



Influence of Compost Tea and Potassium Humate on Soil Properties and Plant Growth

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Authors' contributions

This work was carried out in collaboration between both authors. Authors SEEF and EMN designed the study and wrote the protocol. Author SEEF wrote the first draft of the manuscript, managed the analyses of initial soil analysis and managed the literature searches. Author EMN managed element analysis in the plant after the experiment and performed the statistical analysis and managed the analyses of the other analyses. Both authors read and approved the final manuscript.

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ABSTRACT

An experiment was conducted during two seasons 2018/2019 and 2019/2020, cultivated with soybean, at farm Ismailia Governorate, Egypt. The aim of this study was to evaluate the effect of two treatments (potassium humate and compost tea) at different rates of (0, 2, 4 and 6 ml/L water) with two application methods (soaking and foliar application) on soil fertility and soybean productivity. In both seasons, each experiment was carried out in randomized complete blocks design with four replicates. Data showed that the lowest value of soil pH 7.87 was obtained in the soil treated with foliar application of compost tea at 6 ml/L compared with other treatments. Also, the used of potassium Humate and compost tea foliar application was significant decrease of soil salinity (EC dSm⁻¹), while soaking method was no significant for decrease soil salinity. The different rates of all treatments soaking method to soil gave significant increase of N and P available contents in soil while the foliar application was no significant. As well as, the K available in soil treated with all rates of treatments led to significant increase for soaking. The highest mean values of Fe, Mn and Zn contents in soil treated were with foliar application of compost tea. Compost tea soaking and foliar application increased soybean productivity. The highest values of all growth parameters plants *i.e.* (plant height (cm), No. of leaves/plant, No. of pods/plant, pods weight (g)/plant, seeds yield (ton/ha) and weight of 100 seed (g) were treated with potassium humate foliar application than all treatments.

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1. INTRODUCTION

Sandy soil usually have a poor properties *i.e.*, low specific surface area, low water retention, low organic matter content, low fertility and high infiltration rate. These poor physical properties cause inefficient water use [1]. The low content of clay in sandy soils usually limits humus accumulation, nutrients and water availability as well as buffering capacity, which is a reason the many of these soils become acidified. Croker et al. [2] illustrated that the increase loses of fertilizer-supplied nutrients from upper soil horizon into deeper soil layers led to low crop yields from sandy soils.

Compost tea can provide nutrients to the soil through soil drenches, Nasef et al. [3]. Shrestha et al. [4] indicated that the increase of microbial populations in soil and increase of macro-micronutrients in soil as treated with compost tea. Compost tea (water extract of solid organic compost) may contain hormones and microorganisms useful for plants and soil [5] because mineralization N of organic amendment is positively correlated with their contents of total N [6]. Compost tea can be prepared in a shorter period of time and can be applied directly onto plant surface. However, effects of compost tea are short lived and frequent and repeat applications are required to replenish plant or soil surface with nutrient and/or beneficial microbes [7]. Compost tea is a water tea of plant soluble nutrients and microorganisms from compost. Crops can directly benefit from the macro-and micronutrients found in compost tea. Foliar fertilization with compost tea allows nutrients to be absorbed by the plants directly through stomata on their leaf surfaces. [8-10] they found that, foliar application of humic acid led to positive effects on plant growth and improvement of production of garlic plant. In addition, potassium humate application led to improving plant growth parameters, yield and quality of sweet pepper.

Humic substances have been widely used for agricultural research, affecting the quality of soil as well as yield quantity. Humic acids are responsible for pH adjustment, enhancing soil cation exchange capacity and extending the survival mechanism of plants grown under stress conditions such as salinity, drought and harmful effects of toxic and heavy metal elements in the soil, [11]. Hanafy et al. [12] reported that

application of potassium humate significantly increased all the studied growth characters, *i.e.* plant height, number of leaves and branches/plant, leaf area as well as dry weight of shoots, roots and protein content of snap bean plants. Atak et al. [13] found that, humic acids as foliar treatment significantly increased yield and protein contents of common bean.

The objective of this investigation was to study the effect of compost tea and potassium humate different rates and two methods application (soaking and foliar application) on some physical and chemical soil properties and soybean production. Amino acid foliar application has been proved to be a successful strategy to promote growth of many crops grown under low fertile soils.

2. MATERIALS AND METHODS

Two field experiments were carried out in loamy sand soil at farm in Ismailia Governorate, Egypt. The study was made during successive winter seasons 2018/2019 and 2019/2020, to study the evaluation of application methods of potassium humate and compost tea different rates (0, 2, 4 and 6 ml/L) on soil chemical properties and soybean productivity in loamy sand.

The Soil samples before planting were air dried, finely ground then sieved by a 2 mm sieve and kept for analysis. Some of the physical and chemical properties of the experiment soil were estimated Cottenie et al. [14], Page et al. [15] and Klute et al. [16]. The obtained data were recorded in Table 1.

In both seasons, each experiment was carried out in randomized complete blocks design with three replicates. The area of each experimental plot was 3.5 X 3m which divided into rows with 50 cm. All farming processes were carried out before planting. Super phosphate (15.5 % P₂O₅) was applied at 200 kg /fed during tillage soil.

Chemical analysis of compost tea was done according to the standard methods described by Brunner and Wasmer, [17]. Chemical analysis of compost tea and potassium humate used is shown in Tables 2 and 3.

Soybean seeds were supplement from Agriculture Research Center, Egypt. Soaking of seeds by humic acid and compost tea were three rates (2, 4 and 6 ml/L water). Foliar application method of all treatments at rates (2, 4, and 6 ml/L) *i.e.* (800

ml/400 L water /fed; 1.600 L/ 400L water /fed and 3.60 L /400/ water /fed) after soybean sowing from 21, 45 and 65 days.

Sowing of soybean was performed on the 15th November 2016 and 2017. The seeds had been hand sown 2-3 seeds/hill of 5 cm depth and 25 cm apart. After 31 days planting the plants were thinned to one plant. Urea (46 % N) was applied as N fertilizer at rate of 40 kg N/fed on three equal doses after 21, 45 and 65 days from planting. Potassium sulphat (48 % K₂O) was applied at rate of 50 kg /fed on two times 21 and 45 after planting. At harvesting was the plants of the other three replicates were harvested. Each fresh plant sample was separated into pods. Yield characters (Plant height (cm) , No. of leaves/plant , No. of pods/plant, pods dry weight (g)/plant, seeds yield /plant (g), weight of 100 seeds (g), seeds yield (ton/fed) and straw yield (ton/fed). Each of oven-dried seeds were ground and kept in plastic bags for chemical analysis. A 0.5 g each of oven dried ground plant sample was digested using H₂SO₄, HClO₄ mixture according to the method described by Chapman and Pratt [18]. The plant content of N, P, K, Fe, Mn, Zn and Cu was determined in plant digestion using the methods described by Cottenie et al. [14] and Page et al. [15]. Protein percentage of seeds was calculated by multiplying the nitrogen percentage by the factor 6.25 [19].

2.1 Statistical Analysis

Data was statistically analyzed for analysis of variance (ANOVA) and least significant difference (LSD) at 0.05 probability level which was applied to make comparisons among treatment means according to Snedecor and Cochran [20].

3. RESULTS AND DISCUSSION

3.1 Effect of Treatments and Different Rates Application on Soil Properties

Data presented in Table 4 show that the use of all treatments i.e. potassium humate and

compost tea foliar or soaking methods and different rates gave decrease slightly soil pH. The lowest value of soil pH 7.87 was obtained in the soil treated with foliar application of compost tea at 6 ml/L compared with other treatments. These results are in agreement by El-Maaz and Ismail [21] indicated that the soil pH decreased due to the application of compost tea a potassium humate soaking and foliar application. The slight of soil pH values may be reflect the activity microorganisms and organic matter releasing organic acid.

3.2 Soil Salinity (EC dSm⁻¹)

Data is given in Table 4 indicated that the effect of potassium humate and compost tea different rates foliar or soaking on soil salinity (EC) was decrease. The lowest mean value of EC in soil was 1.30 (dSm⁻¹) for soil treated with foliar application of compost tea. The used of potassium humate and compost tea foliar application was significant, while soaking method was no significant for soil salinity. The foliar and soaking all treatments different rate to soil salinity led to significant decreases with increasing rates. The interaction between all treatments and different rates gave decrease soil salinity using soaking and foliar application. Concerning, it could be noticed that mean values of EC in soil can be arranged 1.3:187. The order was compost tea > potassium humate > without treatments (control) for foliar application and soaking. El-Maaz and Ismail [21] indicated that soil EC decreased due to application of potassium humate and compost tea soaking and foliar compared control. These results could be explained as a reflection of the activity of microorganisms in reducing salinity and simultaneously improving soil structure; increasing drainable pores, total porosity and aggregate stability, and consequently enhanced leaching process through irrigation fractions, [22]. These results are in agreement by El-Galad et al. [23] indicated that the application of potassium humate and compost led to increases of micronutrients Fe, Mn and Zn in both seasons.

Table 1. Physical and chemical properties in soil study

Sand(%)	Silt(%)	Clay(%)	Texture	O.M(%)	SAR	CaCO ₃ (%)		
86.20	11.17	2.63	Loamy sand	0.43	4.23	1.65		
Chemical Properties in soil								
pH (1:2.5)	EC(dS/m)	Cations (meq/l)			Anions (meq/l)			
		Ca ⁺⁺	Mg ⁺⁺	Na ⁺	K ⁺	HCO ₃ ⁻	Cl ⁻	SO ₄ ⁻
7.79	1.95	4.65	2.34	11.62	0.39	1.40	15.44	2.16
Macronutrients (mg/kg)		Micronutrients (mg/kg)						
N	P	K	Fe	Mn	Zn			
39.52	6.33	125	1.85	0.98	0.41			

The experimental treatments were as follows:

Soaking		Foliar application	
1	Control (without)	1	Control (without)
2	Potassium humate (2m/L)	2	Potassium humate (2m/L)
3	Potassium humate (4m/L)	3	Potassium humate (4m/L)
4	Potassium humate (6m/L)	4	Potassium humate (6m/L)
5	Compost tea (2m/L)	5	Compost tea (2m/L)
6	Compost tea (4m/L)	6	Compost tea (4m/L)
7	Compost tea (6m/L)	7	Compost tea (6m/L)

Table 2. Chemical analysis of compost tea

EC dSm ⁻¹	pH	C	C/N	O.M	N	P	K	Fe	Mn	Zn
4.65	7.16	35.32	13.10	40.23	2.70	0.40	3.14	170.00	123.00	84.00

Table 3. Chemical properties of used humic acid

pH	EC (dSm ⁻¹)	O.M.(%)	Macronutrients(%)			Micronutrients(mg kg ⁻¹)		
			N	P	K	Fe	Mn	Zn
7.60	1.95	57.00	2.35	0.37	3.80	211.00	145.00	108.00

3.3 Available Macronutrients in Soil

Data presented in Table 4 show that the effect of soaking and foliar application of humic acid, and compost tea on available macronutrients N and P contents in soil were no significant, while the K was significant. The different rates of all treatments soaking method to soil gave significant increase of N and P available contents in soil while the foliar application was no significant. As well as, the K available in soil treated with all rates of treatments soaking and foliar application were significant increase by increasing rates. Also, the interaction between all treatments and different rates soaking and foliar application to soil significant increase of K available content in soil, while the P content in soil was no significant and the available N content in soil with all treatments soaking

different rates were no significant. The highest mean values of N, P and K available contents in soil treated with compost tea soaking or foliar application compared other treatments. These results are in agreement by Heather et al. [24] suggested that compost extracts applied to the soil improve its quality by altering its chemical and physical properties, by increasing organic matter content, water holding capacity, overall diversity of microbes, by providing macro- and micro-nutrients. Siddiqui et al. [25] found that application of compost tea increased N, P and K soil content compared with inorganic fertilizer alone, and the increase depended on compost tea ratios. On the other hand, it could be noticed that mean values of EC in soil can be arranged according to the following order: Compost tea > potassium humate > without treatments for foliar application and soaking.

Table 4. Ph, EC (dSm⁻¹) and some macronutrients available in soil after harvest

Treatments	Rates (ml/L)	pH(1:2.5)		EC (dSm ⁻¹)		N (mgkg ⁻¹)		P(mgkg ⁻¹)		K(mgkg ⁻¹)	
		Foliar	Soaking	Foliar	Soaking	Foliar	Soaking	Foliar	Soaking	Foliar	Soaking
Potassium humate	0	7.94	7.96	1.83	1.87	38.40	37.15	4.10	4.00	120.28	112.89
	2	7.92	7.95	1.72	1.83	39.58	38.45	4.31	4.12	135.10	115.30
	4	7.89	7.92	1.68	1.75	41.20	39.00	4.65	4.38	155.80	126.60
	6	7.87	7.90	1.55	1.69	42.84	39.65	4.79	4.50	159.00	134.76
Mean		7.91	7.93	1.70	1.79	40.51	38.56	4.46	4.25	142.55	122.39
Compost tea	0	7.94	7.96	1.83	1.87	38.40	37.15	4.10	4.00	120.28	112.89
	2	7.89	7.90	1.70	1.75	39.90	39.54	4.80	4.55	140.39	133.67
	4	7.85	7.89	1.59	1.68	42.70	41.20	4.94	4.85	159.66	145.00
	6	7.82	7.87	1.30	1.58	43.38	41.95	5.10	4.90	167.00	153.00
Mean		7.88	7.91	1.61	1.72	41.1	39.96	4.74	4.58	146.83	136.14
LSD. 0.05% Treat.		ns	ns	0.030	ns	ns	ns	ns	ns	1.090	2.340
LSD. 0.05% Rates		ns	ns	0.034	0.049	ns	1.001	ns	0.750	1.272	2.710
Interaction		ns	ns	***	**	ns	**	ns	ns	***	***

Potassium humate materials increase soil organic matter, particularly for the sandy soils in Egypt, and hence improve its physical, chemical and biological properties El-Ghozoli [26]. Hassan [27] reported that the foliar application of Potassium humate of soil was increase of N ranged (24- 30 %), increase of P content of 25 % to 28 % and increase of K contents 35 % by over control.

3.4 Available Micronutrient in Soil

Data presented in Table 5 show that the effect of potassium humate, and compost tea at different rates either foliar application or soaking on micronutrients content in soil i.e. Fe, Mn and Zn were positive effect, which the increase of rate led to increasing of Fe, Mn and Zn for soil treated with all treatments. The highest mean values of Fe, Mn and Zn contents in soil treated with foliar application of compost tea. The effect of all treatments foliar application on Fe available was significant, while the Mn content in soil was significant for soaking method and the Zn content in soil was no significant for foliar application and soaking methods. The different rates of all treatments foliar application or soaking methods were significant increase of Fe, Mn and Zn content in soil. The interaction between all treatments and different rates foliar or soaking method were significant increase for Fe, Mn and Zn contents in soil. Also, the relative increase of mean values were 1.16 and 2.98 % for Fe; 3.80 and 3.16 % for Mn and 5.08 and 9.09 % for Zn content in soil as affected of soaking and foliar application potassium humate compared with without potassium humate. On the other hand, the relative increase of mean values 1.35 and 2.51 % for Fe; 3.70 and 3.68 % for Mn and 9.68 and 8.77 % Zn for soil treated with foliar and soaking compost tea compared other treatments. As well as, the relative increase of mean values 2.02 and 2.59 % for Fe; 2.78 and 4.03 % for Mn and 7.02 and 7.55 % for Zn content in soil treated with potassium humate foliar and soaking methods compared with control.

3.5 Effect of Compost Tea and Potassium Humate on Plants Growth

Data presented in Table 6 show that the effect of humic acid, and compost tea soaking and foliar application methods system and different of rates on plant height (cm), No. of leaves/plant, No. of pods/plant, pods weight (g)/plant, seeds yield

/plant, seeds yield (ton/ha) and weight of 100 seed (g) were significant increase with increasing of rate. Also, the effect of all treatments soaking and foliar application on the No. of leaves/plant, seeds yield /plant and weight of 100 seeds (g) were no significant, while the plant height (cm) was significant. On the other hand, the effect of foliar method all treatments on No. of pods /plant, pods dry weight (g/plant) and seeds yield (ton/ha) were significant compared with soaking method. Concerning, the interaction between all treatments potassium humate at different rates and soaking and foliar application methods were significant for plant height (cm), No. of leaves/plant, No. of pods/plant, pods weight (g)/plant, seeds yield (ton/ha), while the weight of 100 seed (g) were no significant. However the highest values of all parameters growth plants were treated with potassium humate application compared with other all treatments. The relative increases of values were 10.97 % for plant height (cm); 38.69 % and 27.56 % for No. of leaves/plant; 32.87 % and 31.61 % for No. of pods/plant; 37.51 % and 31.68 % for pods dry weight (g/pant); 23.37 %; 16.17 and 18.51 % for seeds yield (ton/ha); 24.66 % and 11.56 % and 9.05 % for weight of 100 seeds (g) respectively as treated with soaking and foliar application potassium humate compared without all treatments. Concerning, the relative increases of mean values were 2.02 and 2.59 % for plant height (cm); 12.53 and 6.10 for No. of leaves/plant; 18.83 and 15.98 % for No. of pods/plant; 7.45 and 10.20 % for pods dry weight (g/pant); 10.76 and 9.40 and 15.30 % for seeds yield (ton/ha); 4.91 and 6.50 % for weight of 100 seeds (g) respectively as treated with soaking and foliar application compost tea compared without all treatments. As well as, the relative increases of values 14.19 and 15.90 % for plant height (cm); 72.99 and 47.70 % for No. of leaves/plant; 56.12 and 52.59 % for No. of pods/plant; 52.69 and 49.49 % for pods dry weight (g/pant); 28.57 and 23.84 % for seeds yield (ton/ha); 31.90 and 18.02 and 13.23 % for weight of 100 seeds (g) respectively as treated with soaking and foliar application of potassium humate without all treatments. These results are in agreement by Shaban et al. [28] revealed that there was an increase in pod yield (Mg ha^{-1}); seed yield (Mg ha^{-1}) and 100 seed weight (g) of soybean as affected by humic acid. Abd El-Kader and El-Shabury [29] reported that compost tea; potassium humate and bio-fertilizer on seeds soaking or foliar application were significantly increases seed yield and yield components of faba bean.

Table 5. Available micronutrients in soil after soybean harvest

Treatments	Rates(ml/L)	Fe(mgkg ⁻¹)		Mn(mgkg ⁻¹)		Zn(mgkg ⁻¹)	
		Foliar	Soaking	Foliar	Soaking	Foliar	Soaking
Potassium humate	0	2.85	2.59	2.02	1.74	0.65	0.61
	2	2.88	2.62	2.08	1.76	0.67	0.64
	4	2.90	2.66	2.10	1.78	0.68	0.65
	6	2.94	2.70	2.12	1.83	0.70	0.68
Mean		2.89	2.64	2.08	1.78	0.68	0.65
Compost tea	0	2.85	2.59	2.02	1.74	0.65	0.61
	2	2.89	2.66	2.12	1.84	0.72	0.65
	4	2.94	2.71	2.16	1.86	0.75	0.68
	6	2.96	2.73	2.18	1.89	0.78	0.70
Mean		2.91	2.67	2.12	1.83	0.73	0.66
LSD. 0.05% Treatment.		0.023	ns	ns	0.020	ns	ns
LSD. 0.05% Rates		0.026	0.023	0.022	0.023	0.023	0.023
Interaction		***	**	***	***	**	**

3.7 Macronutrients Concentration in Soybean Seeds Plants

Effect potassium humate and compost tea foliar application and soaking on N, P and K concentrations in seeds soybean plants were positive effect especially plants treated with foliar application potassium humate followed by compost tea than soaking method. Data in Table 7 show that the significant increases of N concentration in seeds soybean with increasing rates all treatments foliar application, while the P concentration was significant affected, when plant treated with foliar and soaking methods. On the other hand, K concentration was no significant as affected with foliar or soaking methods. Also, the foliar application and soaking all treatments i.e. potassium humate and compost tea on N and K concentration in seeds were no significant, while the P concentration in seeds soybean as treated with soaking seeds was significant. These results are in agreement by Mazher et al. [30] indicated that the effect of tryptophan foliar application at a rate 100 ppm on N, P and K contents in shoot and roots was increase than untreated. The effect of amino acids foliar application may be led to enhancing many physiological processes including nutrients uptake by roots and their metabolism in treated plants. Amin et al. [31] reported that the humic foliar application led to increase the nitrogen, phosphorus, potassium of soybean compared with their control at the harvest stage. Fouda and Ali [32] psuggested that the used of compost tea increasing macronutrients uptake in plant. This result may be due to the increase of macronutrient content, and this was related to a positive effect on increasing the root surface area unit of soil volume,

water use efficiency and photosynthetic activity, which directly affect physiological processes. Meshref et al. [33] found that compost tea application have positive effect on N, P and K concentration because of the role of organic extracts which develop the root system of plant and improved nutrient uptake. Khafaga et al. [34] indicated that the addition of humic acids and compost tea combined with recommended dose of N, P and K fertilizers led to increase of N, P and K concentration in seeds faba bean with increasing rate of all treatments. Hussien and Hassan [35] found that the foliar application of humic acids increased the concentration of P and K in seeds.

Concerning the effect of humic acid, compost tea foliar and soaking treatments on protein (%) content in seeds soybean plants were no significant, while the soaking method was significant of protein yield (kg/fed) content in seeds. The different rates of all treatments were significant increases of protein (%) and protein yield (kg/fed) with increasing rate. The interaction between all treatments and different rates for protein (%) and protein yield (kg/fed) were significant increases with increasing rate. The highest values of protein (%) 30.47 % and protein yield 341.30 (kg/fed) contents in seeds soybean treated with foliar application for potassium humate than all treatments and soaking method. The relative increase of mean values of protein (%) and protein yield (kg/fed) content in seeds soybean plants were 12.04 and 33.03 % for soaking seeds, while 15.72 and 35.16 % for foliar application with potassium humate compared without potassium humate. Also, the relative increases of mean values

Table 6. Yield and yield component of soybean plants

Treatments	Rates (m/L)	Plant height (cm)		No. of leaves/plant		No. of pods/plant		Pods dry weight (g)/plant		Weight of 100 seeds (g)		Seeds yield (ton/ha)	
		Soaking	Foliar	Soaking	Foliar	Soaking	Foliar	Soaking	Foliar	Soaking	Foliar	Soaking	Foliar
Methods of application													
Humic acid	0	91.0	93.6	12.4	16.0	15.3	19.1	22.5	24.7	27.8	30.6	2.38	2.38
	2	94.5	99.8	16.2	19.6	18.2	21.5	27.8	28.8	29.7	32.4	2.62	2.86
	4	98.2	104.0	19.1	21.3	20.5	25.5	29.7	31.0	31.3	33.2	2.62	2.86
	6	102.3	108.0	20.3	23.2	22.2	27.8	32.8	34.7	31.9	33.9	2.86	3.09
Mean		96.5	101.1	17.0	20.0	19.1	23.5	28.2	29.8	30.2	32.5	2.62	2.80
Compost tea	0	90.0	92.9	11.4	15.0	15.3	19.1	22.5	24.7	27.8	30.6	2.38	2.38
	2	87.3	91.8	13.6	14.6	15.3	20.5	19.2	20.5	27.4	31.6	2.38	2.62
	4	91.2	94.8	15.2	16.2	18.6	21.2	20.5	21.4	29.2	32.7	2.62	2.86
	6	92.7	98.0	16.3	16.5	20.6	24.2	21.1	22.5	30.9	33.3	2.86	2.86
Mean		90.30	94.38	14.13	15.58	17.45	21.25	20.83	22.28	28.83	32.05	2.56	2.68
LS.D. 0.05% Treat.		1.08	0.12	ns	ns	ns	0.96	ns	1.22	ns	ns	ns	0.040
LS.D. 0.05% Rates		1.52	1.41	2.08	2.61	1.49	1.22	4.03	1.55	2.68	2.84	0.048	0.048
Interaction		***	***	**	**	***	***	***	***	ns	ns	***	**

Table 7. Macronutrients; protein (%) and protein yield (kg/fed) content on seeds soybean plants

Treatments	Rates (ml/L)	Concentration (%)						Protein (%)		Protein yield (kg/fed)	
		N		P		K		Soaking	Foliar	Soaking	Foliar
Methods of application		Soaking	Foliar	Soaking	Foliar	Soaking	Foliar	Soaking	Foliar	Soaking	Foliar
Humic acid	0	3.49	3.61	0.52	0.55	1.69	1.73	21.83	22.55	189.9	214.3
	2	3.57	3.71	0.53	0.56	1.75	1.77	22.33	23.18	218.8	245.7
	4	3.71	4.30	0.55	0.59	1.78	1.85	23.18	26.89	241.0	301.2
	6	4.46	4.52	0.57	0.62	1.84	1.88	27.85	28.24	298.0	322.0
<i>Mean</i>		3.8	4.04	0.5	0.6	1.8	1.8	23.80	25.22	236.93	270.8
Compost tea	0	3.48	3.60	0.51	0.54	1.69	1.73	21.83	22.55	189.9	214.3
	2	3.54	3.63	0.52	0.54	1.78	1.79	22.10	22.67	196.7	233.5
	4	3.68	4.10	0.54	0.57	1.81	1.83	23.00	25.60	223.1	276.4
	6	4.01	4.46	0.55	0.60	1.82	1.86	25.03	27.85	262.8	314.7
<i>Mean</i>		3.7	3.9	0.53	0.56	1.77	1.80	22.99	24.67	218.13	259.73
LS.D. 0.05% Treat.		ns	ns	0.01	ns	ns	ns	ns	ns	1.85	ns
LS.D. 0.05% Rates		ns	0.15	0.014	0.02	ns	ns	1.25	1.58	2.14	27.4
Interaction		ns	***	***	***	ns	ns	***	***	***	***

protein (%) and protein yield (kg/fed) were 7.13 and 22.66 % contents in seeds soybean soaking in compost tea, while 14.18 and 40.57 % contents in seeds soybean for seeds treated with foliar application of compost tea compared without compost tea. As well as, the relative increases of mean values protein (%) and protein yield (kg/fed) were 18.83 and 44.62 % for soaking seeds method, while, 16.07 and 37.45 % for foliar application method respectively, than seeds untreated. This result could be attributed to the beneficial effect of amino acids on new cell production through restoring the specific enzymes for protein synthesis. These results are in agreement by Abd El-Kader and El-Shaboury [29] they found that the foliar and soaking of seeds for potassium humate and compost tea led to increase of protein (%) content in seeds of faba bean plants. Shaban et al. [22] they showed that the foliar application of compost tea and potassium humate combined with mineral N fertilizer caused significant increases in seed protein contents.

3.8 Effect of Soaking and Foliar Application with Potassium Humate and Compost Tea on Concentration of Some Micronutrients in Seeds Soybean Plants

The concentrations of some micronutrients (Fe, Mn and Zn mgkg⁻¹) in seeds of soybean plants for both foliar application and soaking methods are presented in Table 8. Data show that the applying of potassium humic acids and compost tea caused markedly increases in concentrations

of Fe, Mn and Zn for seeds soybean plants, with a more pronounced increasing the rates. The highest mean values of Fe, Mn and Zn concentrations in seeds of soybean plants were 74.51, 106.64 and 40.27 mg kg⁻¹ for concentration in seeds soaking method and 77.56; 111.42 and 42.07 mg kg⁻¹ for seeds foliar method respectively for plants treated with compost tea compared with other treatments.

Concerning, the effect of all treatments on seeds soybean soaking was no significant on Fe, Mn and Zn concentration in seeds plants, while the foliar application was significant for Fe concentration in seeds plants compared with Mn and Zn concentration in seeds plant were no significant. As well as, the different rates of potassium humate and compost tea foliar and soaking methods led to significant increases of Fe and Zn concentrations in seeds and Fe and Mn of seeds soybean plants. The Mn concentration in seeds soaking different rates was significant increase with increasing rate. The interaction between all treatments and different rates on Fe and Zn concentrations in seeds were significant for both methods and Fe, Mn and Zn concentration in seeds were significant for soaking and foliar application methods. Meshref et al. [33] reported that compost tea have positive effect on nutrients concentration because of the role of organic extracts which develop the root system of plant. Hussein and Hassan [35] suggested that foliar application in 0.1 % potassium humate increased the Fe, Mn and Zn amounts in plants compared with control.

Table 8. Micronutrients concentration in seeds of soybean

Treatments	Rates(ml/L)	Concentration(mg/kg plant)					
		Fe		Mn		Zn	
Methodsof application		Soaking	Foliar	Soaking	Foliar	Soaking	Foliar
Humic acid	0	108.37	114.26	75.79	79.81	37.29	39.58
	2	113.30	119.02	81.29	81.83	40.15	42.64
	4	117.80	125.33	82.93	86.27	43.95	47.19
	6	120.12	127.93	83.58	90.53	45.34	47.30
Mean		114.90	121.64	80.89	84.61	41.68	44.18
Compost tea	0	108.37	114.26	75.79	79.81	37.29	39.58
	2	111.95	115.61	75.88	79.93	37.62	40.46
	4	115.94	120.38	80.30	82.61	38.48	44.61
	6	119.46	124.30	81.14	84.04	40.14	45.83
Mean		113.93	118.64	78.28	81.60	38.38	42.62
LSD. 0.05% Treat.		ns	ns	ns	1.57	ns	ns
LSD. 0.05% Rates		2.74	ns	1.50	1.81	2.31	1.87
Interaction		***	ns	***	***	***	***

4. CONCLUSION

This study the role of application potassium humate and compost tea foliar and soaking methods different rates caused improving loamy sand soil and increases of soil fertility and the increase of macro-micronutrients concentrations in seeds soybean plants. Foliar application rates of compost tea were improving growth plants yield and characters plant under loamy sand soil.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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