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Response of eggplant for folair spray with Malva*parvflora* extract and inoculation with biofertilizer in green houses.

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Abstract: *A factorial experiment was executed in greenhouse unit in the Department of Horticulture and Landscape Design- College of Agriculture- University of Diyala in the season 2014/2015 to study the effect of spraying with Malvaparvflora extract and inoculation with Bionutrients on the growth and yield of eggplant hybrid eshbilia F1. The experiment included two factors: Malvaparvflora extract with two concentrations that were 50% and 75% and inoculation with Biofertilizer "Bionutrients" as well as the control treatment. Randomized complete block design (RCBD) was used to execute the experiment. Which included three replicates, each replicate was composed of six experimental units. The total number of experimental units was 18. The results were analyzed by using SAS program and the averages of the study parameters were compared according to the least significant difference at a probability of 5%. The results showed superior significance of the Malvaparvflora extract with a concentration 75% and the Bionutrients in most of the study parameters which included: leaf nutrient content, vegetative growth traits, and the yields qualitative and quantitative parameters. The interaction treatment between Malvaparvflora extract of 50% concentration and Bionutrients was superiorly significant in the two parameter: Nitrate reductase activity and TSS in eggplant fruits, as it recorded the values: 4.56 µmol NO_2.gm^{-1}fresh weight.hr^{-1}, and 7.16 respectively. While the control treatment gave the values 2.71 µmol NO_2.gm^{-1}fresh weight.hr^{-1}, and 2.88 respectively.*

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I. Introduction

Solanummelongena L, which belongs to the family "*Solanaceae*", is characterized by having low calorie fruits, and a percentage of proteins and carbohydrates. As well as containing mineral salts especially potassium and iron, vitamins such as vitamin A,B_1, B_2, B_5 and C, and Anthocyanin. (Daunay et al, 2000), (Christman, 2003).

Plant extracts are highly important as they have a positive effect in plant growth due to containing a lot of compounds that affect plant growth like riboflavin, which stimulates photosynthesis, and the synthesis of natural uxins that stimulate growth which affects early fruiting.(Derhab, 2007) These extracts also contain gelatin and mucous substances that aid in the adherence of pollen which increases the percentage of fruit sets. (Al-dijwe, 1996).Ersin et al (2008) pointed out the importance of using plant extracts as a method of improving growth and increasing production. Ghorbani et al (2008) reached out that using plant extracts with sheep manure improved the growth and characteristics of tomato plants. In a study performed by Nasser and Abbass in 2012, it was found that using *licorice* extract significantly increased the vegetative and flowering growth of the geranium plant "*pelargonium zonale* L".

Spraying eggplants with *scharginia* extract in a concentration of 3. % lead to improving the plants vegetative and fruiting growth.(Al-shamary,2012)

Biofertilizers, which were increasingly used in the last four centuries, are considered one of the most important pillars of sustainable agriculture as they are characterized by being cheap and environment friendly. Biofertilizers play an important role in plant growth due to their ability to increase the availability of nutrients which helps in increasing their uptake by plants thus improving the plants growth, in addition to the ability of some types of bacteria to fix air nitrogen (Bashan and de-Bashan, 2010) and produce plant growth regulators (Hayat et al, 2010) it also increases the plant's ability to resistance abiotic stress(Glick et al, 2007) as well as the production of sidrophores which contributes to the chelation of trace elements especially Iron. (Ali and Vidhale, 2013)

Bacillus bacterial species are characterized by their high ability to increase the availability of nutrients for the plants (barriuso and solano, 2008), and increasing the length of roots and their dry matter content.(Kaymak et al, 2008).Han et al, 2006, Supanjani et al, 2006) pointed out the role of *bacillus*spp in

increasing the availability of nutrients as well as improving the growth of bell pepper and *MalvaParvflora* plants, and they suggested their use as plant fertilizers.

This study thus aims to investigate the eggplant response to spraying with *Malvaparvflora* extract, and the fertilization with biofertilizers and their effects on the growth characteristics inside green houses.

II. Materials And Methods

This study was performed in one of the greenhouses at the Department of Horticulture and Landscape Design at the College of Agriculture- University of Diyala at the Agricultural season 2014-2015.

On the 30th of August 2014hybrid Eshbilia F1 eggplant seeds were planted in cork plates filled with an agricultural medium containing peatmoss and were put in the greenhouse.

Seedlings were transferred to the permanent field after the appearance of four true leaves on the 13th of August 2015 after the greenhouse was prepared by performing perpendicular plowing of the land, as well as solar sterilization of the soil. Samples of the green houses' soil were taken to study their chemical and physical characteristic. Table(1) . Decomposed organic fertilizer (poultry manure) was added at an average of $8m^3$.greenhouse^{-1}.Half the recommended amount ofchemical fertilizer of the amount of 400 Kg N.h^{-1} , 100 Kg P_2O_5 .h^{-1} and 100 Kg K.h^{-1} was added on three stages through the growth season.

The land was divided to lines the distance between which is 75 cm , with a width of 50 cm. Dripping irrigation pipes were extended on the sides of the line. plants were planted with an area of 40 cm between each plant and the other on the sides of the line. An insulation distance of 150 cm was left between the treatments fertilized with the biofertilizer and the non-fertilized ones to prevent any overlap.

Management practice were performed.such as Irrigation, and removal of weeds.

Malvaparvflora extract was prepared using methods used by Organic farming certified farmers (Abu Rayyan, 2010)

Plants were cut before flowering and were immersed in water with a percentage 1:5 in tightly closed barrels insulated from air for 20 days. The solution was filtered with clean gauze. In the early morning, plants were sprayed with the solution after dilution with a percentage of 50%, 70%. In an average of 4 sprays for both concentrations until full wetting after adding (tween-20) as a spreading substance.

Biofertilizer (Bionutrients) product of theamerican company (T growth products) that contains *Bacillus* species (table 2) was injected folowing the recommendations of the producing company.

An insulation space of 150 cm was made between the biofertilizer treatment and the other treatments. The randomized complete block design (RCBD) were used in the experiment as a factorial experiment with two factors with three replicates. The experiment consisted of 18 experimental units. Each experimental units contained ten plants. The factors were as follows: control symbolized (M_0, B_0), *Malvaparvflora* extract with a concentration of 50% (M_1), *Malvaparvflora* extract with a concentration of 75% (M_2), Biofertilizer (bionutrients) (B_1), *Malvaparvflora* extract with a concentration of 50% + bionutrients (M_1 B_1), *Malvaparvflora* extract with a concentration of 75% + bionutrients (M_2B_1).

Results were analyzed using SAS (2001). The averages were compared for all the used study parameters according to LSD test with a probability of 5%.

Study Parameters:

Four plants were chosen from each experimental unit and the following measures were taken:

Vegetative growth parameters that included the plant's height (cm), Leaf area (Dcm^2) using Digimizer program (Sadik et al,2011), relative chlorophyll content in leaves (spad unit) (Jemison and Williams, 2006), Dry weight for vegetative system (gm), N% (Jackson, 1958), P% (page 1982), K% by using flame photometer (Haynes, 1980) , Fe (mg.Kg^{-1}) dry matter andMn (mg.Kg^{-1}) dry matter. (atomic absorption spectrophotometer)

Yield Parameters:

Fruit number per plant, fruit weight (gm) , plant yield (gm), greenhouse yield (Ton .house^{-1})

Fruit qualitative traits:

Fruit Anthocyanin content (mg.100g^{-1}) (Rangana, 1977), fruit nitrate content (mg.g^{-1}) (cataldo et al, 1975), nitrate reductase activity in fruits (µmol NO_2.gm^{-1}fresh weight.hr^{-1}) (Andrews et al, 1984) and TSS.

Table (1): soil physical and chemical parameters of greenhouses before planting.

Parameters	Unit	Value
pH		7.18
EC(Electric Conductivity)	dsm^{-1}	4.71
Total Carbonate	gm.Kg^{-1}	1.86
OM		11.58
Available N	mg.Kg^{-1}	64.78

Available P		11.47
Available K		209.30
sand	gm. Kg^{-1}	202
Loam		485
clay		313
Soil texture	SCL	

Table (2): Bionutrients components.

Bacillus subtilis	$1.5*10^8$ CFU.gm^{-1}
Bacillus licheniformis	$1.5*10^8$ CFU.gm^{-1}
Bacillus pumilus	$5*10^8$ CFU.gm^{-1}
Bacillus amyloliquefaciens	$1.3*10^8$ CFU.gm^{-1}
Yeast (saccharomyces cerevisiae)	$4.4*10^5$ CFU.gm^{-1}
Amino acids	35.7%
Humic acid	20%
Zn 0.06%, Fe 3%, K_2O 9%, P_2O_5 1%, N 8%.	

III. Results and discussion

Eggplant leaves nutrient content:

Table (3) results refer to superior significance of foliar spraying treatment with *Malvaparvflora* extract of the two concentrations (50% and 75%) compared with the control treatment Which recorded lowest values of nutrients in leaves, that included N%, P%, k%, Fe , Mn which were (1.38, 0.14, 1.59) % for nutrients: N, P,K respectively and (99.80, 54.32) mg.kg^{-1} dry matter for Fe and Mn respectively. Results also showed superior significance of the bionutrients treatment in the leaves nutrient content of N%, P%, k%, Fe , Mn. Values recorded (1.52, 0.27, 1.96)% for nutrients: N, P, K respectively and (184.63, 84.40) mg.kg^{-1} dry matter for Fe and Mn respectively. While the control treatment recorded (1.43, 0.17, 1.60)% for N, P,K respectively and (126.18, 62.36) mg.kg^{-1} dry matter for Fe and Mn respectively. The interaction treatment (M_2B_1) was significantly superior with values of (1.64, 0.39,2.2))% for N, P,K respectively and (228.13, 97.92) mg.kg^{-1} dry matter for Fe and Mn respectively compared with control treatment which recorded (1.37, 0.13,1.49))% for N, P,K respectively and (90.10, 41.80) mg.kg^{-1} dry matter for Fe and Mn respectively.

Table (3): The effect of spraying with *Malvaparvflora* extract and inculcation with Biofertilizer on the eggplant leaves nutrients content .

Parameters / Treatments	N%	P%	K%	Fe	Mn
M_0	1.38	0.14	1.59	99.80	54.32
M_1	1.40	0.21	1.79	156.40	73.78
M_2	1.64	0.32	1.96	210.03	92.06
L.S.D 0.05 M	0.06	0.09	0.16	37.97	19.75
B_0	1.43	0.17	1.60	126.18	62.36
B_1	1.52	0.27	1.96	184.63	84.40
L.S.D 0.05 B	0.05	0.07	0.13	31.00	15.98
M_0 B_0	1.37	0.13	1.49	90.10	41.80
M_1 B_0	1.41	0.13	1.61	96.52	59.09
M_2 B_0	1.50	0.25	1.70	191.93	86.19
M_0 B_1	1.39	0.14	1.68	109.50	66.83
M_1 B_1	1.39	0.29	1.97	216.28	88.46
M_2 B_1	1.64	0.39	2.22	228.13	97.92
L.S.D 0.05 M*B	0.09	0.12	0.23	53.69	27.68

Superior significance of the interaction treatments (M_2B_1) may be attributed to the contents of the *Malvaparvflora* extract of chemical compounds which improve plant growth and its metabolic activities (Ersin et al, 2008). In addition to the fact that Bionutrientscontaints multiple *Bacillus* bacteria species which play an important role in improving plants growth as they encourage Nitrogen fixation(Dobereinand Camplo, 1971) and increase the solubility of Phosphorous and trace minerals (Gyameshwar et al, 2002) and synthesizing siderophores which chelates Fe and increase its uptake by plants (Scher and Baker, 1982) that increase the plants nutrient content.

Vegetative growth traits: Table (4) results show superior significance of the 75% concentration of *Malvaparvflora* (M_2) extract in plant height (cm), leaf area (Dcm^2), relative chlorophyll leaves content (spad unit) and vegetative dry weight (gm) which recorded 72.38cm, 234.71 Dcm^2, 54.35 spad unit, and 91.11gm

respectively. The table shows superior significance of the Biofertilizer treatment in the mentioned traits as it recorded 74.77 cm, 228.89 Dcm^2, 52.27 spad unit, and 91.43 gm respectively compared with the control treatment which gave the values of 65.67cm, 169.80 Dcm^2, 46.92 spad unit and 79.77 gm respectively. The interaction treatment (M_2B_1) was superiorly significant as it recorded the highest values of the previously mentioned traits as it recorded 67.77cm, 285.22 Dcm^2, 56.32 spad unit and 100.51gm respectively compared to the control treatment which recorded the lowest values as follows 63.52cm, 139.67 Dcm^2, 41.98 spad unit, and 67.17gm respectively.

Table (4): The effect of spraying with *Malvaparvflora*extract and inculcation with Biofertilizer on vegetative growth traits.

Parameters / Treatments	Plant height (cm)	Leaf area (Dcm^2)	Chlorophyl content (spad unit)	Vegetative dry matter (gm)
M_0	68.88	165.24	45.17	97.33
M_1	69.41	198.10	49.28	86.37
M_2	72.38	234.71	54.35	91.11
L.S.D 0.05 M	2.58	30.80	4.12	7.42
B_0	65.76	169.80	46.92	79.77
B_1	74.77	228.89	52.27	91.43
L.S.D 0.05 B	2.11	25.15	3.36	6.06
M_0 B_0	63.52	139.67	41.98	76.17
M_1 B_0	65.52	185.54	46.41	81.43
M_2 B_0	67.98	184.20	52.37	81.70
M_0 B_1	74.24	190.81	48.35	82.49
M_1 B_1	73.29	210.65	52.14	91.30
M_2 B_1	76.77	285.22	56.32	100.51
L.S.D 0.05 M*B	3.65	43.56	5.82	10.50

Yield traits:

Table (5) results show the effect of spraying treatment with *Malvaparvflora*extract of both concentrations 50% and 75% on the number of fruit per plant, average fruit weight (gm), plant yield (gm), and greenhouse yield ($ton.house^{-1}$). As both concentrations were significantly superior to the control treatment which recorded the lowest value of 6.75, 144.10gm, 981.5gm, and 0.96 $ton.house^{-1}$ of the same traits respectively. Also, the Bionutrients treatment was significantly superior for the same traits as it recorded 9.91, 173.37gm, 1747.40gm, and 1.70 $ton.house^{-1}$ respectively. The interaction treatment B1M2 showed superior significance as well as it recorded the following values for the same traits respectively: 11.45, 197.93gm, 2268.00gm, and 2.19 $ton.house^{-1}$. Compared to the control treatment which recorded 5.77, 136.60gm, 790.00gm, and 0.76 $ton.house^{-1}$ respectively.

Table (5): The effect of spraying with *Malvaparvflora* extract and inculcation with Biofertilizer on yield traits.

Parameters / Treatments	Number of fruits per plant	Fruit weight (gm)	Plant Yield (gm)	Greenhouse yield ($ton.house^{-1}$)
M_0	6.75	144.10	981.50	0.96
M_1	8.66	155.90	1378.00	1.33
M_2	11.03	178.80	1981.00	1.92
L.S.D 0.05 M	1.73	9.87	370.90	0.24
B_0	7.71	145.83	1146.20	1.11
B_1	9.91	173.37	1747.40	1.70
L.S.D 0.05 B	1.41	8.06	302.8	0.20
M_0 B_0	5.77	136.60	790.00	0.67
M_1 B_0	6.76	141.23	954.70	0.92
M_2 B_0	10.60	159.67	1694.00	1.64
M_0 B_1	7.37	151.60	1173.00	1.16
M_1 B_1	10.56	170.57	1801.30	1.74
M_2 B_1	11.45	197.93	2268.00	2.19
L.S.D 0.05 M*B	2.44	13.96	524.50	0.35

Fruits quantitative traits:

Table (6) results show superior significance of spraying with 75 % Malvaparvflora extract (M_2) treatment on the Fruits cortex Anthocyanin concentration, Fruits Nitrate reductase activity, Fruits nitrate

content, and TSS. As it recorded the following values of the traits respectively: 538.40 mg.100g^{-1}, 3.98µmol NO_2.gm^{-1}fresh weight.hr^{-1}, 376.20 mg.g^{-1}, and 6.53. Compared to M_0 treatment which recorded 400.20mg.100g^{-1}, 2.93µmol NO_2.gm^{-1}fresh weight.hr^{-1}, 308.30 mg.g^{-1}, and 4.74 of the traits respectively. The results also show superior significance of the Bionutrient (B_1) on the same traits as it recorded the following values of the traits respectively: 572.40mg.100g^{-1}, 4.12µmol NO_2.gm^{-1}fresh weight.hr^{-1}, 375.10 mg.g^{-1}, and 6.95. while the control treatment (B_0) recorded the values 381.60 mg.100g^{-1}, 3.06µmol NO_2.gm^{-1}fresh weight.hr^{-1}, 325.60 mg.g^{-1}, and 4.67 respectively. The interaction treatment (M_2 B_1) was significantly superior in recording the highest values for the Fruits cortex Anthocyanin concentration, and Fruits nitrate content as follows 656.70 mg.100g^{-1}, and 385.00 mg.g^{-1} respectively while control treatment (M_0B_0) recorded the values 323.00 mg.100g^{-1}, and 260.30 mg.g^{-1} respectively, while the (M_1B_1) treatment was superiorly significant in the traits Fruits Nitrate reductase activity, and TSS as it recorded the values 4.56 µmol NO_2.gm^{-1}fresh weight.hr^{-1} , and 7.16 respectively, compared with the control treatment (M_0B_0) which recorded the values 2.71 µmol NO_2.gm^{-1}fresh weight.hr^{-1} , and 2.88 for the traits respectively.

Table (6): The effect of spraying with *Malvaparvflora* extract and inculcation with Biofertilizer on fruits quantitative traits.

Parameters / Treatments	Fruits cortex Anthocyanin concentration	Fruits Nitrate reductase activity	Fruits nitrate content	TSS
M_0	400.20	2.93	308.30	4.74
M_1	476.50	3.82	366.70	6.17
M_2	538.40	3.98	367.20	6.53
L.S.D 0.05 M	96.30	0.40	35.60	1.38
B_0	381.60	3.06	325.60	4.67
B_1	572.40	4.12	375.10	6.95
L.S.D 0.05 B	78.60	0.33	29.10	1.13
M_0 B_0	323.00	2.71	260.30	2.88
M_1 B_0	369.70	3.07	349.30	5.18
M_2 B_0	452.00	3.40	367.30	5.94
M_0 B_1	477.30	3.15	356.30	6.59
M_1 B_1	583.30	4.56	384.00	7.16
M_2 B_1	656.70	4.55	385.00	7.11
L.S.D 0.05 M*B	136.10	0.57	50.40	1.96

Malvaparvflora extract component compound which contribute to improving plant growth and yields qualities and quantities as it contains mucous and gelatin substances which aid in the adherence of pollen, increase the fruit sets, and improve their qualities. (Al-dijwe, 1966), (Al-shamary, 2012). The superior significance of Bionutrients on the yields qualitative and quantitative traits may be attributed to the role of *Bacillus* spp. on dissolving the nutrients and increasing their availability which facilitated their uptake by the plants. As well as the production of phytohormones which improve plant growth which reflects on the plants metabolic activities.(Saharan and Nehra,2011) The interaction between the contents of *Malvaparvflora* extract and the products of*Bacillus* spp. of organic and amino acids in addition to producing theACC-deaminase which inhibits ethylene that improves the roots proliferation. The*Bacillus* bacterial spp. also has the ability to produce IAA, gibberellic acid, and cytokinines which encourage cell division and enlargement (Ekinci et al, 2014). This is what caused improvement in the plants metabolism which was reflected on the plants fruit yield and its qualitative traits.

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