, *Trichoderma viride* TVI and *T. harzianum* T39 on grapevine in different environments. *Bulletion oil. B/Srop*, 29(2): 131-134.
- Phillips, J.M. and Hayman, D.S. (1970). Improved procedures for clearing roots and staining parasitic and vesicular-arbuscular mycorrhizae fungi for rapid assessment of infection. *Transaction of the british mycological soc.* 55,158-161.

- Rupam, K.; Giri, B.; Mukerji, K.G. and Kapoor, R. (2001). Effect of vesicular arbuscular mycorrhizae on growth and essential oil yield of *Anethum graveolens* L. *Indian-Journal-of-plant-physiology*. 6(1):77-80.
- Saia, S.; Amato G.; Frenda A. S.; Giambalvo D. and Ruisi P. (2015a). Influence of arbuscular mycorrhizae on biomass production and nitrogen fixation of berseem clover plants subjected to water stress. *PLOS ONE* 9: e90738. 10.1371/journal.pone.]
- Saia, S.; Ruisi P.; Fileccia V.; Di Miceli G.; Amato G. and Martinelli F. (2015b). Metabolomics suggests that soil inoculation with arbuscular mycorrhizal fungi decreased free amino acid content in roots of durum wheat grown under N-limited, P-rich field conditions. *PLOS ONE* 10: e0129591. 10.1371/journal.pone.
- Saas (2006). The 13th International Static Analysis Symposium Seoul, Korea.
- Scotti R.; Pane C.; Spaccini R.; Palese A. M.; Piccolo A. and Celano G. (2016). On-farm compost: a useful tool to improve soil quality under intensive farming systems. *Appl. Soil Ecol.* 107: 13–23.
- Sramkova; Z, Gregova; E. and Sturdik; E (2009). Chemical composition and nutritional quality of wheat grain. *Acta Chimica Slovaca*, Vol. (2), No. (1). pp:115-135.
- Tanwar, A.; Aggarwal, A.; Yadav A. and Parkash, V. (2013). Screening and selection of efficient host and sugarcane bagasse as substrate for mass multiplication of *Funneliformis mosseae*. *Biol. Agric. Hortic.* 29 107–117.]
- Valarini, P. J.; Curaqueo, G.; Seguel, A.; Manzano, K.; Rubio, R. and Cornejo, P. (2009). Effect of compost application on some properties of a volcanic soil from central South Chile. *Chil. J. Agr. Res.* 69: 416–425.
- Velasco, V.J.; Ferrera, C. R. and Almaraz, S.J.J. (2001). Vermicompost, arbuscular mycorrhizae and *Azospirillum brasilense* on tomatillo. *Terra.* 19(3):241-248.
- Walsh, K.B. and Ragupathy, S. (2007). Mycorrhizal colonization of three hybrid papayas (*Carica papaya*) under mulched and bare ground conditions. *Australian Journal of Experimental Agriculture.* 47(1) :81-85.
- Yang, W.; Guo, Y.; Wang, X.; Chen, C., Hu, Y. and Cheng, L. (2017). Temporal variations of soil microbial community under compost addition in black soil of Northeast China. *Appl. Soil Ecol.* 121: 214–222.

استجابة نباتات القمح والذرة الشامية للمعاملة بالكومبوست والتلقيح بالميكورهيذا

فاروق شحاته علي؛ عمر عبد اللطيف عمر؛ ياسمين شرف الدين ميسر

قسم الميكروبيولوجيا الزراعية - كلية الزراعة - جامعة المنيا

أجريت تجربة أصص تحت ظروف الصوبة بغرض دراسة تأثير الكومبوست والتلقيح بالميكورهيذا على نمو ومحتوى نباتات القمح والذرة الشامية من العناصر الغذائية، وذلك تحت ظروف التربة الطينية الطميية والرملية، كما تم تدعيم التربة بصخر الفوسفات (26.4% P_2O_5) بمعدل 2.4 جرام لكل أصيص أي 300كجم للفدان. ثم إضافة المعدلات المختلفة للكومبوست وذلك قبل الزراعة. وقد أوضحت النتائج ان أعلى زيادة في الأوزان الجافة للمجموع الخضري والجذري والوزن الجاف الكلي للنبات ونسبة الإصابة بالميكورهيذا ومحتوى النباتات من عناصر النيتروجين والفوسفور في المعاملات الملقحة بواسطة الميكوريزا.

وقد سجلت أعلى التقديرات للصفات المدروسة في النباتات المعاملة بالكومبوست عند معدل 80جرام /إصيص أي 20طن للفدان في التربة الطينية الطميية والرملية. وكانت التفاعلات موجبة بين التلقيح بالميكورهيذا ومستويات الكومبوست على طول النبات وطول الجذر ونسبة النيتروجين لنباتات القمح في التربة الرملية، ونسبة الإصابة ونسبة النيتروجين في التربة الطينية الطميية وبالإضافة إلى أن التلقيح بالميكورهيذا ومستويات الكومبوست كانت ذات تأثير معنوي على طول النبات ونسبة الإصابة ونسبة النيتروجين لنباتات الذرة الشامية في كلا النوعين من التربة . ومن ناحية أخرى فإن المعاملة بالكومبوست والتلقيح بالميكورهيذا أدى إلى تقليل كمية الكومبوست المضافة إلى كل من القمح والذرة الشامية بمقدار الربع في كلا النوعين من التربة.