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EFFECT OF MICROBIAL ADDITIVES AND COMPOST TEA ON GROWTH AND PRODUCTIVITY OF WHEAT PLANTS FERTILIZED BY MINERAL NITROGEN IN SANDY SOIL

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ABSTRACT: ***Because of widespread criticisms of extensive usage of the synthetic agrochemicals, the most research papers have an interest in the clean and sustainable agricultural practices with attention in resurgence environmental health. A field experiment was conducted in the sandy soil during winter season of 2015/2016 at experimental farm, ARC, Ismaillia Governorate, Egypt to study the effect of biological (microbial additives), organic (compost tea) fertilization and their combination on rhizosphere properties, growth and productivity of wheat crop under different levels of mineral nitrogen fertilizer. The microbial additive was applied as consortium of Serratia marcescens, Pseudomonas fluorescens, Azorhizobium caulinodans and Paenibacillus polymyxa, which cultured on commercial medium. Compost tea was used as organic fertilizer while nitrogen levels were applied at a rate of 50, 75 or 100 kg N /fed. The experimental treatments were planned in a one way randomized complete block design with three replicates. The obtained data showed that the rhizosphere activity of wheat plants was enhanced due to the addition of microbial additives in combined with compost tea and high dose of nitrogen fertilizer. Wheat plants exhibited significant responses to studied treatments with respect to vegetative growth, total nutrients content, wheat yield and yield attributes. The application of combination of microbial additives and compost tea with 75 kg N/fed revealed optimum treatment in terms of vegetative growth, total nutrients content, wheat yield and yield components.***

Key words: ***Bioorganic fertilizers, Compost tea, Microbial activity, Mineral nitrogen fertilizer, Wheat.***

INTRODUCTION

In recent years, because of widespread criticisms of extensive usage of the synthetic agrochemicals, the most research papers have an interest in the clean and sustainable agricultural practices with attention in resurgence environmental health. To achieve such approach, there is an increase interest in the dependence on biofertilizers and/or organic fertilizers as an alternative to or at least reduce the reliance on synthetic fertilizers or chemicals.

The rhizosphere concept was elaborated in 1904 by Lorenze Hiltner and progressively reported as a hot spot of microbial activities in response to the plant's roots exudates or rhizodeposits (Bakker *et al.,* 2013 and Reinhold-Hurek *et al.,* 2015). Ever since then, the prospect interactions between the roots and microorganisms have an attention by various disciplines resulted in elaboration many terms of the beneficial microbes act in the plant root zone. Plant growth-promoting rhizobacteria (PGPR) were first coined by Kloepper and Schroth (1978) to describe soil bacteria that colonize the roots of plants following inoculation onto seeds, and that enhance plant growth. Plant growth promoting and bio-protecting rhizobacteria (PGPBR); plant health promoting rhizobacteria (PHPR), yield increasing bacteria (YIB) or plant growth promoting and bioprotecting rhizobacteria (PGPBR) also have been described by many authors (Chen *et al.,* 1996; Luz, 2001 and Reimann and Sikora, 2003). According to Ahmad *et al.* (2011) the rhizosphere effect is about 0-2 mm from the root surface by which the soil significantly influenced as nearly 49% of all photosynthetically fixed carbon being transferred to the rhizosphere through root exudates which stimulate microbial proliferation.

Compost tea as a popular one of the compost derivatives are considered the active form of organic matter, where the compost is steeped in water for a period of time with or without additives that are intended to increase microbial population densities (Scheuerell and Mahaffee, 2002). Thus, the purpose of compost steeping is transferring soluble organic matter, beneficial microorganisms, microbial metabolites as well as macro- and micronutrients into a solution of compost tea. Compost tea could applied as a foliar spray or soil drench. It has been demonstrated to improve soil health, plant yield and nutritional quality by various mechanisms including enhancement of beneficial microbial communities and their activities on agricultural soils and plants; improving mineral nutrient status of plants and/or inducing the production of plant defense compounds that may have beneficial bioactivities in humans (Pant *et al.,* 2009; El-Gizawy *et al.,* 2013; Kim et al., 2015 and Fouda and Ali, 2016). However, most of research studies have been target the potential of compost tea for control of plant disease with little work has been done to investigate the effect of combination between microbial additives and compost tea on yield and nutritional quality of cereal crops by way of stimulate the nutrient use efficiency mechanism.

The object of the current study is to investigate the effect of biological, organic fertilizers and their combination under mineral nitrogen fertilization levels on the growth and productivity of wheat plants in sandy soil

MATERIALS AND METHODS

Microbial additive:

The microbial additives of plant growth promoting rhizobacteria (PGPRs) namely *Serratia marcescens* (strain WW4)*, Pseudomonas fluorescens* (strain IFO. 2034)*, Azorhizobium caulinodans* (strain IRBG-314) and *Paenibacillus polymyxa* (local isolate) were supplied by Microbiology Department, Soils, Water and Environment Research Institute (SWERI), Agricultural Research Center (ARC), Giza, Egypt. Peptone glycerol broth (Grimont and Grimont, 2006), nutrient broth, King's-B broth (Atlas, 2010) and TGYE broth (Ladha *et al.,* 1989) were used as basal media for cultivation of *S. marcescens, P. polymyxa, P. fluorescens* and *A. caulinodans,* respectively. Each bacterial culture was incubated at 28ºC for 3 days on rotatory shaker. Afterwards, mixture of PGPRs inoculants formulated of equal portions from the abovementioned microbial cultures and grown on commercial media composed of 5 g/l maize gluten, 0.2 g/l yeast extract, 10 ml glycerol, 0.5g/l KH_2PO_4; 0.2 g/l $MgSO_4.7H_2O$ and 0.1 g/l NaCl. The consortium of PGPRs was incubated at 28ºC for three days on rotatory shaker before usage.

Compost Tea:

Aerated compost tea was prepared using matured compost made from rice straw mixed with farmyard manure, rock phosphate, feldspar, bentonite, urea and elemental sulfur at rates of 100, 50, 50, 100, 10 and 10 kg /ton rice straw respectively as well as vinasse rates of 1 l/ton rice straw which had been composted in an aerobic heap for four months. Some properties of compost are shown in Table (1).

Table 1: Some properties of compost

Property	Unit	Value
pH (1:10)	-	7.2
EC (1:10)	dS m^{-1}, 25°C	5.32
Organic carbon	%	37.81
Organic matter	%	65.03
Total nitrogen	%	1.24
Ammonium nitrogen	mg kg^{-1}	373.23
Nitrate nitrogen	mg kg^{-1}	112.51
Total Available -N	mg kg^{-1}	485.74
Available-P	mg kg^{-1}	258.61
Available-K	mg kg^{-1}	783.73
E_4/E_6 ratio (in aqueous extract)	-	3.52
Total count of bacteria	(cfu/g)	4.2 X 10^6
Total count of fungi	(cfu/g)	1.8 X 10^4
Total count of actinomycetes	(cfu/g)	2.5 X 10^5
**Germination test of cress seeds	%	92

E_4/E_6: Extinction coefficient is optical densities of compost aqueous extract (1:10) measured at 465 (E4) and 665 nm (E6) wavelengths.
**cress seeds incubated for 48 hrs.

To prepare compost tea, fifteen kg of mature compost (in 150 L plastic barrel) blended with 100 L tap water (previously stored for 24 hrs. to avoid the harmful effect of chlorine on microbial load of compost) and some chemical additives, namely 0.5 l vinasse, 0.5 kg sucrose, 0.5 kg $(NH_4)_2SO_4$, 25g $MgSO_4.7H_2O$, 250 ml humic substances and 10 g NaCl. This mixture was thoroughly aerated for three days with using air compressor connected with drill PVC pipe dipped in the barrel. After the brewing period was elapsed, the mixture was filtered on a 100-mesh screen to become ready to use. The procedure and methods of analysis for compost or compost tea were followed as described by Page *et al.* (1982). The main characters of produced compost tea are shown in Table (2).

Experimental design and management:

A field experiment was conducted in the sandy soil at Ismaillia Experimental Research Station, ARC, Ismaillia Governorate, Egypt during winter season of 2015/2016 to study the effect of individual and combined applications of microbial additives, compost tea (bioorganic fertilizers) on growth and productivity of wheat crop (*Triticum aestivum* cv. Giza 168) under different levels of mineral nitrogen fertilizer using sprinkler irrigation system. Some physiochemical and biological characteristics of used soil were carried

out according to methods of Page *et al.* (1982) and the obtained data are recorded in Table (3).

The experiment was planned in a one way randomized complete blocks design with three replicates at plot area of 21 m^2 as an experimental unit. All experimental units received mature compost (Table 1) at a rate of 10 ton/fed, the recommended dose of phosphorus (200 kg/fed superphosphate "15.5% P_2O_5") and potassium (١٠٠ kg/fed potassium sulphate "48% K_2O"). Also, mineral nitrogen fertilizer was added at a rate of 50, 75 and 100 kg N per fed in the form of ammonium sulphate (20.5 % N) in four equal splits at 10, 20, 3٠ and 40 days after sowing. Phosphorus and compost were added during soil preparation, while potassium was added after 15 and 30 days of sowing in equal two doses. The microbial additives and compost tea were applied as foliar spray and soil drench at a rate of ١٥ and 75 L/fed (11.25 kg compost per 75 liter), respectively, in three equal splits 30, 45 and 60 days after sowing. The treatments were arranged as the following:

T1= Recommended nitrogen (100 kg N/fed).
T2 = Microbial additives + 50 kg N/fed.
T3 = Microbial additives + 75 kg N/fed.
T4 = Microbial additives + 100 kg N/fed.
T5 = Compost tea + 50 kg N/fed.
T6 = Compost tea + 75 kg N/fed.
T7 = Compost tea + 100 kg N/fed.
T8 = Microbial additives + compost tea + 50 kg N/fed.
T9 = Microbial additives + compost tea + 75 kg N/fed.
T10= Microbial additives + compost tea + 100 kg N/fed.

Table 2: Some properties of compost tea

Property	Unit	Compost tea
pH	-	6.85
EC	dS/m, 25°C	3.35
Organic carbon	%	5.80
Organic matter	%	9.98
Ammonium nitrogen	mg/l	102.8
Nitrate nitrogen	mg/l	24.60
Total soluble-N	mg/l	127.4
Soluble-P	mg/l	38.60
Soluble-K	mg/l	312.0
E_4/E_6 ratio (in aqueous extract)	-	3.92
Total count of bacteria	cfu/ml	6.3×10^7
Total count of fungi	cfu/ml	5.1×10^4
Total count of actinomycetes	cfu/ml	1.6×10^6
**Germination test of cress seeds	%	94

E_4/E_6: Extinction coefficient is optical densities of compost tea measured at 465 (E4) and 665 nm (E6) wavelengths
****cress seeds incubated for 48 hrs.**

Table 3: Some physiochemical and biological characteristics of used soil

Property	Value
Mechanical analysis:	
Sand %	90.30
Silt %	4.90
Clay %	4.80
Texture grade	Sandy
Saturation percent (S.P. %)	21.13
$CaCO_3$ (%)	1.72
pH (soil paste)	7.57
EC (dS/m, 25^oC)	0.32
Soluble cations (meq/L):	
Ca^{++}	0.84
Mg^{++}	0.52
Na^{+}	1.51
K^{+}	0.15
Soluble anions (meq/L):	
$CO^{=}_3$	0.00
HCO^{-}_3	1.72
Cl^{-}	0.68
$SO^{=}_4$	0.62
Organic matter %	0.31
Total nitrogen %	0.03
Total soluble- N (mg kg^{-1})	16.23
Available phosphorus (mg kg^{-1})	5.90
Available potassium (mg kg^{-1})	58.70
DTPA-extractable (mg kg^{-1}):	
Fe	2.30
Mn	0.50
Zn	0.60
Cu	0.22
Dehydrogenase enzymes (mg TPF/g dry soil/day)	18.43
Total count of bacteria log N. (cfu/g dry soil)	4.86
Total count of fungi log N. (cfu/g dry soil)	3.56
Total count of actinomycetes log N. (cfu/g dry soil)	4.11

DTPA: Di-ethylene tri-amine penta acetic acid.

Rhizosphere analysis:

After 80 days from sowing, the plants uprooted and samples of rhizosphere soil was obtained by gently shaking the roots with adhering soil to free them from the mass of soil. The rhizosphere and bulk soil were collected and stored at 4ºC for microbiological analysis.

The microbial activity in the rhizosphere soil was assayed by measuring the dehydrogenase enzymes based on the reduction of 2,3,5-triphenyltetrazolium chloride (TTC) to the red-colored formazan (TPF) according to Casida (1977)

To estimate the total number of soil bacteria, counts were calculated based on serial 10-fold dilutions using the pour plate method. The bacteria were counted in rhizosphere and non-rhizosphere soil using soil extract agar (Atlas, 2010) and the plates were incubated at 28ºC in the dark. Colony-forming units (CFU) were recorded after one week. A numerical value for the rhizosphere: soil ratio (R/S ratio) representing microbial counts in the rhizosphere divided by the microbial counts in the non-rhizosphere soil, was used as an index of the rhizosphere effect on the microbial population.

Plant analysis:

After 80 days from sowing, wheat plants were sampled and assayed for plant height, shoot and root dry weight, root surface area and the total nutrients content (N, P and k of shoot). Root surface area was estimated using an acid adsorption method according to (Chowdhury and Weatherley, 1990) and expressed as ml equivalent of 0.01N NaOH. A wet digestion of oven dried plant (at 70ºC for 48 hrs.) material was performed using concentrated sulphuric acid and perchloric acid as a catalyst. Total nitrogen was determined using the micro Kjeldahl method, phosphorus was determined Spectrophotometrically using ammonium molybdate and stannous chloride reagents and potassium was determined using Flame photometer (Chapman and Pratt, 1961).

At harvest, plant samples were collected using a wooden frame (0.5 X 0.5 m) to record grain yield (ton/fed), straw yield (ton/fed), 1000 grain weight (g), seed crude protein (%) and straw crude protein (%). The crude protein in grains and straw were estimated by multiplying the nitrogen percent by 5.7 factor according to AOAC (1998).

Statistical analysis:

Statistical analysis of data was done by the analysis of variance (ANOVA) according to the methods described by Snedecor and Cochran (1980). Multiple comparisons of treatment means were done by least significant difference test (LSD) at $p \leq 0.05$ level. The analysis was performed using CoStat program ver. 6.4, CoHort software.

RESULTS AND DISCUSSION

Rhizosphere properties:

Data in Table (4) shows some aspects of wheat plants rhizosphere, affected by mineral nitrogen fertilization or individually and in combination with microbial additives and compost tea alone and together, as estimated in terms of dehydrogenases activity and rhizosphere effect. Dehydrogenase enzymes activity significantly increased in a progressive manner as the mineral nitrogen fertilizer increased under the treatments of microbial additives or compost tea. Under 50 or 75 kg N/fed, the added compost tea recorded higher values of dehydrogenase enzymes as compared with microbial additives. However, the combined application of microbial additives and compost tea highly boosted the microbial activity to record the highest values of dehydrogenase enzymes. The application of 75 kg N/fed with combined application

(T9) of microbial additives and compost tea revealed a non-significant variation in dehydrogenase enzymes as compared with treatments that received 100 kg N/fed. The added compost tea increased microbial activity by 14.07 and 11.87 % over microbial additives under 50 and 75 kg N/fed, respectively. While the combination between compost tea and microbial additive, the dehydrogenase values increased by 37.47 and 28.84% over microbial additives and by 20.52 and 15.17% over compost tea under 50 and 75 kg N/fed, respectively.

Table 4: Effect of microbial additives and compost tea under different levels of nitrogen on some aspects of rhizosphere properties after 80 days from sowing

Treatments \ Paramters	Dehydro-genases (mg TPF/g dry soil/day)	Total bacteria in rhizosphere (CFU/g soil X 10^6)	Total bacteria in bulk soil (CFU/g soil X 10^6)	Rhizo-sphere effect (R/S ratio)
Recommended-N (T1)	133.88b	3.67	0.34	10.75
Microbial additives (MA) + 50 Kg N/fed (T2)	88.73f	4.67	0.32	14.55
Microbial additives (MA) + 75 kg N/fed (T3)	110.41d	5.67	0.33	16.92
Microbial additives (MA) + 100 kg N/fed (T4)	139.66ab	7.00	0.35	19.97
Compost tea (CT) + 50 Kg N/fed (T5)	101.21e	5.00	0.35	14.46
Compost tea (CT) + 75 kg N/fed (T6)	123.51c	6.67	0.36	18.46
Compost tea (CT) + 100 kg N/fed (T7)	141.02ab	7.33	0.37	20.00
MA + CT + 50 kg N/fed (T8)	121.98c	6.00	0.36	16.61
MA + CT + 75 kg N/fed (T9)	142.25ab	7.67	0.37	20.72
MA + CT + 100 kg N/fed (T10)	146.64a	7.33	0.38	19.33
$LSD_{0.05}$	5.03	-	-	-

The means of the same letter are not significantly different at the 5% level according to LSD test.

Regarding the microbial count of bacteria, the total number of bacterial in the rhizosphere region exhibited highly variation as compared with that in the bulk soil. Such variation in rhizosphere bacteria positively reflected on the rhizosphere effect (R/S ration) values. The lowest value was recorded with the recommended-N treatment (T1) for rhizosphere bacteria and rhizosphere effect. The highest values were achieved due to application of 75 kg N/fed (T9) followed by treatments of 100 k N/fed with microbial activity, compost tea or combination of them.

Soil dehydrogenase enzymes are one of the main components of soil enzymatic activities that participate in all the biochemical routes of soil biogeochemical cycles for the maintenance of soil fertility (Kumar *et al.,* 2013). Compost tea is a liquid extract of compost that contains microorganisms, organic matter, nutrients and growth factors that could potentially enhance the microbial activity in the rhizosphere of

plant which indicated by high values of dehydrogenases. The obtained result in harmony with El-Gizawy *et al.* (2013) who documented that inoculation with compost and foliar compost tea applications generally enhanced the bacterial counts, dehydrogenases (DHA) and nitrogenase (N_2–ase) activities.

The ratio of rhizosphere and bulk is widely used to evaluate the degree of rhizosphere effect that could help the plant by maintaining the recycling of nutrients, through the production of hormones, helping to provide resistance to microbial diseases and to aid tolerance to toxic compounds (Morgan *et al.,* 2005 and Dotaniya and Meena, 2014). According to Momin and Dhere (2013), the high bacterial population is attributed to symbiotic and non-symbiotic association between the roots of the plants and the bacteria owing to this positive association there are more nutrients and hence the soil is more fertile and therefore the count of microorganism is very high in rhizosphere as compared to non-rhizosphere. these results support the aforementioned statement since the R/S ratio was positively correlated with the root surface area of wheat plants. Also, these findings are consistent with Guo *et al.* (2015) and Zhu *et al.* (2016) in the microbial biomass is positively correlated with soil organic carbon and total nitrogen because the evident increase in the rhizosphere bacteria due to the addition of microbial additives in combined with compost tea and high dose of nitrogen fertilizer.

Table 5: Effect of microbial additives and compost tea under different levels of nitrogen on some wheat growth parameters after 80 days from sowing

Paramters / Treatments	Plant height (cm)	Shoot Dry weight (g/plant)	Root Dry weight (g/plant)	Root surface area (ml NaOH)
Recommended-N (T1)	79.56a	3.30ab	1.28a	25.01d
Microbial additives (MA) + 50 Kg N/fed (T2)	45.11g	1.94g	0.96f	16.02fg
Microbial additives (MA) + 75 kg N/fed (T3)	63.85d	2.56d	1.15cd	20.71e
Microbial additives (MA) + 100 kg N/fed (T4)	71.79c	3.17b	1.24ab	23.22d
Compost tea (CT) + 50 Kg N/fed (T5)	52.04f	2.11f	1.05e	16.74fg
Compost tea (CT) + 75 kg N/fed (T6)	73.37bc	2.81c	1.19bc	24.02cd
Compost tea (CT) + 100 kg N/fed (T7)	74.52bc	3.23ab	1.25ab	26.11bcd
MA + CT + 50 kg N/fed (T8)	58.72e	2.38e	1.13d	17.43f
MA + CT + 75 kg N/fed (T9)	75.87abc	3.28ab	1.26a	28.37b
MA + CT + 100 kg N/fed (T10)	77.67ab	3.35a	1.27a	30.95a
$LSD_{0.05}$	5.03	0.15	0.05	2.40

The means of the same letter are not significantly different at the 5% level according to LSD test.

Morphological growth parameters of wheat plants:

Data in Table (5) shows some morphological aspects of wheat plants due to the effect of added mineral nitrogen fertilization individually and in combination with microbial additives and compost tea alone and together. The studied treatments have significant variations on the estimated growth parameters. The highest values of plants were appeared due to application of compost tea alone or its combination with microbial additives under nitrogen levels of 75 or 100 kg N/fed (T1, T10, T9, T7, T6 and T4) compared with the values resulted from the treatments of microbial additives with 50 and 75 kg N/fed of mineral nitrogen with microbial additives (T2 and T3) and also these obtained with low nitrogen level (50 kg N/fed) in combination with compost tea (T5) or with combination (T8).

Concerning the data of shoot dry weight, the obtained data show that at the rate of added mineral nitrogen the combined application of microbial additives with compost tea resulted in high values of shoots dry weight compared with their individualized applications. The shoot dry weight gradually increased with increase in nitrogen fertilizer especially with microbial additives (T2 to T4) or with compost tea treatments (T5 to T7). The applications of compost tea increased shoot dry weight by 8.76, 9.77 and 1.89% over treatments of microbial additives with additions of 50, 75 and 100 kg N/fed, respectively. With all application rates of mineral nitrogen, the combined application of microbial additives and compost tea increase the shoot dry weight by 22.68, 28.13 and 5.68% over individual microbial additives or by 12.8, 16.73 and 3.72% over the individual treatments of compost tea with 50, 75 and 100 kg N/fed, respectively.

With regard to the data of root dry weight, data in Table (5) shows that the treatment of recommend nitrogen dose (T1) recorded the maximum value with non-significant difference comparing to microbial additives (T4) and compost tea (T7) that received 100 kg N/fed or with combined treatment of microbial additives and compost tea that received 75 or 100 kg N/fed (T8 or T10). The effect of microbial additives on root dry weight gradually increased with addition of nitrogen fertilizer. With compost tea there are no significant effect on the increase in roots dry weight compared with those associated with the treatments of microbial additives especially under 75 and 100 kg N/fed.

Root surface area of wheat plants were significantly increased by application of microbial additives together with compost tea under 100 kg N/fed (T10) as compared with other treatments. The compost tea application showed higher values in the root surface area as compared with microbial additives under the same level of mineral nitrogen fertilizer. The root surface area ranged from 16.02 to 23.22 ml NaOH, 16.74 to 26.11 ml NaOH and 17.43 to 30.95 ml NaOH in the treatments of microbial additives, compost tea and combination of compost tea and microbial additives comparing with 25.01 ml NaOH for recommended-N treatment dose of nitrogen (T1) without microbial additives or compost tea.

The production of plant growth substances such as indole compounds and gibberellins by PGPRs in addition to the simulative effect of compost tea, which contains a considerable amount soluble nutrients, organic matter and growth factors, are involved in cell division and elongation in the meristmatic region of plant. Further, the accumulation of nutrients in the wheat due to the combined addition of microbial additives and compost tea that act in a synergistic mode to stimulate the uptake of nutrients, which have a vital role in synthesis of chlorophyll, enzymes, amino acids, proteins and the process of photosynthesis enhancement as well as assimilation rate for precursors of carbohydrates increased the vegetative growth organs. The obtained results are consistent with those reported by Kumar *et al.* (2015); Zewail and Ahmed (2015); Desoky and El-Sayed (2016) and Khalil and Agah (2017).

Nutrients content in wheat plants:

Data in Table (6) represent nitrogen, phosphorus and potassium uptake in the shoot as mg/plant of wheat plants treated with microbial additives, compost tea and their combination under three rates of mineral nitrogen. The nutrient uptake was significantly responded to the studied treatments for N, P and K uptake. The maximum values (mg/plant) were recorded by the treatments of 100 kg N/fed without (T1) or with bioorganic addition (T10, T7 and T4) or by treatment that received 75 kg N/fed (T8) with combined application of microbial additives and compost tea. Data also showed that with the same level of nitrogen fertilizer (50 or 75 kg N/fed) compost tea application surpassed microbial additives and significantly increased the nutrient contents except for the content of potassium. However, the combination between microbial additives and compost tea (T8 to T10) appeared a maximized stimulation effect for nutrient uptake comparing with microbial additives (T2 to T4) or compost tea (T5 to T7). Under 50 kg N/fed, the combined addition of microbial additives and compost tea increased the nitrogen, phosphorus and potassium uptake by 30.07, 24.76 and 23.22% or 12.48, 11.78 and 17.76 % over microbial additives or compost tea, respectively. The corresponding values under 75 kg N/fed were 23.39, 18.36 and 17.09% or 14.58, 9.43 and 12.82%, respectively.

Table 6: Effect of microbial additives and compost tea under different levels of nitrogen on shoot of wheat nutrient uptake (mg/plant) of shoot after 80 days from sowing

Treatments \ Paramters	Total nitrogen content (mg/plant)	Total phosphorus content (mg/plant)	Total potassium content (mg/plant)
Recommended-N (T1)	50.65a	23.71a	61.96a
Microbial additives (MA) + 50 Kg N/fed (T2)	29.10f	14.30f	39.50d
Microbial additives (MA) + 75 kg N/fed (T3)	39.93c	19.61c	53.07b
Microbial additives (MA) + 100 kg N/fed (T4)	49.18a	22.85a	59.89a
Compost tea (CT) + 50 Kg N/fed (T5)	33.65e	15.96e	41.33d
Compost tea (CT) + 75 kg N/fed (T6)	43.00b	21.21b	55.46b
Compost tea (CT) + 100 kg N/fed (T7)	49.14a	23.19a	61.40a
MA + CT + 50 kg N/fed (T8)	37.85d	17.84d	48.67c
MA + CT + 75 kg N/fed (T9)	49.27a	23.21a	62.57a
MA + CT + 100 kg N/fed (T10)	50.78a	23.55a	63.15a
$LSD_{0.05}$	1.67	1.59	3.46

The means of the same letter are not significantly different at the 5% level according to LSD test.

Structural and functional characteristics of roots contribute to rhizosphere processes and both have significant influence on the capacity of roots to acquire nutrients. Roots also interact extensively with soil microorganisms which further impact on plant nutrition either directly, by influencing nutrient availability and uptake, or indirectly through plant root growth promotion (Richardson *et al.,* 2009).

Under current study the increased total nutrients content of N, P or K could be due to the stimulation of root dry weight and root surface area (Table 5) as a result of microbial additives in addition to the stimulation effect of compost tea application at rhizosphere of wheat plants. Our findings confirm the results of Rana *et al.* (2012) and Desoky and El-Sayed (2016) whose attributed the increase of mineral content in wheat plants to the enhancement of the root growth and development due to the positive influence of microbial activity. According to Dakora and Phillips (2002), plant root exudates consist of a complex mixture of organic acid anions, phytosiderophores, sugars, vitamins, amino acids, purines, nucleosides, inorganic ions (e.g. HCO_3^-, OH^-, H^+), gaseous molecules (CO_2, H_2), enzymes and root border cells which have major direct or indirect effects on the acquisition of mineral nutrients required for plant growth. Further, Dotaniya and Meena (2014) stated that rhizospheric bacteria participate in the geochemical cycling of nutrients especially nitrogen, phosphorus and micronutrients and determine their availability for plants and enhances crop yield by increasing plant nutrient availability.

Wheat yield and its attributes:

Data in Table (7) shows the effect of bioorganic fertilization (microbial additives, compost tea and their combination) and different levels of mineral nitrogen fertilizer on wheat yield and some yield components in terms of grain yield, straw yield, 1000 grain weight seed crude protein and straw crude protein.

Table 7: Effect of microbial additives and compost tea under different levels of nitrogen on some yield parameters of wheat

Paramters / Treatments	Grain yield (ton/fed)	Straw yield (ton/fed)	1000 grain weight (g)	Seed crude protein (%)	Straw crude protein (%)
Recommended-N (T1)	1.84a	2.58ab	50.49a	13.35ab	4.51a
Microbial additives (MA) + 50 Kg N/fed (T2)	1.07f	1.28g	32.03f	8.10g	2.48d
Microbial additives (MA) + 75 kg N/fed (T3)	1.52c	1.75d	42.69c	10.45d	3.69c
Microbial additives (MA) + 100 kg N/fed(T4)	1.78a	2.45ab	49.03a	12.94b	3.90bc
Compost tea (CT) + 50 Kg N/fed (T5)	1.23e	1.44f	35.99e	9.05f	2.95d
Compost tea (CT) + 75 kg N/fed (T6)	1.64b	1.92c	45.36b	11.85c	4.58a
Compost tea (CT) + 100 kg N/fed (T7)	1.77a	2.45b	48.69a	13.12b	4.27ab
MA + CT + 50 kg N/fed (T8)	1.40d	1.59e	39.73d	9.88e	3.06d
MA + CT + 75 kg N/fed (T9)	1.80a	2.54ab	49.33a	13.04b	4.31ab
MA + CT + 100 kg N/fed (T10)	1.84a	2.59a	50.48a	13.78a	4.32ab
$LSD_{0.05}$	0.11	0.15	2.66	0.56	0.58

The means of the same letter are not significantly different at the 5% level according to LSD test.

In general, the data revealed that all yield components of wheat plants significantly responded to bioorganic and nitrogen fertilization. Irrespective of nitrogen levels all wheat yield parameters significantly responded to bioorganic fertilizers with superiority combined application of microbial additives with compost tea. On the other hand, the increase in nitrogen level within each treatment of bio-fertilizer, compost tea or combination appeared significant increments in the most of wheat yield parameters. However, the data also showed that no significant variations within the estimated growth parameters was observed between the treatments received 100 kg N/fed (T1, T4, T7 and T10) and that received 75 kg N/fed (T9) with combined application of microbial additives and compost tea. The combined treatments of microbial additives with compost tea raised up grain yield, straw yield, 100 grain weight, seed crude protein and straw crude protein under 50 kg N/fed by 30.84, 24.22, 24.04, 21.98 and 23.39% or 13.82, 10.42, 10.39, 9.17 and 3.73% over microbial additives or compost tea, respectively. The corresponding increases under 75 kg N/fed were 18.42, 45.14, 15.55, 24.78 and 16.80% or 9.76, 32.29, 8.75, 10.04 and 5.90%, respectively.

The increments in wheat grain yield and its crude protein could be attributed to the stimulation effect of microbial additives and compost tea to increase the vegetative growth organs (Table, 5) and the nutrient contents (Table, 6) in plant material. Our finding in conformity with many workers (Rana *et al.,* 2012; Desoky and El-Sayed, 2016 and El-Egami *et al.,* 2017). Furthermore, the microorganisms that introduced into microbiome of wheat plants, either by direct microbial additives or indirect via compost tea, have a vital role to prime the plant innate immune system and confer resistance to a broad spectrum of biotic stress (Martin, 2014 and Arya *et al.,* 2018) as well as could provide a fundamental support to the plants in tolerating abiotic stresses such as drought and salinization (Kumar *et al.,* 2018) which reflected on the final yield and/or yield components of wheat.

Conclusion

The obtained results indicated that microbial additives application in combination with compost tea in organic farming could be used to increase the fertilizer use efficiency in sandy soil. In view of environmental pollution, the excessive use of mineral fertilizers with high costs in the production of N, P and K fertilizers, microbial additives and compost tea tested in our study may well be suited in combination to achieve sustainable and ecological agricultural production in sandy soils. The rhizosphere effect of wheat plants was enhanced due to the addition of microbial additives in combination with compost tea. Wheat plants exhibited significant responses to various bio-organics and mineral nitrogen levels with respect to plant growth, wheat yield and yield attributes. The application of combination from microbial additives and compost tea with 75 k N/fed revealed optimum treatment under sandy soils in terms of vegetative growth, nutrients content.

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تاثير الإضافات الميكروبية و شاي الكمبوست على نمو و إنتاجية نباتات القمح المسمد بالنيتروجين المعدني في الأراضي الرملية

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الملخص العربى

أدت الانتقادات الواسعة للاستخدام المفرط للكيماويات الى الاتجاه الى الزراعة النظيفة المستدامة. تم اجراء تجربة حقلية في تربة رملية خلال الموسم الشتوى ٢٠١٥ / ٢٠١٦ لدراسة تاثير بعض الإضافات الميكروبية وشاي الكمبوست والخليط منهما في وجود مستويات مختلفة من التسميد النيتروجيني المعدني على حالة النمو وإنتاجية القمح. وكانت الاضافات الميكروبية عبارة عن خليط من مجموعة من الميكروبات هي السيرتيا والسيدموناس والازوريزوبيا والباسلس والتي تم تنميتهم واكثارهم على بيئة تجارية. بينما كانت مستويات التسميد النيتروجيني المعدني هي ٥٠ و ٧٥ و ١٠٠ كجم نيتروجين للفدان.وكان تصميم التجربة قطاعات كاملة العشوائية مع استخدام نظام الرى بالرش. وإشارت النتائج الى تحسن في المحتوى والنشاط الميكروبي في منطقة الجذور نتيجة الإضافة المشتركة من الميكروبات وشاى الكمبوست في وجود المستوى العالى من التسميد النيتروجيني المعدني. وقد استجابت نباتات القمح استجابة معنوية لكل من التسميد الحيوي والعضوي وكذلك لمستويات التسميد النيتروجيني فيما يخص النمو الخضري ومحتوى العناصر ومحصول القمح وبعض مكوناته. وعموما كانت المعاملة المثلى هي استخدام الإضافات الميكروبية مع شاى الكمبوست مع ٧٥ كجم نيتروجين للفدان والتي يوصى بها تحت ظروف الأراضي الرملية.

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