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Research Article

The Integration of Microbial Inoculation and Organic Fertilization to Improve the Productivity of Wheat (*Triticum aestivum* L.) in New Land

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Abstract: This study was conducted to investigate the integration between the microbial inoculation and organic fertilization to improve the wheat productivity. Therefore, two wheat varieties (Misr-1 and Seds-12) were tested under three rates (8, 10 and 12 tons/fed) of supported compost and various microbial inoculation treatments during of 2012/2013 and 2013/2014 seasons. The main obtained results revealed that the Misr-1 wheat variety recorded significant increases in yield and its components except average of grains number/spike during the two seasons. Moreover, the interaction among three experiment factors showed that Misr-1 wheat variety, 10 ton/fed of supported compost and microbial inoculation by *Trichoderma* + *Bacillus subtilis* gave the greatest values for number of spike/m^2, spike weight, average grain weight per spike, 1000-grain weight, biological yield, total yield/fed and protein content. However, highest number of grains per spike were recorded with Seds-12 wheat variety and 10 tons/fed of supported compost + inoculated by *Trichoderma* + *Bacillus subtilis.*

Keywords: Compost, *Trichoderma*, *Bacillus*, Biological yield and wheat productivity.

1. Introduction

In Egypt, the local wheat production is not sufficient to supply the annual demand of the increasing population. This caused the gap between production and consumption. Hence, increasing the local wheat production is the most important aim for reducing that gap and reach to self-sufficiency of that crop production. To achieve the obvious aim, it could be realized by two ways: first, expanding the area sown, second improving the yield per unit area is sown of crops such as wheat crop, We can expand the area for the wheat area in sandy soils which cover about 90% of Egypt area, Sandy soils are very much considered in the plain of horizontal expansion in Egypt. Such soils are characterized by their bulk density and its low content of native nutrient and the high leaching losses of applied fertilizers.

The use of organic fertilization for crops agricultural is a necessity, especially in the new land. Compost is considered one of the most organic substances that increase soil fertility. Because of its properties including the ability to retain water. Moreover, adding compost led to a positive influence on encouraging crop growth (Abdel-Ati and Zaki, 2006) and cation exchange capacity (CEC) by increasing humic substance levels (HS) (Youssef, 2006).

Furthermore, microbial and fungi inoculants represent an emerging technology designed to improve the productivity of agricultural systems in the long run. They can be seen as a technology aligned with principles of sustainable agriculture, as opposed to the increased use of pesticides and fertilizers in recent times. Several microorganisms are used in normal agricultural practice. Most of them have the ability to colonize and establish an ongoing relationship with plants producing increases in biomass, many kinds of bacteria can fixation nitrogen such as *Azotobacter* (El-Shanshoury, 2008). Moreover, inoculation of *Azotobacter* with *Bacillus* significantly increased the dry matter (Khan and Zaidi, 2007). The organisms were accompanied with pH reduction of the culture medium.

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Maximum pH reduction was 2.8, 1.2 and 0.5 units for *Bacillus megaterium* and *Azospirillum lipoferum* strain (El-Komy, 2005). They also added that *Bacillus megaterium* strains were the most powerful phosphate solubilizers. In addition, *Trichoderma* is free-living fungi that are common in soil and root ecosystems. Also, frequently enhances root growth and development, crop productivity, resistance to biotic stress and the uptake and use of nutrients (Harman *et al.,* 2004). Furthermore, *Bacillus subtilis* a role of plant growth promoting bacteria *Bacillus subtilis* and caused significant increase in fresh and dry masses of roots and leaves, photosynthetic pigments, proline, total free amino acids and crude protein (Mohamed and Gomaa, 2012). The performance of each of the *Trichoderma* and *Bacillus* combinations was better than the *Bacillus* isolates used alone (Yobo, *et al*., 2011). They are usually called plant growth-promoting rhizobacteria (PGPR) or more generally plant growth promoting bacteria.

Consequently, the aim of the current study was integration between the microbial inoculation and organic fertilization to improve the wheat productivity through the winter experiment.

2. Materials and Methods

The field experiment were conducted during the winter season of 2012/2013 and 2013/2014 under the condition of sandy soil at the Agriculture farm of Assiut Company for reclamation, located in the Assiut valley (Assiut East desert). Climatic data for the experimental sites during the two growing seasons are given in Table (1). Also, chemical and mechanical analysis of the experimental site recorded in Table (2). The aim of that study is the integration between the microbial inoculation and organic fertilization to improve the wheat productivity. The wheat experiment included the following treatments.

A - Wheat varieties (V): V1 = Misr-1; V2= Seds-12,

B - Compost rates (C): C1 = 8 ton/fed; C2 = 10 ton/fed; C3 = 12 ton/fed;

C - Microbial inoculation treatments (T):

T1 = Supported compost + fungi isolate *Trichoderma harzianum* at the rate of [600 g/fed (1 g= 10^8 - 10^9 hive)];

T2 = Supported compost + Bacteria *Bacillus subtilis* at the rate of [600 g/fed (1 g= 10^8 - 10^9 hive)];

T3 = Supported compost + fungi isolate *Trichoderma harzianum* and Bacteria *Bacillus subtilis*;

T4 = Supported compost (Compost with (*Azotobacter – Azospirillum* + *Bacillus megaterium* + *Bacillus circulans* + Natural mineral ores) to fixation nitrogen and facilitation potassium and dissolve phosphorus);

T5 = Compost alone.

Chemical analysis for compost was recorded in the Table (3).

The experiment was arranged in randomized complete block design with a three-factor factorial arrangement in three replicates. The experiment included 30 treatments which wear the combination of two wheat varieties × three compost rates × five microbial treatments.

The hollow compost amount of each compost rate was calculated according to the plot area of 12.5m^2 (2.5 m wide × 5 m long) (1/33 of fed) and distributed equally for each plot. The amount of compost of each plot was distributed in the lines in plot (5m long) and interline space was 25cm. The microbial treatments were taking place by the same outline methodology of compost application.

The drip irrigation system was used to irrigated wheat crop each plot contains 5GR pipelines of hoses GR- diameter 16mm at the distance of 50cm apart, each pipeline contain drippers in between 30cm. The output of each one under the condition of the experiment irrigation network was 1.6 L/h. The irrigation was conducted every three days after germination for one hour. Wheat grains were hand drilled at the seeding rate of 70 kg/fed on November on tow season at the two sides of each pipeline.

Table 1. Maximum and minimum temperature, relative humidity, wind speed and ETo for experimental sites during 2012/2013 and 2013/2014 seasons.

Month	Temperature (c°) Max.	Temperature (c°) Min.	Relative humidity (%)	Wind speed (km/day)	ETo (mm/day)
Winter season 2012/2013					
November	28.1	13	54.8	314.4	4.91
December	21.4	7.6	65	326.4	3.39
January	21.3	6.7	59.7	144.0	2.66
February	24	7.6	48.1	147.6	3.64
March	29.7	12.1	35	188.4	5.59
April	29.9	14	34.2	171.6	6.03
Winter season 2013/2014					
November	28.4	13.2	53	124.8	3.36
December	21.6	7.3	56	140.4	2.59
January	22.4	6.3	55.2	94.8	2.42
February	23.8	7.4	49.2	144.0	3.58
March	27.9	12.1	42.4	138.0	4.68
April	28.4	13.2	53	124.8	3.36

Table 2. Chemical and mechanical analysis of the experimental soil sites in the two growing seasons of 2012/2013 and 2013/2014.

Chemical analysis	
Total N (%)	0.011
Available K (ppm)	65.00
pH	8.1
Saturation point	23.86%
Available P (ppm)	12.65
Organic matter (%)	0.055
Ec (ds/m) 1:1	1.93
Mechanical analysis	
Sand (%)	
Clay (%)	
Silt (%)	6.47
Texture	Sand

Table 3. Chemical analysis of compost.

Characteristics	Values
Total-N %	1.20
Total-P %	0.78
Total-K %	0.82
Organic matter %	32.74
Organic-C	18.98
pH (1:10)	6.27
E.C (ds/m) (1:10)	2.47
C/N ratio	1:15.81

Studied attributes: At harvesting time 10 wheat plants were chosen randomly from each plot to determine the averages of the following traits: Spike weight (g), number of grains/spike, weigh grains per spike (g), number of spikes/m^2, was determined from random samples of one m^2 taken from each plot, 1000-grain weight in grain was obtained from the weight of 1000-kernels taken at random from each plot, biological yield in ton/feddan was determined from the weight of all plants (grain + straws) in each plot, grain yield/fed (ton/fed), after harvesting wheat plant of each plot, the plants were threshed, and then the grains were weighted and multiplied by 336 to be for feddan.

3. Results

The effect of some supported compost rates and microbial treatments as well as the interaction effects between them on some traits of Misr-1 and Seds-12 wheat varieties in 2012/2013 and 2013/2014 seasons.

The results of the experiment will present through the effect of each source of variance on the studied wheat traits as follow:

3.1 The genetic variance between wheat varieties (V) studied

Results recorded in Tables (4, 5, 6, 7, 8, 9 and 10) revealed that Misr-1 and Seds-12 wheat varieties were varied significantly on all wheat studied traits during 2012/2013 and 2013/2014 seasons.

Misr-1 wheat variety exceeded Seds-12 wheat variety on Average number of spikes/m^2 (330.52 and 317.21), average spike weight (3.13 and 3.02 g), average grain weight/spike (2.13 and 1.98 g), 1000-grain weight (42.26 and 38.89 g), biological yield/fed (3192.6 and 3402.0 kg/fed), and total grain yield/fed (1471.6 and 1240.3 kg/fed) in 2012/2013 and 2013/2014 seasons, respectively. However, Seds-12 wheat variety shows its superiority on the number of grains/spike, which gave 64.10 and 54.61 grains/spike during 2012/2013 and 2013/2014 seasons, respectively.

3.2 The effect of compost (C) rates

Regarding the effect of compost rates on the studied wheat traits were presented in Tables (4, 5, 6, 7, 8, 9 and 10).

The results in the previous Tables observed about strong and significant effect of the applied compost rates and all studied wheat traits during 2012/3013 and 2013/2014 seasons. The results direction pointed that, the greatest value for all studied wheat traits were resulted by adding the compost rate of 10 ton/fed during the two seasons.

The greatest value of average number of spikes/m^2 (331.6 and 319.27 spikes/m^2), average spike weight (3.26 and 3.14g/spike), number of grains/spike (66.91 and 56.15 grains/spike), average grain weight/spike (2.21 and 2.05 g), 1000-grains weight (43.43 and 39.94g), biological yield/fed (3311.6 and 3480.6 kg), and total grain yield/fed (1494.1 and 1301.9 ton/fed) were resulted by fed wheat plant by supporting compost at the rates of 10 ton/fed.

3.3 The microbial treatments (T) effect

As for effect of conducting the studied microbial treatments, results recorded in Tables (4, 5, 6, 7, 8, 9 and 10) revealed that it had a significant effect on all studied wheat traits during the two experimental seasons 2012/2013 and 2013/2014. T3 microbial treatment (supported compost + *Trichoderma* + *Bacillus subtilis*) pronounced its superiority for all studied wheat traits during two seasons. Which gave the greatest value of the number of spikes/m^2 (349.35 and 336.92), heaviest average spike weight (3.24 and 3.12g), number of grains/spike (66.67 and 56.93), greatest average grains weight/spike (2.16 and 2.10 g), maximum 1000-grain weight (44.42 and 40.86 g), highest biological yield/fed (3313.5 and 3501.5 kg/fed) and the highest average of grain yield/fed (1493.6 kg/fed and 1287.9 kg/fed) during two seasons.

3.4 The interaction effect between factors studied

A. The first order interaction effects:-

- **A1 - (V×C) effect**

Results recorded in Tables (4, 5, 6, 7, 8, 9 and 10) revealed about significant of wheat varieties (V) and compost rate (C) effect of (V×C) interaction all wheat studied traits during 2012/2013 and 2013/2014 seasons. Planting wheat variety Misr-1 under adding 10 ton/fed of supported compost led to gave the maximum values of most studied trait of average number of spikes/m^2 (339.63 and 326.37 spikes/m^2), average spike weight (3.51 and 3.38 g/spike), average grain weight/spike (2.51 and 2.26 g), 1000-grains weight (44.98 and 41.38 g), biological yield/fed (3662.9 and 3696.5 kg), total grain yield/fed (1550.3 and 1409.3 ton/fed) during 2012/2013 and 2013/2014 seasons respectively. On the other hand, wheat Sed-12 variety secured the greatest value of an average number of grains/spike (71.95 and 63.37) under the effect of the same compost rate (10 ton/fed) during 2012/2013 and 2013/2014 seasons consecutively.

- **A2 - (V×T) effect**

Data presented in Tables (4, 5, 6, 7, 8, 9 and 10) observed significant effect on all wheat studied traits during the two experimental seasons. The greatest values of average number of spikes/m^2 (359.09 and 345.40 spikes/m^2), average spike weight (3.41 and 3.28 g/spike), average grain weight/spike (2.94 and 2.88 g), 1000-grains weight (45.86 and 42.18 g), biological yield/fed (3547.1 and 3676.4 kg), and total grain yield/fed (1539.5 and 1328.9 ton/fed) were associated by cultivating wheat Misr-1 variety under effect of T3 (supported compost + *Trichoderma* + *Bacillus subtilis*) microbial treatment in 2102/2013 and 2013/2014 season respectively. On the other hand sowing wheat Seds-12 variety and treated by T3 microbial treatment secured (73.69 and 64.62 grain/spike) greatest values of number of grains/spike compared with other treatments of the same interaction (V×T).

- **A3 - (C×T) effect**

Results recorded in the above-mentioned Tables revealed that greatest values all studied wheat traits were recorded the greatest values by planting wheat plants under the condition of adding 10 tons of supported compost/fed and infested the soil with (*Trichoderma* + *Bacillus subtilis*) (T3) microbial treatment during the two experimental seasons 2012/2013 and 2013/2014. For example, in 2013/2014 season the previous treatment led to gave the greatest, number of spikes/m^2 (350.15 spikes/m^2), average spike weight (3.55 g/spike), number of grains/spike (66.71 grains/spike), average grain weight/spike (2.46 g), 1000-grains weight (44.43 g), biological yield/fed (3932.3 kg) and total grain yield/fed (1471.9 ton/fed). The same trained of results took the same direction under the same treatment.

- **A4 - The second order interaction effect (V×C×T)**

The effect of the second order interaction (V×C×T) pronounced significant effect during 2012/2013 and 2013/2014 seasons on all studied wheat traits.

Growing wheat variety Misr-1 plants under the effect of adding 10 ton/fed supported compost and T3 microbial treatment (supported compost + *Trichoderma* + *Bacillus subtilis*) led to gave the greatest values of, number of spikes/m^2 (372.4 and 357.87 spikes/m^2), average spike weight (3.93 and 3.79 g/spike), average grain weight/spike (2.94 and 2.88 g), 1000-grains weight (50.23 and 46.23 g), biological yield/fed (4284.3 and 4098.7 kg) and total grain yield/fed (1681.2 and 1533.5 ton/fed) during 2012/2013 and 2013/2014 seasons respectively.

On the other hand, the highest value of an average number of grains/spike (82.77 and 80.44 grains/spike) was recorded with sowing Seds-12 wheat variety provided its 10 ton/fed of the supported compost and treated by T3 microbial treatment during the previous season.

Table 4. Effect of some, supported compost rates and microbial treatments on an average number of spike/m^2 of Misr-1 and Seds-12 wheat varieties as well as the interaction effects between them in 2012/2013 and 2013/2014 seasons.

Seasons		2012/2013						2013/2014					
Varieties (V)	Compost (C)	Microbial treatments (T)					Mean (V × C)	Microbial treatments (T)					Mean (V × C)
		T1	T2	T3	T4	T5		T1	T2	T3	T4	T5	
	8 tons/Fed (C1)	340.63	325.30	346.80	324.83	250.43	317.60	327.37	312.57	333.27	312.17	240.67	305.2
Misr-1	10 tons/Fed (C2)	365.23	363.20	372.40	324.30	273.00	339.63	350.97	349.03	357.87	311.63	262.33	326.37
	12 tons/Fed (C3)	356.33	359.10	358.07	344.73	253.50	334.35	336.23	344.10	345.07	331.27	243.63	320.06
Mean V × T		354.07	349.20	359.09	331.29	258.98	330.52	338.19	335.23	345.40	318.36	248.88	317.21`
	8 tons/Fed (C1)	289.40	301.70	320.13	299.63	223.80	286.93	278.13	289.93	307.63	287.93	215.03	275.73
Seds-12	10 tons/Fed (C2)	350.90	341.70	349.87	319.13	256.27	323.57	337.23	328.33	324.43	306.63	246.27	308.57
	10 tons/Fed (C3)	293.73	305.80	348.83	290.40	267.87	301.33	282.27	293.83	335.23	279.07	257.43	289.57
Mean V × T		311.34	316.40	339.61	303.06	249.31	303.94	299.21	304.03	322.43	291.21	239.58	292.49
Mean of T		332.71	332.80	349.35	317.17	254.14		318.70	319.63	336.92	304.78	244.23	
Mean C × T													
C1		315.02	313.50	333.47	312.23	237.12	302.27	302.75	301.25	320.45	300.05	227.85	290.47
C2		358.07	352.45	361.13	321.72	264.63	331.60	344.10	338.68	350.15	309.13	254.30	319.27
C3		325.03	332.45	353.45	317.57	260.68	317.84	309.25	318.97	340.15	305.17	250.53	304.81
L.S.D 0.05			V	6.32						6.06			
			C	1.92						1.85			
			T	2.49						2.39			
			V × C	2.71						2.62			
			V × T	3.52						3.38			
			C × T	4.31						4.14			
			V × C × T	6.10						5.86			

T1 = Supported compost + *Trichoderma*; **T2** = Supported compost + *Bacillus subtilis*; **T3** = Supported compost + *Trichoderma* + *Bacillus subtilis*; **T4** = Supported compost; **T5** = Compost without microbial treatment.

Table 5. Effect of some, supported compost rates and microbial treatments on average spike weight (g) of Misr-1 and Seds-12 wheat varieties as well as the interaction effects between them in 2012/2013 and 2013/2014 seasons.

Seasons		2012/2013						2013/2014					
Varieties (V)	Compost (C)	Microbial treatments (T)					Mean	Microbial treatments (T)					Mean
		T1	T2	T3	T4	T5	(V × C)	T1	T2	T3	T4	T5	(V × C)
Misr-1	8 tons/Fed (C1)	2.86	2.81	2.92	2.76	2.72	2.82	2.76	2.71	2.84	2.66	2.64	2.71
	10 tons/Fed (C2)	3.69	3.62	3.93	3.60	2.73	3.51	3.55	3.49	3.79	3.47	2.63	3.38
	12 tons/Fed (C3)	3.18	3.09	3.34	3.01	2.74	3.07	3.06	2.79	3.22	2.90	2.64	2.96
Mean V × (T)		3.24	3.17	3.41	3.12	2.73	3.13	3.12	3.06	3.28	3.01	2.63	3.02
Seds-12	8 tons/Fed (C1)	2.75	2.75	2.79	2.69	2.65	2.72	2.65	2.65	2.68	2.59	2.55	2.62
	10 tons/Fed (C2)	3.38	2.80	3.45	2.76	2.67	3.01	3.25	2.70	3.32	2.66	2.57	2.90
	12 tons/Fed (C3)	2.80	2.79	2.99	2.76	2.67	2.80	2.69	2.69	2.88	2.66	2.57	2.70
Mean V × (T)		2.97	2.78	3.07	2.74	2.66	2.85	2.86	2.68	2.96	2.64	2.56	2.74
Mean of (T)		3.11	2.98	3.24	2.93	2.69		2.99	2.87	3.12	2.82	2.59	
Mean of C × (T)													
C1		2.81	2.78	2.87	2.72	2.68	2.77	2.70	2.68	2.76	2.62	2.58	2.67
C2		3.53	3.21	3.69	3.18	2.70	3.26	3.40	3.09	3.55	3.07	2.60	3.14
C3		2.99	2.94	3.17	2.89	2.71	2.94	2.88	2.83	3.05	2.78	2.60	2.83
L.S.D 0.05		V		0.07						0.06			
		C		0.08						0.07			
		(T)		0.09						0.09			
		V × C		0.11						0.10			
		V × (T)		0.12						0.12			
		C × (T)		0.15						0.15			
		V × C × (T)		0.22						0.21			

T1 = Supported compost + *Trichoderma*; **T2** = Supported compost + *Bacillus subtilis*; **T3** = Supported compost + *Trichoderma* + *Bacillus subtilis*; **T4** = Supported compost; **T5** = Compost without microbial treatment.

Table 6. Effect of some, supported compost rates and microbial treatments on an average number of grains/spike of Misr-1 and Seds-12 wheat varieties as well as the interaction effects between them in 2012/2013 and 2013/2014 seasons.

Seasons		2012/2013						2013/2014					
Varieties (V)	Compost (C)	Microbial treatments (T)					Mean	Microbial treatments (T)					Mean
		T1	T2	T3	T4	T5	(V × C)	T1	T2	T3	T4	T5	(V × C)
Misr-1	8 tons/Fed (C1)	50.77	47.99	52.44	48.21	44.44	48.77	44.77	45.66	42.94	47.66	40.77	44.36
	10 tons/Fed (C2)	70.33	69.99	71.44	51.44	46.21	61.88	52.88	50.44	52.99	45.99	42.33	48.92
	12 tons/Fed (C3)	53.33	54.21	55.10	48.55	51.10	52.46	50.88	49.88	51.77	46.66	41.55	48.15
Mean V × T		58.14	57.40	59.66	49.40	47.25	54.37	49.51	48.66	49.23	46.77	41.55	47.14
Seds-12	8 tons/Fed (C1)	55.88	57.44	64.10	61.99	45.21	56.92	51.44	52.10	52.33	42.99	41.99	48.17
	10 tons/Fed (C2)	77.77	75.88	82.77	72.55	50.77	71.95	72.21	64.10	80.44	55.99	44.10	63.37
	10 tons/Fed (C3)	75.88	62.44	74.20	55.21	49.44	63.43	45.33	52.77	61.10	51.21	41.99	50.48
Mean V × T		69.84	65.25	73.69	63.25	48.47	64.10	56.33	56.32	64.62	50.07	42.70	54.61
Mean of T		63.99	61.32	66.67	56.32	47.86		54.42	52.49	56.93	48.42	42.12	
Mean C × T													
C1		53.32	52.71	58.27	55.10	44.82	52.85	48.10	48.88	47.63	45.33	41.38	46.26
C2		74.05	72.94	77.10	61.99	48.49	66.91	62.55	57.27	66.71	50.99	43.21	56.15
C3		64.60	58.32	64.56	51.88	50.27	57.95	52.60	51.32	56.44	48.94	41.77	50.21
L.S.D 0.05			V	2.88						1.16			
			C	2.10						1.40			
			T	2.51						1.49			
			V × C	Ns						1.98			
			V × T	3.55						2.10			
			C × T	4.34						2.57			
			V × C × T	6.14						3.64			

T1 = Supported compost + *Trichoderma*; **T2 =** Supported compost + *Bacillus subtilis*; **T3 =** Supported compost + *Trichoderma* + *Bacillus subtilis*; **T4 =** Supported compost; **T5 =** Compost without microbial treatment.

Table 7. Effect of some, supported compost rates and microbial treatments on average grain weight/spike (g) of Misr-1 and Seds-12 wheat varieties as well as the interaction effects between them in 2012/2013 and 2013/2014 seasons.

Seasons		2012/2013						2013/2014					
Varieties (V)	Compost (C)	Microbial treatments (T)					Mean	Microbial treatments (T)					Mean
		T1	T2	T3	T4	T5	(V × C)	T1	T2	T3	T4	T5	(V × C)
Misr-1	8 tons/Fed (C1)	1.98	1.94	1.98	1.79	1.51	1.84	1.88	1.84	1.96	1.81	1.40	1.78
	10 tons/Fed (C2)	2.74	2.66	2.94	2.63	1.57	2.51	2.59	2.39	2.88	1.99	1.44	2.26
	12 tons/Fed (C3)	2.19	2.19	2.34	1.87	1.55	2.03	2.09	2.00	2.34	1.74	1.40	1.92
Mean V × (T)		2.30	2.26	2.42	2.10	1.55	2.13	2.19	2.08	2.39	1.85	1.42	1.98
Seds-12	8 tons/Fed (C1)	1.68	1.57	1.77	1.45	1.39	1.57	1.58	1.79	1.76	1.42	1.13	1.54
	10 tons/Fed (C2)	2.08	2.04	2.17	1.85	1.41	1.91	1.97	1.97	2.04	1.77	1.43	1.84
	12 tons/Fed (C3)	1.68	1.58	1.77	1.45	1.39	1.58	1.64	1.53	1.62	1.51	1.46	1.55
Mean V × (T)		1.82	1.73	1.91	1.59	1.40	1.69	1.73	1.77	1.81	1.57	1.34	1.64
Mean of (T)		2.06	2.00	2.16	1.84	1.47		1.96	1.92	2.10	1.71	1.38	
Mean of C × (T)													
C1		1.83	1.76	1.88	1.62	1.45	1.71	1.73	1.82	1.86	1.61	1.27	1.66
C2		2.41	2.35	2.55	2.24	1.49	2.2.1	2.28	2.18	2.46	1.88	1.43	2.05
C3		1.94	1.89	2.02	1.66	1.47	1.80	1.86	1.77	1.98	1.63	1.43	1.73
L.S.D 0.05		V		0.04						0.01			
		C		0.03						0.00			
		(T)		0.03						0.00			
		V × C		0.04						0.01			
		V × (T)		0.05						0.00			
		C × (T)		0.06						0.01			
		V × C × (T)		0.08						0.01			

T1 = Supported compost + *Trichoderma*; **T2** = Supported compost + *Bacillus subtilis*; **T3** = Supported compost + *Trichoderma* + *Bacillus subtilis*;
T4 = Supported compost; **T5** = Compost without microbial treatment.

Table 8. Effect of some, supported compost rates and microbial treatments on average 1000 grain weight (g) of Misr-1 and Seds-12 wheat varieties as well as the interaction effects between them in 2012/2013 and 2013/2014 seasons.

Seasons		2012/2013						2013/2014					
Varieties (V)	Compost (C)	Microbial treatments (T)					Mean	Microbial treatments (T)					Mean
		T1	T2	T3	T4	T5	(V × C)	T1	T2	T3	T4	T5	(V × C)
Misr-1	8 tons/Fed (C1)	41.23	41.76	42.06	41.13	32.70	39.78	37.96	38.40	38.66	37.80	30.06	36.58
	10 tons/Fed (C2)	46.83	46.83	50.23	46.50	34.53	44.98	43.06	43.06	46.23	42.76	31.76	41.38
	12 tons/Fed (C3)	44.60	44.96	45.30	44.66	30.90	42.08	41.03	41.36	41.66	41.10	28.43	38.72
Mean V × (T)		44.22	44.52	45.86	44.10	32.71	42.28	40.68	40.96	42.18	40.55	30.08	38.89
Seds-12	8 tons/Fed C1)	39.13	36.90	39.86	38.23	29.90	36.80	36.00	33.96	36.63	35.16	27.50	33.58
	10 tons/Fed (C2)	45.80	42.76	46.33	39.93	34.53	41.87	42.10	39.33	42.63	36.70	31.76	38.50
	12 tons/Fed (C3)	40.23	39.83	42.76	38.33	35.66	39.36	36.96	36.66	39.33	35.24	32.83	36.20
Mean V × (T)		41.72	39.83	42.98	38.83	33.36	39.34	38.35	36.35	39.53	35.70	30.70	36.18
Mean of (T)		42.97	42.17	44.42	41.46	33.03		39.52	38.80	40.86	38.12	30.39	
Mean of C × (T)													
C1		40.81	39.33	40.96	39.68	31.30	38.29	36.98	36.18	37.65	36.48	28.78	35.21
C2		46.31	44.80	48.28	43.21	34.53	43.43	42.58	41.20	44.43	39.73	31.76	39.94
C3		42.41	42.40	44.03	41.50	33.28	40.72	39.00	39.01	40.50	38.16	30.63	37.46
L.S.D 0.05		V		0.33						0.30			
		C		0.91						0.78			
		(T)		0.77						0.70			
		V × C		ns						ns			
		V × (T)		1.09						0.99			
		C × (T)		1.34						1.21			
		V × C × (T)		1.89						1.71			

T1 = Supported compost + *Trichoderma*; **T2** = Supported compost + *Bacillus subtilis*; **T3** = Supported compost + *Trichoderma* + *Bacillus subtilis*;
T4 = Supported compost; **T5** = Compost without microbial treatment.

Table 9. Effect of some, supported compost rates and microbial treatments on average biological yield (kg) of Misr-1 and Seds-12 wheat varieties as well as the interaction effects between them in 2012/2013 and 2013/2014 seasons.

Seasons		2012/2013						2013/2014					
Varieties (V)	Compost (C)	Microbial treatments (T)					Mean	Microbial treatments (T)					Mean
		T1	T2	T3	T4	T5	(V × C)	T1	T2	T3	T4	T5	(V × C)
Misr-1	8 tons/Fed (C1)	2712.7	2825.1	3050.9	2839.7	2655.3	2816.7	3179.9	3179.4	3193.9	3086.3	2796.7	3087.3
	10 tons/Fed (C2)	3974.8	3786.8	4284.3	3607.3	2661.5	3662.9	3820.7	3795.3	4098.7	3777.2	2990.9	3696.5
	12 tons/Fed (C3)	3268.7	3167.2	3306.1	3156.9	2591.9	3098.2	3504.5	3503.4	3736.6	3427.9	2938.4	3422.2
Mean V × (T)		3318.7	3259.7	3547.1	3201.3	2636.2	3192.6	3501.7	3492.7	3676.4	3430.5	2908.7	3402.0
Seds-12	8 tons/Fed (C1)	2714.0	2661.6	2696.9	2636.2	2459.8	2633.7	2978.2	3019.2	3014.0	2967.1	2642.3	2924.2
	10 tons/Fed (C2)	3306.6	2892.4	3455.5	2651.0	2495.5	2960.2	3752.1	3175.2	3766.0	2974.2	2655.9	3264.7
	12 tons/Fed (C3)	2902.9	2810.8	3087.1	2732.9	2585.0	2823.7	3069.8	3127.6	3199.8	3089.8	2845.9	3066.6
Mean of V × (T)		2974.5	2788.3	3079.8	2673.4	2513.4	2805.9	3266.7	3107.3	3326.6	3010.3	2714.7	3085.1
Mean of (T)		3146.6	3024.0	3313.5	2937.3	2574.8		3384.2	3300.0	3501.5	3220.4	2811.7	
Mean of C × (T)													
C1		2713.3	2743.3	2873.9	2737.9	2557.5	2725.2	3079.1	3099.3	3104.0	3026.7	2719.5	3005.7
C2		3640.7	3339.6	3869.9	3129.2	2578.5	3311.6	3786.4	3485.3	3932.3	3375.7	2823.4	3480.6
C3		3085.8	2989.0	3196.6	2944.9	2588.4	2960.9	3287.1	3315.5	3468.2	3258.8	2892.2	3244.4
L.S.D 0.05			V	114.3					97.1				
			C	48.7					41.6				
			(T)	26.1					23.6				
			V × C	68.8					58.9				
			V × (T)	37					33.3				
			C × (T)	45.3					40.8				
			V × C × (T)	64.1					57.8				

T1 = Supported compost + *Trichoderma*; **T2** = Supported compost + *Bacillus subtilis*; **T3** = Supported compost + *Trichoderma* + *Bacillus subtilis*; **T4** = Supported compost; **T5** = Compost without microbial treatment**.**

Table 10. Effect of some, supported compost rates and microbial treatments on average grain yield (kg) of Misr-1 and Seds-12 wheat varieties as well as the interaction effects between them in 2012/2013 and 2013/2014 seasons.

Seasons		2012/2013						2013/2014					
Varieties (V)	Compost (C)	Microbial treatments (T)					Mean	Microbial treatments (T)					Mean
		T1	T2	T3	T4	T5	(V × C)	T1	T2	T3	T4	T5	(V × C)
Misr-1	8 tons/Fed (C1)	1397.0	1405.1	1452.3	1425.9	1364.3	1408.9	1134.0	1098.8	1139.8	1078.7	1025.4	1095.3
	10 tons/Fed (C2)	1595.6	1581.1	1681.2	1528.3	1365.3	1550.3	1514.9	1480.5	1533.5	1478.7	1038.9	1409.3
	12 tons/Fed (C3)	1482.0	1480.4	1484.9	1476.5	1353.9	1455.6	1296.6	1227.8	1313.3	1226.0	1021.9	1217.1
Mean V × (T)		1491.5	1488.9	1539.5	1476.9	1361.2	1471.6	1315.2	1269.1	1328.9	1261.1	1028.7	1240.6
Seds-12	8 tons/Fed (C1)	1442.1	1373.1	1381.1	1362.0	1342.8	1380.2	1056.5	1031.6	1120.4	928.5	868.7	1001.1
	10 tons/Fed (C2)	1496.5	1473.5	1506.0	1363.1	1350.7	1437.9	1330.0	1201.3	1410.3	1059.6	970.9	1194.4
	12 tons/Fed (C3)	1448.3	1399.6	1456.4	1408.4	1350.8	1412.7	1060.6	1125.2	1210.1	1050.0	1012.3	1091.7
Mean V × (T)		1462.3	1415.4	1447.8	1377.8	1348.1	1410.3	1149.0	1119.4	1246.9	1012.7	950.7	1095.7
Mean of (T)		1476.9	1452.1	1493.6	1427.4	1354.6		1232.1	1194.2	1287.9	1136.9	989.7	
Mean of C × (T)													
C1		1419.6	1389.1	1416.7	1393.9	1353.5	1394.6	1095.2	1065.2	1130.1	1003.6	947.1	1048.2
C2		1546.0	1527.3	1593.6	1445.7	1358.0	1494.1	1422.4	1340.9	1471.9	1269.2	1004.9	1301.9
C3		1465.1	1440.0	1470.7	1442.5	1352.4	1434.1	1178.6	1176.5	1261.7	1138.0	1017.1	1154.4
L.S.D 0.05			V	17.3						35.7			
			C	7.5						17.5			
			(T)	5.1						9.1			
			V × C	10.6						24.8			
			V × (T)	7.1						12.8			
			C × (T)	8.7						15.7			
			V × C × (T)	12.3						22.2			

T1 = Supported compost + *Trichoderma*; **T2** = Supported compost + *Bacillus subtilis*; **T3** = Supported compost + *Trichoderma* + *Bacillus subtilis*; **T4** = Supported compost; **T5** = Compost without microbial treatment.

4. Discussion

The results of present investigation showed that organic fertilizer applications and microbial inoculations improved growth and yield of wheat. The results are comparable to those of Jala-Abadi *et al.*, (2012) and Badr *et al.*, (2009), who reported that the application of organic manure and biofertilizer led to increasing the grain yield, biological yield, harvest index, 1000-grain weight and chlorophyll content. Moreover, Shahaby *et al.*, (2000) mentioned that plants amended with biogas manure together with inoculation developed well and showed better appearance than those supplied only with N fertilizer.

There are often different responses among varieties to inoculation treatments, therefore, the mentioned results was in agreement with the finding of Sangwan *et al.*, (2012), who observed that wheat varieties were varied significantly in its response to inoculation. Similarly, Milošević *et al.,* (2012) who assessed the inoculation effect on two wheat varieties. They reported that the tested cultivars significantly differed on wheat seed quality (germination energy and percentage), yield and 1000-seed weight. Also, the study results of Zaki *et al.*, (2007) showed that wheat cultivars significantly affected yield and its components except harvest index on its response to biofertilizers. In the same trend, wheat varieties are responding differently to organic fertilizer. However, our results contrast with those of Hossain *et al.,* (2002), which showed that the two tested wheat varieties did not vary significantly under different levels of organic and chemical fertilizers with respect to plant height, length of spike. Meanwhile, our finding was similar in the number of grains/spike, 1000-grains weight, grain yield and protein content, which wheat varieties differed significantly to organic fertilizer response.

Also, similar results for number of spikes/m^2 were observed in plants fed by 30 m^3/fed of sheep manure (Badr *et al.*, 2009). Moreover, El-Hamdi *et al*., (2012); Yousefi and Sadeghi (2014) and Zahoor (2014), showed that the combination of compost and biofertilizer along or with nitrogen application improved number of spikes/m^2. The treatment of *B. subtilis* and *T. harzianum* were best treatments to increase the number of spikes (Moubarak and Abdel-Monaim, 2011).

Grain yield is one of the significant parameters between yield and yield components. The application of organic materials (Barzegar *et al*., 2002; Sarwar *et al*., 2007; Ibrahim *et al*., 2008; Badr *et al*., 2009; Abedi *et al*., 2010 and Ahmed *et al.*, 2015), enriched compost (Akhtar *et al*., 2007), application of organic manure and biofertilizer (Jala-Abadi *et al.,* 2012 and Youssef *et al*., 2013) and compost inoculated with *T. viride* and *A. chroococcum* (Chauhan and Thakur, 2012) significantly increased wheat yield. In addition, application of *T. harzianum* with the coating of wheat grains with *B. subtilis* is a promising approach (Atef, 2008).

1000-grain weight was increased with microbial inoculation and application of supported compost. Our findings were supported by Sarwar *et al.,* (2007); Ibrahim *et al*., (2008); Badr *et al.*, (2009); Agamy *et al*., (2012); Ahmed *et al*., (2012); Jala-Abadi *et al.,* (2012); Youssef *et al.,* (2013); Zahoor (2014); Ahmed *et al*., (2015). However, our results were in contrast with the obtained results by Kabesh *et al*., (2008) and Islam *et al.*, (2015), who reported that, no significant difference between bio-organic fertilization for a 1000 grain weight.

Biological yield per fed was increased with application of organic fertilizer, the mentioned results were supported by Badr *et al*., (2009) and Ahmed *et al*., (2015). Moreover, Jala-Abadi *et al.*, (2012); Youssef *et al*., (2013) indicated that application of organic manure and biofertilizer led to increasing the biological yield. Also, microbial inoculation had a positive effect on biological yield (Rajaee *et al.*, (2007); Esmailpour *et al*., (2012) and Namvar and Khandan (2013). However, Bahrani *et al*., reported that biological yield was only affected by chemical fertilizer.

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