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EFFECT OF MINERAL NITROGEN, BIOFERTILIZERS AND CULTURE MEDIA ON TOMATO TRANSPLANTS PRODUCTION

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ABSTRACT: The present work was done in a private nursery under plastic conditions houses in Belbeis District, Sharkia Governorate (Egypt) during 2015 and 2016 seasons to study the effect of four mineral nitrogen, biofertilizer treatments and three culture media on seed germination (%), vegetative growth characters, fresh and dry weights, growth analyses and chemical composition of tomato transplants at 60 days from seed sowing. The obtained results showed that, the treatments of mineral nitrogen and biofertilizer, the culture media and their interactions recorded a significant effect in both seasons of study on most studied characters, but this effect was varied from treatment to another and from season to another.

Key words: Tomato, transplants, culture media, fertilizers, germination, growth, fresh weight, growth analyses.

INTRODUCTION

Tomato (*Lycopersicon esculentum* L.) belongs to family Solanaceae considered one of the most important vegetable crops cultivated in Egypt and a lot of countries around the world for their local consumption, processing and exportation. The total cultivated area of tomato in Egypt was about 488,753 faddan, during 2013/2014 season which produced 8,269,249 million tons with average of 16, 91 tons/fad., (Statistics of the Ministry of Agriculture, 2014).

Yet, the cultivated area and total production of tomato increased by the time. Nurseries which using in the production of various vegetable transplants in different forms such as in plastic houses or open field have a pronounced influence on plant development in the field, growth and marketable yield of many vegetable crops, especially tomato.

Depending on the biofertilizers as a part of transplants fertilization in nurseries playing a great role to reduce the high amounts of mineral nitrogen fertilizers which caused a harmful effect on agricultural environment of transplants, also on human and animal health in the end. In addition, these fertilizers have the major cost in transplants production. On the other hand, microbiological fertilizers are important to environment friendly stainable agricultural practices **(Bloomberg *et al*., 2000)**.

Not that only, but using biofertilizers is very important for the production through the role of *Azotobacter* genus for nitrogen fixation unsymbiotic and exudation of some compounds like auxins, gibberellins, cytokinins and antibiotics for fungus, and bacteria that can improve soil fertility of transplants, growth and production of agricultural crops **(Sarhan, 2012)**.

In addition, compost holds water wall, provides the culture media with nutrients and can be made right on the farm. Peat moss and vermiculite mixes have been popular for production of many crop transplants, but the high cost of these components stimulated a search for substitutes. In this connection, **Reis and Coelho (2007)** studied the effect of mixing compost with peat to prepare substrates for the production of vegetable transplants. Sewage sludge, municipal solid waste and yard prunings,

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were mixed at the proportions (*V/V/V*) of 1:0:3; 0:1:1.5 and 1:1:2, respectively on tomato. The emergence of transplants was not affected and reduced in compost mixes. **Liptay *et al*. (1982)** found that mixture of shredded sphagnum peat moss and vermiculite (1:1) with nutrient added, gave rapid emergence in tomato seeds.

Therefore, the objective of this work was to determine the optimum components of the transplants culture media and their ratios for growing tomato transplants and suitable amounts of mineral nitrogen and biofertilizers, as well as the combination between them for tomato transplants production.

MATERIALS AND METHODS

This work was carried out during the two successive seasons of 2015 and 2016 at a private nursery under plastic houses conditions, in Belbeis District, Sharkia Governorate (Egypt), to study the effect of mineral nitrogen, biofertilizers and culture media on seed germination percentage, vegetative growth characters, fresh and dry weights, growth analyses and chemical composition of tomato transplants.

The experiment included 12 treatments, which were the combinations between four fertilizer treatments and three culture media as follows:

Fertilizer Treatments

1) Without nitrogen fertilizer (control).

2) Mineral nitrogen fertilizer.

3) Biofertilizers (Nitrobein and Biogein).

4) Mineral nitrogen and biofertilizers.

Culture Media

1) Peat moss: Vermiculite (1:1 *V/V*)

2) Peat moss: Vermiculite (2:1 *V/V*)

3) Peat moss: Vermiculite (3:1 *V/V*)

These treatments were arranged in a split plot design system with three replicates. Fertilizer treatments were randomly arranged in the main plots, while the culture media were randomly distributed in the sub plots. Every replicate contained nine speedling trays (three speedling trays every treatment). In addition, every speedling tray contained 209 eyes.

In this experiment, ammonium nitrate (33.5% N) was used as a source of mineral nitrogen fertilizer (added to the culture media which prepared according to the distributed treatments). Calcium super phosphate (15.5% P_2O_5) and potassium sulphate (48%K_2O) were used as a source of P and K fertilizers, respectively. Recommended doses of every one are presented in Table 1 and were added during the preparation of the culture media before seed sowing in the speedling trays to all treatments. In addition, magnesium sulphate and micronutrients elements also added as recommended to the culture media which prepared.

Nitrobein biofertilizer contained (*Azospirillium* spp. and *Azotobacter* spp.) and biogein which contain (*Azotobacter* spp.) were used as a source of N biofertilizers and added by mixed with the other components of the culture media (peat moss + vermiculite) according to the distributed treatments before sowing tomato seeds in the speedling trays(recommended doses which used from every one were 100 g to 100 kg culture media).The source of nitrobein and biogein was from General Organization for Agricultural Equalization Foundation (GOAEF), Ministry of Agriculture, Egypt.

Preparation of Speedling Trays

The speedling trays were full by the different ratio of culture media as described above. Tomato seeds (Castle Rock cv.) were sown in speedling trays on 15 June and 10 October in 2015 and 2016 seasons, respectively. After sowing, the speedling trays were incubated in the incubation room for one week. After then, all speedling trays were putted on the benches under the plastic house.

In addition, the used recommended fertilizers were added as nutrient solutions to the culture media in the speedling trays weekly during the growing season of tomato transplants as shown in Table 1.

The other normal agricultural treatments for growing tomato transplants production, except fertilization were practiced.

Table 1. The chemical recommended dose of fertilizers which added to the speedling trays during the two growing seasons of tomato transplants

Materials	Quantity
Peat moss	Package (50 kg)
Vermiculite	Package (50 kg)
Ammonium nitrate (33.5% N)	400 g
Calcium super phosphate (15.5% P_2O_5)	500 g
Potassium sulphate (48% K_2O)	300 g
Magnesium sulphate (Mg SO_4)	30 g
Micronutrients elements Fe, Mn and Zn (20/20/20)	80 g
Tiles powder	4 kg

Data Recorded

The recorded data were as follows:

Seed germination (%)

Seed germination percentage was calculated according to the following formula:

$$\text{Germination percentage} = \frac{\text{Number of germinated seeds}}{\text{Number of total seeds}} \times 100$$

Vegetative growth characters of transplants

A random sample of ten transplants from each experimental unit (in the three replicates) were randomly taken at 60 days from seed sowing in both seasons of study and the following data were determined:

Morphological characters

A) Average root length (cm).

B) Average stem length (cm).

C) Average number of leaves /transplant.

Fresh weight of transplants (g)

A) Average fresh weight of root.

B) Average fresh weight of shoot (stem + leaves).

C) Total fresh weight of transplant (whole transplant).

Dry weight of transplants (g)

Different parts of transplants, *i.e.* root, stem and leaves were dried at 70°C till constant weight and the following data were recorded.

A) Average dry weight of root.

B) Average dry weight of shoot (stem+ leaves).

C) Total dry weight of transplant (whole transplant).

Growth analyses

All growth analyses characters were determined according to the formulas as described by **Radford, (1967)** as follows:

Leaf area per plant (LA)

$$\text{LA/plant (cm}^2\text{)} = \frac{\text{Leaves dry weight per plant (g)} \times \text{disk area (cm}^2\text{)}}{\text{Disk dry weight (g)}}$$

Specific leaf area (SLA)

$$SLA = \frac{LA}{LW}$$

Where:

LA: Leaf area per plant (cm²)

LW: Leaves dry weight per plant (g)

Specific leaf weight (SLW)

$$SLW = \frac{L_W}{LA}$$

Where:

L_W: Leaves dry weight per plant (g)

LA: Leaf area per plant (cm²)

Leaf area ratio (LAR)

$$LAR = \frac{LA}{W}$$

Where:

LA: Leaf area per plant (cm²)

W: Dry weight per plant (g)

Leaf weight ratio (LWR)

$$LWR = \frac{LW}{W}$$

Where:

LW: Leaves dry weight per plant (g)

W: Dry weight per plant (g)

Fresh/ dry weight ratio (FWR)

$$FWR = \frac{FW}{W}$$

Where:

FW: Fresh weight per plant (g)

W: Dry weight per plant (g)

All mentioned growth analyses measurements were calculated at 60 days from seed sowing in the second season of the study only.

Chemical Composition

The dry weight of shoots were finely ground and wet digested with sulfuric acid and perchloric acid (3:1, respectively). Nitrogen, phosphorus and potassium were determined as dry weight basis according to the methods described by **Bremner and Mulvaney (1982)**, **Olsen *et al.* (1982) and Jackson (1970)**, respectively. Moreover, total carbohydrates in dry shoot (stem + leaves) were determined according to the method described by **Dubois *et al.* (1956).**

Statistical Analysis

The obtained data were subjected to the analysis of variance according to **Snedecor and Cochran (1980)**. Mean separation was done by **Duncan (1958)**.

RESULTS AND DISCUSSION

Seed Germination (%)

Effect of mineral nitrogen and biofertilizers

The obtained results in Table 2 show that, application of all treatments of mineral nitrogen and biofertilizers to the culture media did not reflect any significant effect on tomato seed germination (%) in the first season, but had a significant promotive effect on the second one. These results might be due to that, both mineral nitrogen and biofertilizer encouraged the physiological and biochemical processes in the seeds during germination, which in turn increased the germination of tomato seeds.

These results are in harmony with those reported by **Mahato *et al.* (2009) and Angadi *et al.* (2017)**. They showed that, application of biofertilizers to the culture media recorded the highest germination percentage of tomato seeds.

Effect of the culture media

It is quite clear from the presented results in Table 3 that, there were no a significant differences among all the culture media treatments in the first season only. While, the culture media treatment of peat moss + vermiculite at a ratio of 3:1 (*V/V*), being the most effective and favorable treatment for increasing the germination percentage of tomato seed in the second season of the study. On the contrary, the lowest values in this respect were more achieved *via* using the culture media treatment of peat moss + vermiculite at a ratio of 1:1 (*V/V*) in the two investigated seasons.

In this connection, the superiority of increasing germination percentage of tomato seeds by using the culture media which contained peat moss + vermiculite at a ratio of 3:1 (*V/V*), might be due to that, these treatment contained good balance between water content and aeration, which in turn increased the germination percentage of tomato seeds.

These results are going in agreement with those reported by **Arenas *et al.* (2002), Favaro *et al.* (2002) and Mahmoud *et al.* (2014)** on

Table 2. Effect of mineral nitrogen and biofertilizers on the germination percentage of tomato seeds and the morphological characters of tomato transplants at 60 days from seed sowing during 2015 and 2016 seasons

Treatment	Seed germination (%)	Morphological characters		
		Root length (cm)	Stem length (cm)	Number of leaves
		2015 season		
1. Without mineral nitrogen and biofertilizers (control)	74.76	6.36	5.78	5.24
2. Mineral nitrogen fertilizer	79.65	6.83	7.54	5.26
3. Biofertilizer	82.08	6.68	7.03	5.16
4. Mineral nitrogen and iofertilizer	77.77	6.47	6.07	4.80
LSD (0.05)	NS	0.26	0.54	0.38
		2016 season		
1. Without mineral nitrogen and biofertilizers (control)	75.75	4.93	4.85	3.79
2-Mineral nitrogen fertilizer	83.78	5.56	5.52	3.95
3-Biofertilizer	72.67	6.34	4.99	3.91
4-Mineral nitrogen and biofertilizers	84.37	6.09	5.14	4.15
LSD (0.05)	4.19	0.39	0.43	NS

NS = Not significant

Table 3. Effect of the culture media on the germination percentage of tomato seeds and the morphological characters of tomato transplants at 60 days from seed sowing during 2015 and 2016 seasons

Culture media Peat moss: Vermiculite (*V/V*)	Seed germination (%)	Morphological characters		
		Root length (cm)	Stem length (cm)	Number of leaves
		2015 season		
1:1	76.92	6.58	6.23	5.02
2:1	77.75	6.68	6.95	4.98
3:1	81.03	6.50	6.65	5.35
LSD (0.05)	NS	NS	0.46	0.34
		2016 season		
1:1	76.27	5.85	4.82	3.81
2:1	79.54	5.87	5.29	4.03
3:1	81.61	5.47	5.26	4.02
LSD (0.05)	3.16	0.32	0.28	NS

NS = Not significant

tomato. In this connection, **Atif *et al.* (2016)** examined the effect of peat and compost (vegetable waste) and traditional practicing media (soil, sand and farm yard manure) alone and in combinations. They indicated that the maximum germination percentage (95%) was observed in treatment (peat, compost and traditional practicing media at a ratio of 1:1:1.

Effect of the interaction

The presented results in Table 4 show that, the maximum value of tomato seed germination (%) in the first season were obtained by application of biofertilizer to the culture media treatment of peat moss + vermiculite at a ratio of 3:1 (*V/V*), followed by application of mineral nitrogen fertilizer to the culture media treatment of peat moss+ vermiculite at a ratio of 2:1 (*V/V*), respectively without significant differences between them. While, in the second season, the highest value of seed germination percentage was more distinct *via* application of mineral nitrogen and biofertilizers to the culture media treatment of peat moss+ vermiculite at a ratio of 3:1 (*V/V*), respectively.

From the foregoing results, it could be concluded that the germination percentage of tomato seeds varied significantly according to the treatments of mineral nitrogen and biofertilizer, as well as to the components of the culture media and their ratio.

These results are in accordance with those reported by **Augustinus (2007)** on basil seed germination percentage.

Morphological Characters of Transplants

Effect of mineral nitrogen and biofertilizers

The obtained results in Table 2 show that, application of mineral nitrogen fertilizer to the culture media caused a significant effect and recorded the maximum value of root length, stem length and number of leaves per tomato transplants at 60 days from seed sowing in the first season. While, in the second one, the highest value of each of root length and stem length were recorded by application of biofertilizer only and mineral nitrogen fertilizers, respectively. In addition, all fertilizer treatments did not reflect any significant effect on number of leaves per transplant.

From the above mentioned results, it could be suggested that, the favorable effect of mineral nitrogen fertilizer on the vegetative growth of tomato transplants owing directly to the promotive effect on activation of photosynthesis, metabolic processes, physiological and biological processes of the transplants **Bidwell (1979)**. In addition, the increment in vegetative growth of tomato transplants due to application of biofertilizer might be owe much to the role of bacteria that present in the applied biofertilizer capable of contributing some hormones substances, *i.e.* gibberellins, auxins and cytokeyinins. Moreover, the activity of these bacteria in the absorption zone of transplant roots might improve the development of transplants by N2 fixation and due to releasing of certain other nutrients, *i.e.* Fe, Zn and Mn through the breakdown of organic material in the culture media.

The obtained results are in accordance with those reported by **Mahato *et al.* (2009) and Ibiene *et al.* (2012)**, they found that application of biofertilizer to the cultural media increased growth parameters (plant height, stem length, root length, internode length) of tomato transplants as compared to the untreated control.

Effect of the culture media

It is quite clear from the obtained results in Table 3 that, the culture media treatment of peat moss+ vermiculite at a ratio of 2:1 (*V/V*),being the most effective treatment for increasing both of root and stem lengths, with no significant differences between other treatments in the first season of study. On the other hand, the values of root length did not reach the level of significant at 0.05 level in the same season.

With regard to number of leaves per transplants, it is evident from such results in the same Table that, the maximum increment in this respect in the second season only were recorded by using the culture media treatment of peat moss+ vermiculite at a ratio of 3:1 (*V/V*).

From the foregoing results, it could be suggested that, the superiority of these treatments on the vegetative growth characters of tomato transplants may be due to the good balance between water content and aeration which in turn encourage the vegetative growth of tomato transplants.

Table 4. Effect of the interaction between mineral nitrogen, biofertilizers and the culture media on the germination percentage of tomato seeds and the morphological characters of tomato transplants at 60 days from seed sowing during 2015 and 2016 seasons

Fertilizer	Culture media Peatmoss: Vermiculite (*V/V*)	Seed germination (%)	Morphological characters		
			Root length (cm)	Stem length (cm)	Number of leaves
			2015 season		
1. Without mineral nitrogen and biofertilizers (control)	**1:1**	77.88	5.97	4.58	5.23
	2:1	71.45	6.62	6.73	4.83
	3:1	74.95	6.48	6.01	5.67
2. Mineral nitrogen fertilizer	**1:1**	71.93	7.03	7.13	5.27
	2:1	84.36	6.67	7.77	5.20
	3:1	82.66	6.78	7.73	5.30
3. Biofertilizer	**1:1**	82.93	6.95	6.75	4.97
	2:1	76.87	6.58	7.27	4.90
	3:1	86.44	6.52	7.08	5.60
4. Mineral nitrogen and biofertilizers	**1:1**	74.96	6.37	6.42	4.60
	2:1	78.30	6.87	6.05	5.00
	3:1	80.06	6.18	5.73	4.80
LSD (0.05)		8.85	0.39	0.92	0.33
			2016 season		
1. Without mineral nitrogen and biofertilizers (control)	**1:1**	76.07	5.60	4.30	3.57
	2:1	75.27	5.22	5.00	3.83
	3:1	75.91	3.97	5.25	3.97
2. Mineral nitrogen fertilizer	**1:1**	83.25	4.90	4.83	3.70
	2:1	84.21	5.83	5.83	4.07
	3:1	83.89	5.95	5.88	4.10
3. Biofertilizer	**1:1**	67.14	6.48	4.93	3.93
	2:1	73.36	6.27	5.13	3.93
	3:1	77.51	6.27	4.90	3.87
4.Mineral nitrogen and biofertilizers	**1:1**	78.62	6.43	5.22	4.03
	2:1	85.32	6.15	5.18	4.30
	3:1	89.15	5.70	5.02	4.13
LSD (0.05)		6.33	0.64	0.55	0.55

The obtained results are in harmony with those reported by **Arenas *et al.* (2002), Favaro *et al.* (2002), Herrera *et al.* (2008), Soliman (2010) and Atif *et al.* (2016)**, they indicated that, maximum shoot length and vigor index of tomato transplants were observed in the treatment of peat + compost + traditional practicing media at a ratio of 1:1:1.

Effect of the interaction

It is evident from the presented results in Table 4 that, all interaction treatments between the two factors of study (mineral nitrogen and biofertilizers × the culture media) exerted a marked effect on the vegetative growth characters of tomato transplants in the two investigated seasons.

In this regard, the maximum value of root length was more achieved by the interaction between mineral nitrogen fertilizer and the culture media treatment of peat moss + vermiculite at a ratio of 1:1 (*V/V*) in the first season, and by the interaction between biofertilizer and such media in the second one.

Furthermore, the interaction between mineral nitrogen fertilizer and the culture media treatment of peat moss + vermiculite at a ratio of 2:1 (*V/V*) and 3:1 (*V/V*), being the most effective and favorable treatments for increasing stem length of tomato transplants without significant differences among them in both seasons of study.

On the other hand, the maximum value of leaf number per transplant was more distinct *via* the interaction between without application any fertilizers and the culture media treatment of peat moss+ vermiculite at a ratio of 3:1 (*V/V*), without any additives followed by that fertilizer by mineral nitrogen fertilizer without significant differences among them in the first season. While, in the second season, the maximum value in this respect was recorded by the interaction between mineral nitrogen and biofertilizer × the culture media treatment of peat moss + vermiculite at a ratio of 2:1 (*V/V*), respectively.

These results are going in agreement with those reported by **Arenas *et al.* (2002) and Unal (2013)** in tomato transplants.

Fresh Weight of Transplants

Effect of mineral nitrogen and biofertilizers

It is quite clear from results in Table 5 that, there were significant differences between the studied treatments in the two growing seasons.

In addition, the application of biofertilizers only to the culture media recorded the maximum values of fresh weight of different parts of tomato transplants, *i.e.* root, shoot (stem and leaves) and the whole transplant during the two investigated seasons, as compared to the other treatments. On the other hand, the value of shoot fresh weight did not reach level of significant at 0.05 in the second season only. On the contrary, the lowest values of fresh weight of all parts of tomato transplants were more distinct *via* the control treatment (without application of mineral nitrogen and biofertilizer).

The favorable effect of application biofertilizer to the culture media on the fresh weight of tomato transplants might be due to its biochemical associations in the transplants and utilization of metabolites, as well as translocation of energy compounds.

In this regard, the obtained results are in accordance with those reported by **Kokalis-Burelle et al. (2003)** on muskmelon and watermelon, as well as **Sharaf-Eldin *et al.* (2015)** on cabbage transplants, who found that all organic fertilizers increased fresh weight of the transplants. However, micro granulated organic fertilizer (NPK: 4-4-4) was the most effective treatment.

Effect of the culture media

It is obvious from results in Table 6 that, using the culture media treatment of peat moss + vermiculite at a ratio of 1:1 (*V/V*), significantly increased the fresh weight of root and shoot (stem and leaves) and whole transplant, as compared to the other treatments in the first season of study. On the other hand, there were no significant differences between all treatments of the culture media in respect of fresh weight of root and total fresh weight per transplant in the second season of study. In addition, using the culture media treatment of peat moss + vermiculite at a ratio of 3:1, followed by 2:1 (*V/V*), significantly increased the fresh weight of

Table 5. Effect of mineral nitrogen and biofertilizers on the fresh weight (g) of tomato transplants at 60 days from seeds sowing during 2015 and 2016 seasons

Fertilizer	Fresh weight (g)		
	Root	Shoot (stem+ leaves)	Total
		2015 season	
1. Without mineral nitrogen and biofertilizers (control)	0.61	1.74	2.35
2. Mineral nitrogen fertilizer	0.46	1.82	2.28
3. Biofertilizer	0.62	2.10	2.72
4. Mineral nitrogen and biofertilizers	0.50	1.38	1.88
LSD (0.05)	0.12	0.26	0.35
		2016 season	
1. Without mineral nitrogen and biofertilizers (control)	0.27	0.86	1.13
2. Mineral nitrogen fertilizer	0.41	1.09	1.50
3. Biofertilizer	0.44	1.12	1.56
4. Mineral nitrogen and biofertilizers	0.44	1.02	1.46
LSD (0.05)	0.13	NS	0.35

NS = Not significant

Table 6. Effect of the culture media on the fresh weight (g) of tomato transplants at 60 days from seed sowing during 2015 and 2016 seasons

Culture media Peat moss : Vermiculite (*V/V*)	Fresh weight (g)		
	Root	Shoot (stem+ leaves)	Total
		2015 season	
1:1	0.60	1.87	2.47
2:1	0.55	1.61	2.16
3:1	0.48	1.80	2.28
LSD (0.05)	0.06	0.15	0.18
		2016 season	
1:1	0.38	0.95	1.33
2:1	0.43	1.05	1.48
3:1	0.36	1.07	1.43
LSD (0.05)	NS	0.04	NS

NS = Not significant

shoot (stem and leaves) in the second season of study without significant differences among them.

These results are in harmony with those reported by **Botrini *et al.* (2006)** on tomato transplants. In this regard, **Soliman (2010)** found that, the plants derived from the mixtures peat moss + vermiculite or peat moss + sand, significantly, increased shoot and root fresh weights of tomato transplants.

Effect of the interaction

It is interest to note from results in Table 7 that, application of biofertilizers only to the culture media treatment of peat moss + vermiculite at a ratio of 3:1 (*V/V*), were the best interaction treatment which had a significant effect on the fresh weight of shoot (stem and leaves) and total fresh weight per transplant in the first season only, as compared with the other interaction treatments. While, using the culture media treatment of peat moss + vermiculite at a ratio of 1:1(*V/V*) without any application of mineral nitrogen or biofertilizers were the superior interaction treatment for increasing the fresh weight of root in the same season. Moreover, in the second season, using the culture media treatment of peat moss + vermiculite at a ratio of 3:1 (*V/V*), with application of mineral nitrogen fertilizers only, being the most effective treatment for enhancing the fresh weight of shoot (stem and leaves) and whole transplant, as compared with the other interaction treatments. While, application of mineral nitrogen and biofertilizers to the culture media treatment of peat moss + vermiculite at a ratio of 2:1 (*V/V*), being the superior treatment for increasing the fresh weight of root, followed by the application of mineral nitrogen fertilizer to the culture media treatment of peat moss vermiculite at a ratio of 3:1 (*V/V*), without significant differences among them.

Dry Weight of Transplants

Effect of mineral nitrogen and biofertilizers

The presented results in Table 8 show that, application of mineral nitrogen fertilizers only to the culture media recorded the maximum value and came in the first rank for increasing the dry weight of different parts of tomato transplants, *i.e.* roots and shoot, as well as total dry weight of transplant, as compared with the other treatments in the first season only. On the other hand, application of mineral nitrogen and biofertilizers to the culture media of tomato transplants, being the most effective treatment for increasing the dry weight of shoot (stem and leaves) and whole transplant, as compared to the other treatments in the second season of study. Moreover, the application of mineral nitrogen fertilizer to the culture media being the superior treatment for increasing the dry weight of roots without significant differences with the other treatments, except the control treatment (without application of mineral nitrogen and biofertilizers).

From the above mentioned results, it could be suggested that, the superiority of increasing the dry weight of tomato transplants by application of mineral nitrogen fertilizer might be due to the positive effect on activation of photosynthesis and metabolic processes of organic compounds in the transplant.

In addition, the favorable effect of application of biofertilizer on the dry weight of tomato transplants could be attributed to its role on improving the accumulation of metabolic compounds in different parts of tomato transplants, which in turn increased the dry matter content.

These results are in agreement with those reported by **Ekinci *et al*. (2014)** on cauliflower transplants and **Angadi *et al.* (2017)** on tomato transplants.

Effect of the culture media

The results listed in Table 9 show the effect of culture media on the dry weight of tomato transplants at 60 days from seed sowing during 2015 and 2016 seasons. It is obvious from such results that, there were no significant effects at 0.05 among all the studied treatments on the dry weight of tomato transplants during the first season of study. In addition, the results in such table indicated that using the culture media treatment of peat moss + vermiculite at a ratio of 2:1 (*V/V*), significantly increased the dry weight of different parts of tomato transplants; *i.e.* root, shoot (stem and leaves) and total dry weight per transplant, followed by using the culture media treatment of peat moss + vermiculite at a ratio 1:1 (*V/V*) without significant differences between them.

Table 7. Effect of the interaction between mineral nitrogen, biofertilizers and the culture media on the fresh weight (g) of tomato transplants at 60 days from seeds sowing during 2015 and 2016 seasons

Fertilizer	Culture media Peat moss : Vermiculite (*V/V*)	Fresh weight (g)		
		Root	Shoot (stem+ leaves)	Total
		2015 season		
1. Without mineral nitrogen and biofertilizers (control)	1:1	0.78	1.78	2.56
	2:1	0.58	1.57	2.15
	3:1	0.46	1.88	2.34
2. Mineral nitrogen fertilizer	1:1	0.47	1.92	2.39
	2:1	0.40	1.57	1.97
	3:1	0.52	1.97	2.49
3. Biofertilizer	1:1	0.63	2.18	2.81
	2:1	0.63	1.85	2.48
	3:1	0.58	2.27	2.85
4. Mineral nitrogen and Biofertilizers	1:1	0.53	1.59	2.12
	2:1	0.60	1.45	2.05
	3:1	0.37	1.11	1.48
LSD (0.05)		0. 13	0.29	0.35
Peat moss : Vermiculite (*V/V*)		2016 season		
1. Without mineral nitrogen and biofertilizers (control)	1:1	0.32	0.81	1.13
	2:1	0.27	0.78	1.05
	3:1	0.23	0.99	1.22
2. Mineral nitrogen fertilizer	1:1	0.28	0.81	1.09
	2:1	0.47	1.11	1.58
	3:1	0.50	1.34	1.84
3. Biofertilizer	1:1	0.49	1.23	1.72
	2:1	0.47	1.20	1.67
	3:1	0.36	0.93	1.29
4. Mineral nitrogen and biofertilizers	1:1	0.43	0.94	1.37
	2:1	0.54	1.13	1.67
	3:1	0.35	1.00	1.35
LSD (0.05)		0.18	0.24	0.24

Table 8. Effect of mineral nitrogen and biofertilizers on the dry weight (g) of tomato transplants at 60 days from seed sowing during 2015 and 2016 seasons

Fertilizer	Dry weight (g)		
	Root	Shoot (stem+ leaves)	Total
		2015 season	
1. Without mineral nitrogen and biofertilizers (control)	0.19	0.24	0.43
2. Mineral nitrogen fertilizer	0.20	0.29	0.49
3. Biofertilizer	0.16	0.28	0.44
4. Mineral nitrogen and biofertilizers	0.15	0.25	0.40
LSD (0.05)	0.03	0.04	0.05
		2016 season	
1. Without mineral nitrogen and biofertilizers (control)	0.07	0.05	0.12
2. Mineral nitrogen fertilizer	0.10	0.05	0.15
3. Biofertilizer	0.09	0.08	0.17
4. Mineral nitrogen and biofertilizers	0.09	0.14	0.23
LSD (0.05)	0.02	0.04	0.03

Table 9. Effect of the culture media on the dry weight (g) of tomato transplants at 60 days from seed sowing during 2015 and 2016 seasons

Culture media	Dry weight (g)		
Peat moss : Vermiculite (*V/V*)	**Root**	**Shoot (stem+ leaves)**	**Total**
		2015 season	
1:1	0.17	0.27	0.44
2:1	0.18	0.26	0.44
3:1	0.17	0.27	0.44
LSD (0.05)	NS	NS	NS
		2016 season	
1:1	0.10	0.08	0.18
2:1	0.09	0.11	0.20
3:1	0.07	0.08	0.15
LSD (0.05)	0.02	0.03	0.03

NS = Not significant

The obtained results are in harmony with those reported by **Soliman (2010) and Atif *et al.* (2016)** on tomato transplants.

Effect of the interaction

The results in Table 10 indicat that, application of mineral nitrogen fertilizer alone to the culture media treatment of peat moss + vermiculite at a ratio of 1:1 (*V/V*), significantly increased the dry weight of shoots and total dry weight of tomato transplant in the first season. In addition, in the same season, the maximum value of root were recorded without application of both mineral nitrogen and biofertilizers to the culture media treatment of peat moss + vermiculite at a ratio of 2:1 (*V/V*), respectively, without significant differences among most of the interaction treatments. Moreover, it is also clear from the same results that, using of both mineral nitrogen and biofertilizers in the culture media treatment of peat moss + vermiculite at a ratio of 2:1 (*V/V*), respectively, being the most effective interaction treatment for increasing the dry weight of roots, shoots and whole transplant in the second season only, as compared to the other interaction treatments. The obtained results are in accordance with those reported by **Danaher *et al.* (2016)** on tomato transplants.

Growth Analysis of Transplants

Effect of mineral nitrogen and biofertilizers

The obtained results in Table 11 indicat that, there were significant differences between the tested treatments on the growth analysis characters, expressed as leaf area (cm²), specific leaf area, leaf area ratio, fresh/dry weight ratio and leaf weight ratio. In this respect, application of mineral nitrogen and biofertilizers to the culture media of tomato transplants caused a significant effect on leaf area, leaf area ratio and leaf weight ratio characters in tomato transplants, as compared to the other treatments of study. While, application of mineral nitrogen fertilizers only to the culture media recorded the maximum value of fresh/dry weight ratio, followed by the control treatment without significant differences among them. In addition, such treatments being the superior one for increasing specific leaf ratio.

The obtained results are in line with those found by **Ramteke *et al.* (2013)** on *Pisum sativum*, *Vigna radiant* and *Vigna catjang*, and **Sharaf-Eldin *et al.* (2015)** on cabbage transplants.

From the above mentioned results, it could be suggested that the growth analysis of tomato transplants was affected and varied greatly according to all treatments of mineral and biofertilizer under these study.

Effect of the culture media

The presented results in Table 12 show that, there were no clear significant differences at 0.05 level between the ratios of the tested cultures media on both growth analysis of tomato transplants, *i. e.* leaf area, leaf area ratio and specific leaf area of tomato transplants. On the other hand, using the culture media treatment of peat moss + vermiculite at a ratio of 3:1 (*V/V*), significantly affected in both fresh/dry weight ratio and leaf weight ratio.

The obtained results are in accordance with those reported by **Rahimi *et al.* (2013)** on tomato transplants.

Effect of the interaction

The effect of interaction treatments between mineral nitrogen, biofertilizers and the tested culture media on the growth analysis of tomato transplants at 60 days from seed sowing during 2016 season are presented in Table 13 and revealed that, the application of both mineral nitrogen and biofertilizers to the culture media of tomato transplants [peat moss + vermiculite at a ratio of 2:1 (*V/V*)], recorded the maximum values in both of leaf area and leaf weight ratio. While, application of both mineral nitrogen and biofertilizers to the culture media treatment of peat moss + vermiculite at a ratio of 1:1 (*V/V*), being the most effective and favorable interaction treatment for encouraged the leaf area ratio, as compared with the other interaction treatments. In addition, it is also obvious from the same results in Table (13) that, application of mineral nitrogen fertilizer to the culture media treatment of peat moss + vermiculite at a ratio of 2:1and 3:1 (*V/V*), were the most effective interaction treatments and recorded the maximum values of both fresh/ dry weight ratio and specific leaf area, respectively.

Consequently, from the forgoing results it can be concluded that the two factors of study (fertilizers and culture media) affected greatly the growth analysis of tomato transplants.

Table 10. Effect of the interaction between mineral nitrogen, biofertilizers and the culture media on the dry weight (g) of tomato transplants at 60 days from seed sowing during 2015 and 2016 seasons

Fertilizer	Culture media Peat moss : Vermiculite (*V/V*)	Dry weight (g)		
		Root	Shoot (stem+ leaves)	Total
		2015 season		
1. Without mineral nitrogen and biofertilizer (control)	**1:1**	0.16	0.20	0.36
	2:1	0.21	0.23	0.44
	3:1	0.19	0.28	0.47
2. Mineral nitrogen fertilizer	**1:1**	0.19	0.32	0.51
	2:1	0.20	0.27	0.47
	3:1	0.20	0.29	0.49
3. Biofertilizer	**1:1**	0.17	0.27	0.44
	2:1	0.16	0.28	0.44
	3:1	0.15	0.29	0.44
4. Mineral nitrogen and biofertilizer	**1:1**	0.16	0.28	0.44
	2:1	0.16	0.25	0.41
	3:1	0.13	0.21	0.34
LSD (0.05)		**0.06**	**0.07**	**0.09**
		2016 season		
1. Without mineral nitrogen and biofertilizer (control)	**1:1**	0.08	0.05	0.13
	2:1	0.08	0.05	0.13
	3:1	0.04	0.07	0.11
2. Mineral nitrogen fertilizer	**1:1**	0.12	0.05	0.17
	2:1	0.08	0.04	0.12
	3:1	0.09	0.07	0.16
3. Biofertilizer	**1:1**	0.11	0.10	0.21
	2:1	0.10	0.08	0.18
	3:1	0.07	0.06	0.13
4. Mineral nitrogen and biofertilizer	**1:1**	0.09	0.08	0.17
	2:1	0.10	0.25	0.35
	3:1	0.09	0.11	0.20
LSD (0.05)		**0.03**	**0.06**	**0.05**

Table 11. Effect of mineral nitrogen and biofertilizers on the growth analysis of tomato transplants at 60 days from seed sowing during 2016 season

Fertilizer	Growth analysis				
	Leaf area (cm^2)	Specific leaf area	Leaf area ratio	Fresh/dry weight ratio	Leaf weight ratio
	2016 season				
1. Without mineral nitrogen and biofertilizers (control)	7.59	179.09	62.15	9.61	0.36
2. Mineral nitrogen fertilizer	6.51	177.51	44.13	10.55	0.25
3-Biofertilizer	7.84	124.79	44.32	9.01	0.36
4-Mineral nitrogen and biofertilizers	18.04	177.54	76.96	6.58	0.45
LSD (0.05)	3.53	53.987	20.18	1.05	0.07

Table 12. Effect of the culture media on the growth analysis of tomato transplants at 60 day from seed sowing during 2016 season

Culture media Peat moss : vermiculite (*V/V*)	Growth analysis				
	Leaf area (cm^2)	Specific leaf area	Leaf area ratio	Fresh/dry weight ratio	Leaf weigh ratio
	2016 season				
1:1	8.80	169.02	52.73	7.89	0.31
2:1	11.12	151.82	52.65	9.07	0.36
3:1	10.08	173.36	65.29	9.86	0.40
LSD (0.05)	NS	NS	NS	0.83	0.06

NS = Not significant

Table 13. Effect of the interaction between mineral nitrogen, biofertilizers and the culture media on the growth analysis of tomato transplants at 60 days from seed sowing during 2016 season

Fertilizer	Culture media Peat moss: vermiculite (*V/V*)	Growth analysis				
		Leaf area (cm^2)	Specific leaf area	Leaf area ratio	Fresh / dry weight ratio	Leaf weight ratio
		2016 season				
1.Without mineral nitrogen and biofertilizers (control)	**1:1**	7.94	229.43	62.16	8.95	0.28
	2:1	5.52	152.97	43.84	8.78	0.29
	3:1	9.31	154.87	80.44	11.09	0.51
2. Mineral nitrogen fertilizer	**1:1**	4.11	112.05	23.26	6.30	0.21
	2:1	4.99	166.80	43.54	13.63	0.26
	3:1	10.43	253.67	65.60	11.73	0.28
3 Biofertilizer	**1:1**	8.57	108.17	41.35	8.35	0.38
	2:1	9.64	154.02	53.20	8.97	0.36
	3:1	5.32	112.19	38.40	9.71	0.34
4. Mineral nitrogen and biofertilizers	**1:1**	14.56	226.41	84.14	7.95	0.38
	2:1	24.30	133.47	70.01	4.88	0.52
	3:1	15.25	172.73	76.72	6.91	0.45
LSD (0.05)		6.81	89.980	35.65	1.66	0.11

The obtained results are in line with those found by **Grazia *et al.* (2007)** on sweet pepper transplants.

Chemical Composition of Transplants

Effect of mineral nitrogen and biofertilizers

It is quite clear from the obtained results in Table 14 that, the chemical composition of tomato transplants at 60 days from seed sowing in both season of study, affected greatly by all treatments of mineral nitrogen and biofertilizers, while the maximum increments of the percentage of N, P, K and total carbohydrates were more distinct and came in the first rank *via* application of mineral nitrogen and biofertilizer to the culture media. On the contrary, the lowest values in this respect were recoded without application of both mineral nitrogen and biofertilizer to the culture media. These results were hold true in the two investigated seasons.

In this connection, the superiority of application of mineral nitrogen and biofertilizer to the culture media on the chemical composition of tomato transplants directly owing to their role in the biological and physiological processes in the transplants.

Furthermore, the favorable effect of application biofertilizer to the culture media on the chemical composition of tomato transplant might be due to its biochemical associations in the transplants and utilization of metabolites, as well as translocation of energy compounds.

The favorable effect of application mineral nitrogen and biofertilizer on building and accumulation of carbohydrates might be due to increasing the activity of carbohydrates hydrolyzing enzymes.

The obtained results are in agreement with those reported by **Baddour (2010)** and **Dawa *et al.* (2013)** on tomato, and **Sharaf-Eldin *et al.* (2015)** on cabbage transplants.

Effect of the culture media

With regard to the effect of the culture media on the chemical composition of tomato transplants at 60 days from seed sowing in 2015 and 2016 seasons, it is evident from the presented results in Table 15 that, all treatments of the culture media exerted a marked effect in this concern, while the highest value of each of N, P, K and total carbohydrates (%) were obtained by using the culture media treatment of peat moss + vermiculite at a ratio of 3:1 (*V/V*), in the first season. But in the second one, the maximum value of each of N, P and K (%) were recorded by using the culture media treatment of peat moss + vermiculite at a ratio of 2:1 (*V/V*), followed by the culture media treatment of peat moss + vermiculite at a ratio of 1:1 (*V/V*), respectively without significant differences between them.

Moreover, the highest increment of total carbohydrates (%) were more achieved *via* using the culture media treatment of peat moss + vermiculite at a ratio of 1:1 (*V/V*), followed by the culture media treatment of peat moss+ vermiculite at a ratio of 2:1 (*V/V*), respectively without significant differences between them.

These results are in accordance with those found by **Riberio *et al.* (2007)** and **Al-Ajmi *et al.* (2009)** and **Soliman (2010)** on tomato transplant.

Effect of the interaction

Results in Table 16 show that, the interaction treatments between mineral nitrogen and biofertilizers × the culture media treatment of peat moss + vermiculite at a ratio of 3:1 (*V/V*), recorded the maximum value of each of N, P, K and total carbohydrates (%) in the first season. While, in the second one, the highest values in this respect were more achieved *via* the interaction between application of mineral nitrogen and biofertilizers × the culture media treatment of peat moss + vermiculite at a ratio of 1:1 or 2:1 (*V/V*), without significant differences between them.

Finally, from the foregoing results, it could be concluded that, the chemical composition of tomato transplants (as described above) were varied according to the two factors of study (mineral nitrogen and biofertilizers × the culture media) during the two growing seasons of study.

Table 14. Effect of mineral nitrogen and biofertilizer on the chemical composition of tomato transplants at 60 days from seed sowing during 2015 and 2016 seasons

Fertilizer	Chemical composition (%)			
	N	P	K	Total carbohydrates
	2015 season			
1. Without mineral nitrogen and biofertilizer (control)	3.13	0.234	3.55	16.64
2. Mineral nitrogen fertilizer	3.99	0.297	4.08	23.56
3. Biofertilizer	3.86	0.267	3.75	20.04
4. Mineral nitrogen and biofertilizer	4.82	0.313	4.40	27.20
LSD (0.05)	0.011	0.003	0.12	0.053
	2016 season			
1. Without mineral nitrogen and biofertilizer (control)	3.18	0.236	3.51	18.53
2. Mineral nitrogen fertilizer	3.92	0.292	3.99	23.83
3. Biofertilizer	3.79	0.268	3.70	19.88
4. Mineral nitrogen and biofertilizer	4.73	0.319	4.30	26.28
LSD (0.05)	0.03	0.006	0.06	0.14

Table 15. Effect of the culture media on the chemical composition of tomato transplants at 60 days from sowing seed during 2015 and 2016 seasons

Culture media	Chemical composition (%)			
Peat moss : Vermiculite (*V/V*)	N	P	K	Total carbohydrates
	2015 season			
1:1	3.86	0.274	3.88	21.59
2:1	3.95	0.275	3.94	21.82
3:1	4.05	0.283	4.02	22.17
LSD (0.05)	0.02	0.003	0.02	0.04
	2016 season			
1:1	3.93	0.284	3.91	22.29
2:1	3.96	0.284	3.94	22.28
3:1	3.82	0.269	3.77	21.82
LSD (0.05)	0.05	0.004	0.04	0.08

Table 16. Effect of the interaction between mineral nitrogen, biofertilizers and the culture media on the chemical composition of tomato transplants at 60 days from seed sowing during 2015 and 2016 seasons

Fertilizer	Culture media Peat moss : Vermiculite (*V/V*)	Chemical composition (%)			
		N	P	K	Total carbohydrates
		2015 season			
1.Without mineral nitrogen and biofertilizers (control)	**1:1**	3.04	0.249	3.50	16.41
	2:1	3.11	0.222	3.54	16.54
	3:1	3.25	0.232	3.61	16.97
2. Mineral nitrogen fertilizer	**1:1**	3.89	0.299	3.98	23.20
	2:1	4.01	0.302	4.08	23.62
	3:1	4.09	0.302	4.18	23.85
3. Biofertilizer	**1:1**	3.79	0.248	3.71	19.71
	2:1	3.87	0.269	3.76	19.88
	3:1	3.94	0.283	3.79	20.53
4. Mineral nitrogen and biofertilizers	**1:1**	4.73	0.310	4.31	27.05
	2:1	4.80	0.312	4.39	27.25
	3:1	4.91	0.316	4.50	27.31
LSD (0.05)		**0.03**	**0.005**	**0.04**	**0.07**
		2016 season			
1.Without mineral nitrogen and biofertilizers (control)	**1:1**	3.12	0.242	3.48	18.29
	2:1	3.30	0.238	3.61	18.92
	3:1	3.12	0.229	3.42	18.37
2. Mineral nitrogen fertilizer	**1:1**	3.91	0.292	4.09	23.97
	2:1	4.02	0.302	4.07	24.11
	3:1	3.83	0.283	3.83	23.42
3. Biofertilizer	**1:1**	3.86	0.279	3.71	20.47
	2:1	3.79	0.274	3.70	19.64
	3:1	3.71	0.249	3.69	19.52
4. Mineral nitrogen and biofertilizers	**1:1**	4.83	0.321	4.37	26.44
	2:1	4.72	0.320	4.36	26.45
	3:1	4.63	0.317	4.15	25.96
LSD (0.05)		**0.10**	**0.008**	**0.08**	**0.16**

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تأثير السماد النيتروجينى المعدنى والحيوى وبيئة الزراعة على إنتاج شتلات الطماطم

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أجرى هذا البحث فى مشتل خاص تحت ظروف الصوبات البلاستيكية، فى منطقة بلبيس- محافظة الشرقية (مصر) خلال موسمى ٢٠١٥، ٢٠١٦، وذلك لدراسة تأثير السماد النيتروجينى المعدني والحيوى، وبيئة الزراعة على نسبة إنبات البذور (%)، صفات النمو الخضري، والوزن الطازج والجاف، وتحليل النمو، والمكونات الكيميائية لشتلات الطماطم بعد ٦٠ يوماً من زراعة البذور، ولقد أوضحت النتائج المتحصل عليها أن معاملات التسميد النيتروجينى المعدنى والحيوى وبيئة الزراعة، والتفاعل بينهما أعطت تأثير معنوي في موسمى الزراعة على الصفات التى تم دراستها، ولكن هذا التأثير اختلف من معاملة لأخرى ومن موسم لآخر.

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