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Original Research Article

Evaluating productivity of an eggplant as influenced by Mycorrhiza fungi and other selected fertilizing materials

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Abstract

A field-based experiment was conducted during the 2017 – 2018 cropping season to evaluate the response of an (*Solanum melongena* L.) to a bio-fertilizer Mycorrhiza relative to other sources of nutrients. The treatments were thus the control (T_1), cow manure (T_2), sheep manure (T_3), poultry residues (T_4), chemical fertilizer (T_5), cow with half chemical (T_6), sheep with half chemical (T_7), and poultry with half chemical (T_8). The treatments were assigned to experimental plots following a randomized complete block design (RCBD) and each treatment was treated in three replicates. The least significance difference (LSD) at 5% error rate was to compare significance means. The measured response variables were plant height, leaf area, fruit setting, early yield, fruit weight, and total soluble solids (TSS) present. Results showed that T_8 was significant and superior to other treatments in leaf area (362.4 cm^2), number of leaves (92), plant height (118.77 cm), fruit setting (79.52%), and yield (3.079 kg/plant). Significant increase in leaf area (281.9 cm^2), fruit setting (74.85%), and TSS (7.08%) was realized in Mycorrhiza. Results also indicated that the interaction of T_7M_1 had a significant increase in yield (3.8 kg/plant) and TSS (8.70%).

Keywords: Bio-fertilizers, cropping practices, fertilizing materials, vegetable crops.

INTRODUCTION

Eggplant (*Solanum melongena* L.) is an important summer vegetable plant of the Solanaceae family, with a recognized highly nutritive value of its fruits. Each 100 g of its soft fruits contains protein (1.43%), fat (2.82%), fibers (12.85%), and carbohydrates (63.87%). It also constitutes many nutrients such as sodium (Na), iron (Fe), calcium (Ca), magnesium (Mg), and potassium (K) (Hussain, 2010; Zenia and Halina, 2008). The quantities of chemical fertilizers used in the cultivation of vegetable crops are large compared with those used in other crops because of the possibility of growing in more than one season per year or shorten the season of growth. This has exacerbates and increase the adverse effects on human health and the environment as well as the residual impact of nitrates, which are among the most dangerous compounds to human health (Osman, 2007). Bio-fertilizers including the Mycorrhiza are vital in reducing the use of mineral fertilizers by 20-50%, producing growth inhibitors for pathogens, and increasing plant tolerance to environmental stresses. The use of bio-fertilizers reduces chemical addition into soils, which in turn reduces environmental pollution (Diab, 2012). Therefore, this study aims at evaluating the use of bio-fertilizers such as Mycorrhiza as an option to substitute for the use of organic substrates and/or chemically synthesized fertilizers.

MATERIALS AND METHODS

Description of the study

This experiment was installed during the 2017–2018 cropping season at the University of Muthanna located in

the Al Bandar area in Al-Summawa city. The coordinates of the location are 270 kilometers southwest of Baghdad city and at an elevation above sea level.

The treatments for the experiment were the control, cow manure, sheep manure, poultry residues, chemical fertilizer, cow with half chemical, sheep with half chemical, and poultry with half chemical. The treatments were assigned to experimental plots following a randomized complete block design (RCBD) and each treatment was treated in three replicates. Seeds of eggplant Pershelona hybrid were sown on 10/9/2017, one seed in each hole of cork container which had 500 holes, after 30 days transplanting process in plastic house.

Data collection

The measured response variables were the plant height, leaf area, fruit setting, early yield, fruit weight, and TSS present.

Statistical analyses

To compare the effect of different treatments to the performance of an eggplant using measured variables, a GenStat software was employed to perform the analysis of variance (ANOVA) following One-way design in randomized blocks. The least significance difference (LSD) at 5% error rate was to compare significance means (Glaser and Biggs, 2010.

RESULTS

Leaf area

The results (Table 2) revealed that the Mycorrhiza (281.9 cm^2 per plant) was superior to control (227.9 cm^2 per plant) in leaf area with an increase of 23.69%. Moreover, fertilizers were significant on leaf area such that poultry with half chemical was superior to give the highest leaf area (362.4 cm^2 per plant). The interaction between fertilizers and Mycorrhiza showed significant differences in leaf area in which the highest was 385.8 cm^2 per plant for poultry manure with half chemical and Mycorrhiza with the smallest (75.7 cm^2 per plant) being recorder in the absolute control where there is no nutrient material application.

Number of leaves

Results indicated that Mycorrhiza had significant effect on the number of leaves (76 leaves per plant) and it was superior to absolute control (64 leaves per plant). A mixture of poultry manure with half chemical produced the highest number of leaves (92) per individual plant.

The interaction between fertilizers and Mycorrhiza was significant (Table 3). The highest mean number of leaves per plant was obtained from application of mixture of poultry manure with half chemical and the Mycorrhiza (94 leaves per plant) while the lowest was 32 leaves per plant recorded in absolute control.

Plant height

The effect of Mycorrhiza on plant height was significant and the highest height was 109.35 cm while the lowest was 104.56 cm in absolute control. The mixture of poultry manure with half chemical recorded the tallest plant height of 118.77 cm compare with the rest of the fertilizer treatments. The interaction between fertilizers and Mycorrhiza showed significant differences in plant height and the highest height was 124.33 cm for application of the mixture of cow with half chemical and the smallest height of 64.87 cm in no application of fertilizers or Mycorrhiza (Table 4).

Fruit setting

The Mycorrhiza gave significantly the highest average fruit setting (74.85%) which was superior to the absolute control (72.86%). A mixture of poultry manure with half chemical was significantly superior to give highest fruit setting (79.52%) compare with the rest of the treatments. The application of combination of poultry manure with half chemical and Mycorrhiza gave the highest mean fruit setting (81.89%) compared with the absolute control which gave the smallest fruit setting of 63.98% (Table 5).

Fruit weight

The Mycorrhiza gave the highest fruit weight of 176.3 g per fruit which differed significantly from 168.0 g per fruit in absolute control, indicating 4.9% of an increment. The application of sheep manure with half chemical gave the highest fruit weight of 184.9 g per fruit which differed significantly from absolute control (120.3 g per fruit), cow manure (172.6 g per fruit), and mixture of poultry manure with half chemical (171.4 g per fruit). Furthermore, significant differences were found in the interactions between fertilizer application and the Mycorrhiza treatments. The combination between poultry residues and Mycorrhiza gave the highest weight of fruits of 198.1 g compared with absolute control and where no Mycorrhiza application which gave the lowest fruit weight of 122.3 g (Table 6).

Table 1. Physical and chemical measured variables in soil

Indicators	Unit	Value
pH	-	7.4
Electrical conductivity (EC)	dS m^{-1}	2.5
Available N	mg kg^{-1} soil	11.4
Available P	mg kg^{-1} soil	4.7
Available K	mg kg^{-1} soil	162
Exchangeable Ca	ppm	200
Exchangeable Mg	ppm	121
Dissolvable CO_3	ppm	0
Dissolvable HCO_3	ppm	67.1
Extractable chlorine	ppm	1785
Organic matter	g kg^{-1} soil	0.95
Texture	Clay loam	

Table 2. Effect of Mycorrhiza and organic fertilizer on leaf area (cm^2 per plant)

Fertilizer treatments	With Mycorrhiza (M_1)	Without Mycorrhiza (M_0)	Mean of fertilizer treatments
Absolute control	94.2	75.7	84.9
Cow manure	276.5	206.6	241.5
Sheep manure	263.4	178.1	220.8
Poultry residues	263.0	211.7	237.3
Chemical	265.5	186.9	226.2
Cow+½chemical	348.1	305.6	326.8
Sheep+½chemical	359.0	319.4	339.2
Poultry+½chemical	385.8	338.9	362.4
Mean Mycorrhiza	281.9	227.9	
$LSD_{0.05}$	T=39.09	M=19.54	TM= 55.28

Table 3. Effect of Mycorrhiza and fertilizers on the number of leaves

Fertilizer treatments	With Mycorrhiza (M_1)	Without Mycorrhiza (M_0)	Mean of fertilizer treatments
Absolute control	41.0	32.3	36.7
Cow manure	75.7	57.3	66.5
Sheep manure	67.7	48.3	58.0
Poultry residues	72.7	62.0	67.3
Chemical	76.0	53.3	64.7
Cow+½chemical	88.3	82.0	85.2
Sheep+½chemical	88.3	86.0	87.2
Poultry+½chemical	94.3	90.3	92.3
Mean Mycorrhiza	75.5	64.0	
$LSD_{0.05}$	T= 8.52	M= 4.26	TM= 12.05

Table 4. Effect of Mycorrhiza and organic fertilizer on plant height (cm)

Fertilizer treatments	With Mycorrhiza (M_1)	Without Mycorrhiza (M_0)	Mean of fertilizer treatments
Absolute control	73.47	64.87	69.87
Cow manure	124.33	116.17	120.25
Sheep manure	110.33	111.23	110.78
Poultry residues	115.80	110.07	112.93
Chemical	106.33	99.03	102.68
Cow+½chemical	116.23	113.93	115.08
Sheep+½chemical	106.67	105.33	106.00
Poultry+½chemical	121.67	115.87	118.77
Mean Mycorrhiza	109.35	104.56	
$LSD_{0.05}$	T= 5.638	M= 2.819	TM= 7.973

Table 5. Effect of Mycorrhiza and organic fertilizer on fruit setting (%)

Fertilizer treatments	With Mycorrhiza (M_1)	Without Mycorrhiza (M_0)	Mean of fertilizer treatments
Absolute control	65.43	63.98	64.70
Cow manure	75.57	73.56	74.56
Sheep manure	73.99	70.58	72.29
Poultry residues	76.99	75.68	76.33
Chemical	74.91	74.68	74.80
Cow+½chemical	76.11	75.75	75.93
Sheep+½chemical	73.94	71.50	72.72
Poultry+½chemical	81.89	77.14	79.52
Mean Mycorrhiza	74.85	72.86	
$LSD_{0.05}$	M= 0.767	T= 1.535	M T= 2.171

Table 6. Effect of Mycorrhiza and organic fertilizer on weight of fruit (g)

Fertilizer treatments	With Mycorrhiza (M_1)	Without Mycorrhiza (M_0)	Mean of fertilizer treatments
Absolute control	118.4	122.3	120.3
Cow manure	180.3	165.0	172.6
Sheep manure	181.5	174.0	177.7
Poultry residues	198.1	177.9	188.0
Chemical	182.0	177.9	179.9
Cow+½chemical	184.2	180.0	182.1
Sheep+½chemical	192.3	177.6	184.9
Poultry+½chemical	173.5	169.4	171.4
Mean Mycorrhiza	176.3	168.0	
$LSD_{0.05}$	T= 12.30	M= 6.15	TM= 17.40

Table 7. Effect of Mycoriza and organic fertilizer on early yield of eggplant

Fertilizer treatments	With Mycorrhiza (M_1)	Without Mycorrhiza (M_0)	Mean of fertilizer treatments
Absolute control	0.4673	0.3663	0.4168
Cow manure	0.8763	0.7747	0.8255
Sheep manure	1.0913	0.9413	1.0163
Poultry residues	1.0393	0.8590	0.9492
Chemical	0.9813	0.9873	0.9843
Cow+½chemical	1.1843	1.0927	1.1385
Sheep+½chemical	1.2427	1.2750	1.2588
Poultry+½chemical	1.0930	1.0740	1.0835
Mean Mycorrhiza	0.9970	0.9213	
$LSD_{0.05}$	T= 0.06720	M= 0.03360	TM= 0.0.9504

Biomass yield

Results indicated significant differences between the Mycorrhiza treatments in early yield of the eggplant. Mycorrhiza gave the highest yield of 0.997 kg per plant which differed significantly from 0.9213 kg per plant in absolute control indicating 8.2% increment. Application of organic substrates indicated that sheep manure with half chemical gave the highest yield (1.26 kg per plant) compare with the lowest (0.42 kg per plant) in absolute control, which is an increment of 202%. Furthermore, significant differences were found for the interactions between fertilizer application and the use of Mycorrhiza. Results indicated that the use of a mixture of sheep manure with half chemical but without Mycorrhiza gave the highest biomass yield (1.275 kg per plant) compared with the absolute control which gave the lowest (0.3663 kg per plant) early yield (Table 7).

TSS in fruits

Mycorrhiza gave the highest TSS in fruits of 7.08% which

Table 8. Effect of Mycorrhiza and organic fertilizer on TSS in fruits

Fertilizer treatments	With Mycorrhiza (M_1)	Without Mycorrhiza (M_0)	Mean of fertilizer treatments
Absolute control	4.567	3.967	4.267
Cow manure	6.367	5.167	5.767
Sheep manure	8.333	5.467	6.900
Poultry residues	7.267	5.467	6.367
Chemical	5.767	4.833	5.300
Cow+½chemical	7.833	5.367	6.600
Sheep+½chemical	8.700	5.867	7.283
Poultry+½chemical	7.867	5.233	6.550
Mean Mycorrhiza	7.087	5.171	
$LSD_{0.05}$	T= 0.2911	M= 0.1455	TM= 0.4117

was significantly superior to the absolute control. Application of poultry manure with half chemical recorded the highest rate of TSS of 7. 3% compared with other treatments. The application of a mixture of poultry manure with half chemical and Mycorrhiza gave the highest TSS of 8.7% but the lowest was 4.0%) In absolute control (Table 8).

DISCUSSION

The improvement in performance plant height, leaf area, number of leaves, and fruit setting in eggplant could be due to the role of Mycorrhiza. The later is likely to increase (facilitation) of phosphorus uptake by dissolving phosphates in soil solution into susceptible ions and make them easily absorbed by plant roots (Bago et al., 1996). Mycorrhiza has a role in increasing the absorption of other essential nutrient elements such as nitrogen and potassium, which escalate positive effect in vegetative growth and fruit setting in plants. This finding is in agreement with Saleh (2006) and Hussain et al. (2007). The incorporation of organic substrates such as cow and sheep manures is likely to significantly increase electrical conductivity due to containment of salt as well as the reduction of the degree of pH in soils. Manures are also likely to have improved soil organic matter, nitrogen levels, and structure of the soil and improve crop productivity this is agreed with (Sahaf and Aati, 2007). Organic residues mighty also have increased the incidence and proliferation of Mycorrhiza fungi and its activity thereby improving overall plant productivity (Rahi et al. 2014).

CONCLUSION

The use of cow or poultry manures with half of the recommended rate of the chemical fertilizer with the addition of Mycorrhiza increased nutrients levels in soils and optimized growth and yield of eggplant. The practice proved to be an alternative option to reduced costs and environmental jeopardy associated with the use of chemically synthesized fertilizers.

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