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EFFECT OF MYCORRHIZAE AND DIFFERENT RATES OF NPK ON VEGETATIVE GROWTH AND YIELD OF TOMATO PLANT UNDER NORTH SINAI CONDITIONS

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ABSTRACT

The experiments were conducted to evaluate the effect of mycorrhizae (*Glomus* sp. and *Gigspora* sp.) application on the vegetative growth and yield of tomato plants (Alisa cultivar), and its relevance to the mineral fertilizers requirements as NPK during the seasons of 2015/2016 and 2016/2017. The experiments were conducted at Baloza Research Station, Desert Research Center, North Sinai Governorate, Egypt. The experimental design was a randomized complete block design with three replicates, every replicate included 4 treatments (75 and100% of the recommended mineral fertilizer only or combined with the mycorrhizae treatment). The results showed that mycorrhizae application significantly increased the vegetative growth characters of tomato plant such as plant height, number of shoots, number of leaves, stem diameter, fresh and dry weights and yield. There were no significant differences in the vegetative growth characteristics of tomato plants receiving 75% of mineral fertilizers in addition to mycorrhizae application as compared with plants receiving 100% of mineral fertilizers only, except for the fresh weight of plants. The plants were received 100% of the recommended mineral fertilizers combined with mycorrhizae treatment gave the highest values of vegetative growth characters and yield. Therefore, we recommended that, using of mycorrhizae could be affective to maximize the utilization of mineral fertilizers, in addition, the mycorrhizea is ecofriendly, economically and considered as one of the most important bio-fertilizer resources.

Key words: Tomato, Vegetative growth, Yield, Mycorrhizae, Mineral fertilizers,

INTRODUCTION

Tomato (*Lycopersicon esculentum* Mill.) is an annual vegetable crop, the most popular vegetable all over the world, has great nutritional value due to its antioxidant contents such as lycopene and vitamin C **(Clinton, 1998 and Kaur et al 2002).** The nutrient management in organic farming is done through materials such mycorrhizae as a nitrogen source, the presence of mycorrhizae enhance plant productivity by the biological nitrogen fixation, phosphate solubilization, production of hormones and vitamins, and other growth factors required for plant growth **(Bhattacharya et al 2000).** On the other hand, some studies indicated that mycorrhizae may inhibit plant growth and nutrient uptake, which may be attributed to the presence of phytotoxins produced by some species of microorganisms which activated by application of mycorrhizae **(Ramadan, 2007),** lack of No_3 concentration around the plant root lead to a decrease in the number of lateral roots and inhibit root hair elongation, thus weakening the root system **(Mantelin and Touraine, 2004).** Mycorrhizae is an environmentally friendly technique such as other biofertilizers not only reduces load of chemical fertilizers in the plants but also minimizes the pollution in the soil with such this substances **(Abul Hossain,**

2012), application of mycorrhizae increases the number of microorganisms, while the application of chemicals can be harmful to the microorganisms in the soil **(Khan et al 2000 and Bareisis et al 2002).** Despite the high prices of mineral fertilizers and lack sometimes, almost all farmers are relying on commercial fertilizers without organic fertilizers for profitable yields, thus reduce the organic matter and affect chemical and physical properties of the soil **(Zia et al 2000). Kumar and Sharma (2004)** reported that using of mycorrhizae in combined with the mineral fertilizers i.e. nitrogen, phosphorus and potassium were found to be more beneficial for the tomato cultivation, where the yield and nutrient content increased. The integration between mineral fertilizers and Bio-fertilizers is very important, which plays a key role in sustain soil fertility and sustainable agriculture development. This study aims to evaluate the role of mycorrhizae application in improving the efficiency of applying mineral fertilizers and its impact on the vegetative growth of tomato plant under newly reclaimed lands.

MATERIAL AND METHODS

Field experiments were carried out at the experimental farm of Baloza Research Station, Desert Research Center, North Sinai, Egypt to study the influence of application of two species of mycorrhizae accompanying with different levels of mineral fertilizers NPK on tomato plant (Alisa cultivar), during two seasons (2015/2016 and 2016/2017), to determine the best treatment under new reclaimed lands conditions. Tomato transplants were obtained from New Star Company, Egypt, and the bio-fertilizer agents (two species of mycorrhizae, *Glomus* sp. and *Gigspora* sp.) from Cairo Micro-Biofertilizers Unit, Faculty of Agriculture, Ain Shams University. The chemical analyses of the experimental soil and irrigation water are presented in **Table 1.** Tomato transplants (Alisa cultivar) were transplanted into the field in the first week of September during the two seasons. Agriculture has been cultivated on an area of 4200 m^2 in open field in new reclaimed soil. The area of the experimental plot was 20 m^2 consisted of one ridges, each ridge was 20 m length and 1 m width. The plant distance was 30 cm apart on one ridge. The experimental design was a randomized complete block with three replications, all replicate included 4 treatments as follow:

T1- 75% of recommended mineral fertilizer.
T2- 75% of recommended mineral fertilizer + mycorrhizae application.
T3- 100% of recommended mineral fertilizer (Control).
T4- 100% mineral fertilizer + mycorrhizae application.

The treatment of mycorrhizae was applied to the planting of tomatoes during the preparation of the cultivation process. The method of drip irrigation was used with the addition of mineral fertilization with irrigation water as follows:

- NPK 19/19/19 + 1 Kg Fe + ½ Kg Zn + ½ Kg Mg, 15 days intervals.
- 4 Kg nitrate + 2 Kg nitrate Mg (3 times a week).
- 3 Kg potassium + 1 Kg MAP (once a week).
- 3 Kg Calcium Nitrate (15 days intervals).
- 1 liter phosphoric acid (once a week).
- 500 g NPK + 100 g Small elements + 200 cm Amino acids / 200 liters of water (15 days intervals)**.**

Table 1. Chemical analysis of the experimental soil and irrigation water.

	Soluble Cations (meg/100g)				Soluble Cations (meg/100g)				pH	EC (ds/m^2)	SAR	ESP
	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	CO_3^{2-}	HCO_3^{-}	Cl^{-}	SO_4^{2-}				
Soil	10.1	5.2	13.2	1.1	-	5	14.4	10.2	7.89	2.95	3.30	3.48
*Water	8.2	3.5	13.9	0.43	-	6	15.2	4.8	7.23	2.6	5.75	6.73

*Irrigation water source is El-Salam Conduit, North Saini, Egypt.

Studied characteristics

After 65 days from transplanting, five plants per plot were randomly chosen to measure plant height, number of shoots/plant, number of leaves/plant and plant fresh and dry weight. Total yield of five plants (from the inner ridges) were recorded from each plot, the average weight of yield/plant was calculated and yield per feddan was calculated by multiplying the average yield per plant by number of plants per feddan. and were recorded NPK ratio in leaves.

Mineral nutrients were determined in the fifth mature leaf from the top of the plant at the fourth week after transplanting (pollination and young fruit stage). The samples were dried at 70 °C for 72 h according to (**Great Britain, 1986).** Wet digestion method was used for total nutrient analysis similar to the sulfuric acid and hydrogen peroxide digestion method described by **Allen et al (1974).** The content of macro-nutrients (N, P, K) were determined as follows:

1. Total nitrogen was determined by Kjeldahl method according to **Jackson, (1958).**
2. Phosphorus content was determined colorimetrically using ammonium molybdate and ascorbic acid **(Watanabe and Olsen, 1965).**
3. Potassium content was determined photometrical using flame photometer **Jackson (1958).**

Statistical analysis

Data were subjected to Analysis of Variance (ANOVA) as described by **(Gomez and Gomez, 1984).** Means were compared according to Duncan's Multiple Range Test **(Duncan, 1955).** Differences at $P<0.05$ were considered significant.

RESULTS AND DISCUSSION

The data in **Tables 2 and 3** show the vegetative growth parameters of tomato plants such plant height, number of leaves, number of shoots, stem diameter, and fresh and dry weights as affected by the application of mycorrhizae and mineral fertilizers levels. The application of 75% of recommended mineral fertilizers leads to a significant decrease in all vegetative growth traits of tomato plant, while application of mycorrhizae beside 75% recommended mineral fertilizers led to a significant increase in all vegetative growth characteristics of tomato in both seasons. There were no significant differences in the vegetative growth characteristics of tomato plants which received 75% of mineral fertilizers with mycorrhizae application as compared with plants receiving 100% of mineral fertilizers only without the mycorrhizae treatment, except for the fresh weight of plants. The highest values of vegetative growth characteristics were recorded in tomato plants receiving 100% of recommended mineral fertilizers with mycorrhizal application in both seasons. Many studies have stated the positive impact of mycorrhizae application on plant growth performance **(Schreiner, 2007, Jansa et al 2008, Pellegrino et al 2011, Ortas and Ustuner, 2014, and Ziane et al 2017).**

Concerning the total yield mycorrhizal inoculation had a significant effect on tomato yield, which was greater in T4 treatment (100% mineral fertilizer + mycorrhizae application), where recorded 24.6 and 22.3 ton/fed in 2015/2016 and 2016/2017 respectively, compared to T1 (75% of recommended mineral fertilizer) and T3 (100% of recommended mineral fertilizer). Also, T2 (75% of recommended mineral fertilizer + mycorrhizae application) was in the same trend with T4 where an increasing level of mycorrhizae significantly increased the fruit yield of tomato **(Fig. 1).**

The increase of vegetative growth and yield indicators values of tomato plants in the presence of mycorrhizae may be due to its role in enhancing the physical properties of soil and nitrogen fixation in soil **(Waller et al 2005 and Ziane et al 2017),** mycorrhizae has a role in protecting plants against abiotic stress conditions **(Mrabet et al 2014).**

Regarding to the NPK content in leaves of tomato plant , data in table 4 shows the highest content of nitrogen, phosphorus and potassium in leaves of tomato plant was observed by 100% mineral fertilizer combined with micorrhizae treatments, while it was no significant differences between others treatments. These results are in line with **Dawa et al (2013).**

Table 2. Effects of mycorrhizae and mineral fertilizer treatments on plant height, number of leaves and number of shoots of tomato plant during 2015/2016 and 2016/2017 seasons

Treatments	Plant height (cm)		Number of leaves		Number of shoots	
	2015/2016	2016/2017	2015/2016	2016/2017	2015/2016	2016/2017
T1	67.3 c	63.6 c	33.9 c	30.4 c	3.6 d	3.1 d
T2	73.6 b	68.3 bc	41.4 b	37.2 b	4.5 b	3.9 b
T3	76.3 b	70.3 b	43.7 b	39.3 b	4.4 c	3.8 c
T4	82.7 a	79.4 a	52.0 a	48.2 a	5.4 a	4.7 a

T1: 75% of recommended mineral fertilizer
T2: 75% of recommended mineral fertilizer+ mycorrhizae application
T3: 100% of recommended mineral fertilizer (Control)
T4: 100% mineral fertilizer + mycorrhizae application

Table 3. Effects of mycorrhizae and mineral fertilizer treatments on stem diameter, dry weight and fresh weight of tomato plant during 2015/2016 and 2016/2017 seasons

Treatments	Stem diameter (cm^2)		Fresh weight (g)		Dry Weight (g)	
	2015/2016	2016/2017	2015/2016	2016/2017	2015/2016	2016/2017
T1	0.478 a	0.420 a	314 d	310 d	55.2 c	53.9 c
T2	0.605 a	0.538 a	435 c	430 c	74.1 b	75.5 b
T3	0.705 a	0.630 a	492 a	448 b	75.8 b	75.3 b
T4	0.753 a	0.685 a	533 a	529 a	89.6 a	89.0 a

T1: 75% of recommended mineral fertilizer
T2: 75% of recommended mineral fertilizer+ mycorrhizae application
T3: 100% of recommended mineral fertilizer (Control)
T4: 100% mineral fertilizer + mycorrhizae application

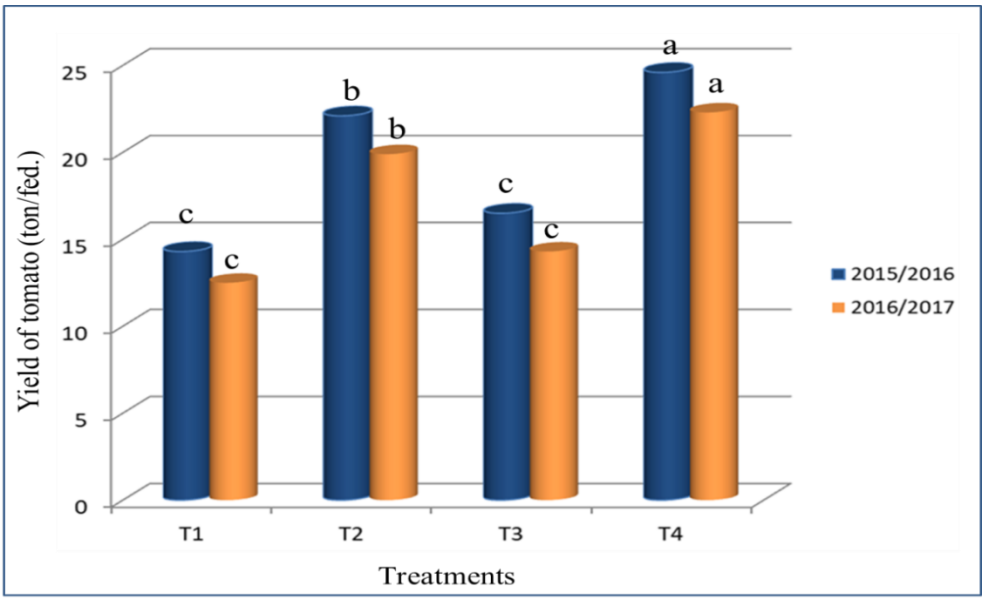

Fig. 1. Effects of mycorrhizae and mineral fertilizer treatments on Yield, of tomato plant during 2015/2016 and 2016/2017 seasons. (T1: 75% of recommended mineral fertilizer; T2: 75% of recommended mineral fertilizer + mycorrhizae application; T3: 100% of recommended mineral fertilizer (Control); T4: 100% mineral fertilizer + mycorrhizae application).

Table 4. Effects of mycorrhizae and mineral fertilizer treatments on NPK in leaves of tomato plant during 2015/2016 and 2016/2017 seasons

Treatments	N (%)		P (%)		K (%)	
	2015/2016	2016/2017	2015/2016	2016/2017	2015/2016	2016/2017
T1	1.74 c	1.56 c	0.29 b	0.27 b	2.03 b	1.77 b
T2	2.25 b	2.01 ab	0.35 a	0.33 a	2.07 ab	1.83 b
T3	2.16 b	1.89 b	0.33 ab	0.32 a	2.30 a	2.20 a
T4	2.47 a	2.21 a	0.37 a	0.35 a	2.28 a	2.13 ab

T1: 75% of recommended mineral fertilizer
T2: 75% of recommended mineral fertilizer+ mycorrhizae application
T3: 100% of recommended mineral fertilizer (Control)
T4: 100% mineral fertilizer + mycorrhizae application

Conclusion

The results of the present study concluded that use of 100% of the recommended mineral fertilizer in combined with mycorrhizae application (*Glomus* sp. and *Gigspora* sp) has led to improved plant growth and increased the values of vegetative growth parameters of tomato plant and yield increased significantly. An increasing level of mycorrhizae also significantly increased the fruit yield of tomato. Therefore, we recommend the use of mycorrhizae to maximize the utilization of added mineral fertilizers.

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تأثير الميكروهيزا ومستويات التسميد المعدني علي نمو ومحصول الطماطم تحت ظروف شمال سيناء

[63]

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الموجـــــــز

تم اجراء عدة تجارب لتقييم تأثير المعاملة بالميكروهيزا (*Glomus* sp. and *Gigspora* sp.) علي نمو نباتات الطماطم (صنف أليسا)، والإحتياجات السمادية بالتسميد المعدني NPK خلال المواسم الزراعية 2016/2015، 2017/2016، بمحطة بحوث بالوظة التابعة لمركز بحوث الصحراء بمحافظة شمال سيناء، مصر وتمت الزراعة علي مساحة 4200 م2 في الأرض المكشوفة والتربة رملية جديدة.

وقد استخدم التصميم الاحصائي قطاعات كاملة العشوائية في ثلاث مكررات لكل معاملة. حيث اشتملت المعاملات علي استخدام السماد المعدني بمعدلين 75%، 100% فقط من الموصي به، ومعاملة النباتات بهذه المعدلات من السماد المعدني مع الميكروهيزا. وأشارت النتائج أن المعاملة بالميكروهيزا أدت الي زيادة معنوية في صفات النمو الخضري للنباتات (ارتفاع النبات، عدد الأفرع، عدد الأوراق، قطر الساق، الوزن الطازج والجاف للمجموع الخضري) وأيضا وزن محصول الثمار.

بينما أشارت النتائج الي عدم وجود فروق معنوية بين صفات النمو الخضري والمحصول عند المعاملة بالسماد المعدني بتركيز 75% مع الميكروهيزا مقارنة بمعاملة النباتات بالسماد المعدني بتركيز 100% فقط فيما عدا الوزن الطازج للمجموع الخضري الذي سجل فروقا معنوية بين المعاملتين.

معاملة النباتات بالسماد المعدني الموصي به بنسبة 100% مع الميكروهيزا أدت الي أعلي قيم في صفات النمو الخضري والمحصول ، لذلك توصي الدراسة باستخدام الميكروهيزا لتعظيم الأستفادة من السماد المعدني وذلك لما للميكروهيزا من صفات بيئية مرغوبة حيث أنها أمنة وأقتصادية وأحد أهم مصادر التسميد الحيوي.

الكلمات الدالة: الطماطم، النمو الخضري، الميكروهيزا، التسميد المعدني.

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