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Impact of Mature Compost Derivatives and Inorganic Fertilizers on the Growth and Productivity of Pea Plants

Mahmoud Y.I., El-Akshar Y.S., Abd Elgwad Sh. A. and Afifi M.M.I.

Soils, Water and Environment Research Institute, Agriculture Research Center, P.O. 12112, Giza, Egypt.

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ABSTRACT

The rice straw was composted with cattle dung, as a raw material, and inoculated with a mixture of *Trichoderma viride* and *Phanerochaete chrysosporium.* The humic substances (HS) and compost tea (CT) were prepared after the compost maturation phase. The study aimed to evaluate the bio-stimulant activity of HS and CT, as organic fertilizer integrated with synthetic inorganic fertilizers (NPK), on the rhizosphere biological activity, growth and productivity of pea (*Pisum sativum* L.) plants in clay soil. The data revealed that addition of organic fertilizers at different forms or rates stimulated high microbial count as compared with mineral fertilizers. As the rate of mineral fertilizers increased (50, 75 to 100% of NPK) the biological status revealed a depletion either in the total microbial count or the enzyme activities. The absolute addition of a full dose of mineral fertilizers has prohibited the nodulation on pea plants while that organic fertilizers at different forms (CT or HS) or two rates (50 or 100%) have fostered the nodulation on the base of nodules number or nodules dry weight. The combined addition of compost tea and humic substances with half dose or 75% of NPK revealed improvement in the nutrition status, in seed and straw of pea plants, against the full dose of NPK or individual treatments of compost tea or humic substances. Furthermore, a half dose of NPK in combined addition of 50% of humic substances and compost tea yielded the highest seed and straw yield as well as total protein percent in seeds. It could be concluded that the combination treatment between compost tea and humic substances with half quantity of NPK fertilizer which contributes to lowing pollution of NPK fertilizers, and decreased the costs by using friendly organic and bioorganic fertilizer with the environment, and to compensate NPK fertilizer for Peas Plants.

Keywords: *Pisum sativum,* Humic substances, compost tea, compost derivatives

Introduction

Pea (*Pisum sativum* L.) is one of an important pulse crop that is grown in the winter season for local consumption consumed as a seed food. The total harvested area grown with peas gradually increased from 17550 to 20592 hectare from 2015 to 2018, respectively, which produced 9.787 to 9.846 tons / hectare, respectively FAOSTAT (2020). Pea has the most important source of vegetarian proteins, vitamins, carbohydrates and minerals in the human diet and livestock nutrition Castell *et al*., (1996). Pea, like other legumes, could able to use atmospheric nitrogen via Biological Nitrogen Fixation (BNF) process in economically sound and environmentally acceptable process (Saikia and Jain 2007).

For a long time, the farmers have depending on synthetic fertilizers especially which contains nitrogen (N), phosphorus (P) and potassium (K) along with bioorganic fertilization because it has a vital role on the plant growth and crops productivity (Hassan *et al*., 2007). However, a huge amount of synthetic fertilizers cause pollution, soil degraded and less productivity as well as severe health and environmental hazards (Mishra *et al.,* 2010). Thus, the application of bioorganic fertilizers such as organic manure, biofertilizers and biogas manure as well as compost and its derivatives could be able to resolve these issues and make our ecosystem healthier (Ritika and Utpal, 2014).

The employment of bioorganic compounds, including compost or its derivatives such as compost tea (CT) or humic substances (HS), in sustainable farming of establish successful beneficial biological interactions, maximize reuse and preserve agro-ecosystem quality is an acceptable option to conventional one (Guzmán Casado and González de Molina 2009; Scotti *et al.,* 2016). Many recent

Corresponding Author: Afifi M.M.I., Soils, Water and Environment Research Institute, Agriculture Research Center, P.O. 12112, Giza, Egypt. E-mail: afifihumic@gmail.com

studies stated that HS and CT could be used to improve and regulate plant growth and to enhance stress tolerance and resilience (Nardi *et al.*, 2002; Siddiqui *et al.,* 2008).

Humic substances are preparations extracted from soil, compost, or other naturally decayed organic matter, while compost tea is an aerobic or non-aerobic liquid extract of compost and essentially contains a dissolved organic and an inorganic molecule as well as beneficial microorganisms (Ingham 1999). Humic substances can directly affect the root growth, especially a lateral root emergence through a mechanism described as the "acid growth hypothesis", which determines an auxin like induction of cell elongation (Zandonadi *et al.,* 2007). Accordingly, HS and CT have a contributable role in diminishing the unsustainable application of synthetic-based pesticides and/or fertilizers in agriculture. So, HS and CT are promising in sustainable horticultural crop management, it is necessary to provide further insights into their application and functionality.

The aim of this study was to evaluate the bio-stimulant activity of HS and CT, obtained from bioactivated rice straw compost, as organic fertilizer integrated with synthetic inorganic fertilizers (NPK), on the rhizosphere biological activity, growth and productivity of pea (*Pisum sativum* L.) plants.

Materials and Methods

Compost preparation

The rice straw was composted with cattle dung, as a primary material, and stimulated by a mixture of *Trichoderma viride* and *Phanerochaete chrysosporium.* Rice straw was air dried and chopped to small pieces (3-5 cm) in order to construct the compost pile in an area of about 2.0 m (w) x 3.0 (L) x1.5m (H). The fungal strains were cultured in flasks containing 150 ml of Czapeck-Dox medium (Difco 1976). or Nutrient–Glucose broth medium (Fouda and Mahmoud 1960) for *T. viride* or *Ph. chrysosporium*, respectively. The inocula were freshly prepared by centrifuging each culture and the obtained cells were resuspended in water to give a concentration of 10^6 CFU/ml. The inocula were applied at 100 ml from previous dilution per kg composted materials and were added to compost pile at starting time.

The pile was biweekly turned and the moisture was maintained at about 60% using hand squeeze test for three months until the maturation phase. Physical and chemical properties were determined in raw materials according to APHA (1989). Total nitrogen, phosphorus and potassium dry yield were also estimated according to Black (1965).. Total and fecal coliform bacteria, *Salmonellae* and *Shigella* in compost were determined according to Difico Manual (1985). Parasitic organisms were determined in compost tea according to Jirillo *et al*. 2014.. Weed seeds in compost according to Yu *et al.* (2010). and nematodes were examined according to Clescerl *et al*. (1999). The physicochemical and biological properties of raw materials (rice straw and cattle dung) and final compost are presented in Table (1).

Evaluation of compost maturity

Humification parameters were determined to evaluate the degree of compost maturity and stabilization were, it's calculated: Humification rate (HR) % = C (HA + FA)/ TOC x100. Humic index (HI) = TEC – C (HA +FA) /C (HA + FA) and Humification degree (HD) % = C (HA + FA) / TEC x100 according to Ciavatta *et al*. (1990. where TOC: total organic carbon TEC: total extract carbon CHA: humic acid carbon CFA: fulvic acid carbon HS: humic substances. Also, some biological assessments were determined during the compost process as indicators for compost maturity.

Humic substances and compost tea preparation

The humic substances (HS) extraction was performed after the compost maturation phase according to the methods described by Sanchez *et al.* (2002). Properties of humic substances were determined according to Afifi (2017). as shown in Table 2).

Compost tea was prepared from matured compost by completely submerging a cotton bag containing respective compost them into tap water by a ratio of 1: 10 (w/v) and supplemented with 0.5 % (v/v) molasses as described in Shrestha *et al*. (2011). Physical and chemical properties determined in compost tea according to APHA (1989). Some properties of product compost tea are presented in Table 3).

Table 1: Physiochemical and biological of raw materials and final compost.

Character	Rice straw	Cattle dung	Compost
Density (kg/ m^3)	--	--	575
Moisture content (%)	8.90	74.64	25.0
Dry matter (%)	91.10	25.36	75.0
pH 1:10	6.55	7.20	7.55
EC (dS/m 1:10)	3.50	1.15	3.85
Ammonia (ppm)	28.0	436.0	85
Nitrate (ppm)	6.00	42.0	385
Total Nitrogen (%)	0.76	1.64	1.82
Organic matter (%)	80.3	77.6	58.8
Organic carbon (%)	46.55	44.98	34.2
C/N ratio	61.3:1	27.4:1	18.8:1
Total potassium (%)	0.42	0.72	1.4
Total phosphorus (%)	0.40	0.63	1.1
Total coliform (cfu /g x10^3)	Not detected		Not detected
Fecal coliform (cfu/g x $10^{3)}$	Not detected		Not detected
***Salmonella* and *Shigella* (cfu/g x 10^2)**	Not detected		Not detected
Nematoda (larva/200g)	Not detected		Not detected
Weeds seeds	Not detected		Not detected

Table 2: Characteristics of humic substances extracted from compost.

Carbon (C) %	Nitrogen (N) %	Hydrogen (H) %	Oxygen (O) %	Sulfur (S) %	Total Acidity (mmol/100g)	Total Carboxylic Groups (mmol/100g)	Total Phenolic Groups (mmol/100g)
50	4.1	5.0	39.9	1.0	600	290	310

Table 3: Physical and chemical properties of compost tea in a field experiment.

Property	Value
Physical and chemical properties	
pH (1:10 extract)	7.08
EC (dS/m, 1:10 extract)	4.11
Organic-C (%)	5.36
Total-N (ppm)	396.50
N-NH_4 (ppm)	96.30
N-NO_3 (ppm)	110.50
Total P (ppm)	88.50
Total K (ppm)	126.40
Biological properties	
Total counts of bacteria (cfu/ml.)	2 X 10^7
Total counts of fungi (cfu/ml.)	8 X 10^4
Total counts of actinomycetes (cfu/ml.)	4 X 10^5
Parasite (cyst or ova/ml.)	Not detected

Plant seeds and rhizobium inoculation

Seeds of pea (*Pisum sativum* L.) Intesar1 were provided by the Department of Vegetable Research, Horticulture Research Institute, Agriculture Research Center (ARC), Giza, Egypt. Pea seeds were inoculated with rhizobium inoculant at a rate of 300 g peat–based inoculum per 60 kg seed before sowing using an a Arabic gum solution (16%) as an adhesive agent.

Rhizobium leguminosarum v. viceae was cultured in yeast mannitol broth medium (Vincent 1970). and incubated at 28°C for three days on a rotary until early log phase to ensure population density of 4x 10^9cfu/ ml culture .Vermiculite supplemented with 10 % Irish peat was packed into polyethylene bag containing 300 g carrier, then sealed and sterilized with gamma irradiation (5.0x 10^6rads). Rhizobial culture was injected into the carrier to 60% of its water holding capacity.

Experiment layout and management

A filed experiment was carried out at the Production Sector of Agric. Res. Center (ARC), Development Unit of Plant and Animal, Moshtohour farm, Kalubia governorate during the winter season in a completely randomized block design with three replicates. The physico-chemical and biological properties of the experimental soil were estimated according to Page *et al.* (1982). and the data are presented in Table (4).

Table 4: Some physical, chemical characteristics of the studied soil.

PH	EC dS/m	Cations meq/L				Anions meq/L			
		Ca^{+2}	Mg^{+2}	Na^{+}	K^{+}	CO_3^{--}	HCO_3^{-}	Cl^{-}	SO_4^{--}
7.67	1.3	5.85	4.08	3.75	0.05	0.00	2.50	4	7.23

Mechanical and physical analysis			Texture class
Sand (%)	Silt (%)	Clay (%)	
37.72	18.45	43.83	Clay

Organic matter (%)	$CaCO_3^{--}$	Available macronutrients (ppm)		
		N	P	K
1.30	2.50	57.00	6.20	250.00

Experimental area was 720 m^2 divided into 45 plots. The plot area was 16m^2 (length 4m in width 4m). It involved 6 cultivated ridges, meanwhile, the seventh and eighth were left between every two experimental units to avoid overlapping, each ridge contained 20 hills.

Pea seeds were sown on November 5th of 2017/2018. Control treatment of the experiment has received the full dose of nitrogen, phosphorus and potassium. Other treatments have received 50 or 75% of NPK in combination with different doses of humic substances (HS) or compost tea (CT). Humic substances were prepared at two concentrations 50% (50HS), and 100% (100HS) from the recommended dose (12 L/fed) from 200 ppm as recommended by Stevenson (1994). It was added at three times 15, 45 and 60 day after sowing. Compost tea doses were applied as full doses (100CT) or half dose (50CT) in rates 60L/fed or 30L/fed, respectively as the following:

T1- Full NPK (control).
T2- 75% NPK + 50 CT.
T3- 75% NPK + 100 CT.
T4- 75% NPK + 50 HS.
T5- 75% NPK + 100 HS.
T6- 50% NPK + 50 CT.
T7- 50% NPK + 100 CT.
T8- 50% NPK + 50 HS.
T9- 50% NPK + 100 HS.
T10- 75% NPK + 50 CT+ 50 HS.
T11- 75% NPK + 100 CT + 100 HS.
T12- 75% NPK + 50 CT + 100 HS.
T13- 50% NPK + 50 CT + 50 HS.
T14- 50% NPK + 100 CT + 100 HS.
T15- 50% NPK + 50 CT + 100 HS.

Biological measurements

Nitrogenase in the rhizosphere was measured by acetylene reduction assay using GC analysis at 30 and 60 days as described by Somasegaran and Hoben (1994). Dehydrogenase activity was also determined according to Skujins (1976). Determination of phosphatase activity was performed according to Gerritse and van Dijk (1978). In addition, the total microbial count (x10^6 cfu/g^{-1} soil) in soil was determined at 30 and 60 days based on serial 10-fold dilutions using the pour plate method with soil extract agar medium (Difco, 1976).

Statistical analysis

Experiment was arranged in a completely randomized block design and data were analyzed according to methods described by Snedecor and Cochran (1980). The averages were compared using L.S.D. values.

Results and Discussion

Compost maturity indicators

The obstacles to the successful use of compost in agriculture are the lack of reliable quality criteria and an understanding of the conversion of organic matter, which occurs throughout the whole process. Proper evaluation of compost maturity is necessary to establish such criteria. Because of the diversity of the origin of compost. It is impossible to use one method to assess compost maturity.

There are some methods of assessing compost maturity either chemical or biological methods as shown in Table (5).

Nitrification is the oxidation process by microorganisms where, NH_4 is converted to NO_3. Ammonia level in initial compost is high because organic matter is mineralized where, organic nitrogen converts to ammonia and nitrate still absent so, NO_3 / NH_4 ratio is less than 1.

Table 5: Some chemical and biological indicators on compost maturation

Analysis	Initial	Final
Chemical and Humification parameters		
Nitrification (NO_3/NH_4 ratio)	≤ 1	≥ 1 = (4.5)
Carbon nitrogen ratio (C/N)	30 : 1	18.8 : 1
Humification parameters		
Total organic carbon (TOC) %	45.60	34.20
Total organic extractable (TEC) %	35.50	24.90
Humic acid carbon (HAC) %	3.22	11.30
Fulvic acid carbon (FAC) %	8.20	6.10
Carbon HA + FA (CHA + CFA) %	11.40	17.42
Humic substances (HS) %	19.65	30.10
Humic acid (HA) %	5.55	19.50
Fulvic acid (FA) %	14.10	10.60
Humic index (HI)	2.10	0.40
Humification degree (HD) %	32.10	69.80
Humification rate (HR) %	24.90	50.90
Biological assessment		
Total coliform bacteria (CFU/g)	51×10^3	Not detected
Fecal coliform bacteria (CFU/g)	43×10^3	Not detected
***Salmonella* and *Shigella* (CFU/g)**	20×10^2	Not detected
Weed seeds	Find	Not detected
Parasitic	Find	Not detected

With the progressive compost process specially thermophile phase where, ammonia converts to nitrate by nitrifying bacteria thus nitrate increased meanwhile ammonia was reduced so, one of the mean indicators of compost mature nitrate ammonia ratio was increased to more than 1 in our case 4.5, the agreement of the results Chukwujindu *et al*. (2006). Who considered decreasing ammonia and increase nitrate in final compost is suitable for the evaluation of compost maturity.

The carbon-nitrogen ration is a good index of compost maturity, where the results showed the C/N ratio in the initial compost is 30:1. Meanwhile, C/N during compost process was low as a result of organic matter degradation where it reached in final compost to 18.8: 1, this result was in line with Jimenze and Garaia (1989). Who reported that carbon/nitrogen ratio has been used as an indication of the potential of compost maturity where, C/N ratio less than 20:1 is a good indicator of compost maturity.

In this respect, humification parameters are very important indicators for compost maturity. Data show that in Table (5) indicated that both TOC and TEC were decreasing predominately during the first stage of compost due to the intense mineralization process where, it reaches in the final compost process to 34.2 and 24.9 % respectively. Also, fulvic acid decreased with the compost progressively to the maturity phase where it reaches in the final compost process to 10.6% meanwhile, it was in the initial process 14.1%. On the other hand, humic acid was in initially 5.55% and in final compost process 19.5% this may be, attributed to organic matter degradation in initially so fulvic acid formes as well as, fulvic acid enters in the polymerization process to form humic acid (more molecular weight than fulvic acid). Humic substances are the sum both of humic and fulvic acids so, it increases in finally compost (30.0%).

Humic index (HI) measures non-humic to humic substances, this index during the first month of compost reached 2.1 while at the final compost was lower than 1. Also, the humification degree in the initial compost process was 32.1% whereas it was more than 50% during process finishing (69.8%), this means that humic substances proportion increase compared with the non-humic substances with the compost trend towards maturity. Meanwhile, the HR% increase from an initial

(24.9%) to final of the composting process (50.9%), which means compost reached to maturation phase. Compost final product was free from pathogens and parasites (Nematoda) and weed seeds which means compost reached to maturation phase. The results are in harmony with Afif (2017). who stated conducted that the compost is mature when proportions of humic acid higher than fulvic acid during the end of the composting process also, HI lower than 1 and both HD% and HR % are more than 50%. In addition, he reported that compost is mature when it is free from pathogen bacteria and parasites. Also, in this regard Gigliotti, *et al*. (2012). suggested that humification parameters (HI, HR and HD%) are considering important means to judge the maturity of compost, where, HR is proportional to the state of humification of the compost organic matter, while HI is representing the ratio non-humic substances to humified carbon (CHA+CFA). Humification degree is representing the ratio carbon of humic and fulvic per the total carbon extracted (HA + FA and non humified) with the alkaline solution. The DH% is 100% when the alkaline extracted organic carbon is completely humified (Non humified = zero).

On another level, the results also showed some parameters as indicators of maturity (Table 3) the data shows can be used the properties of compost tea extracted from mature compost where, we can metaphorically express compost tea as the compost biological extract. Where, the organic carbon contents and NPK nutrients seam the lowest meanwhile, microbial exudates and its counts are higher. From data shown in table compost tea is free from parasites and rich with benefits bacteria where, total count bacteria, fungi and actinomycetes counts were 2 x 10^7, 8 x 10^4 and 4 x 10^5 cfu/ ml respectively.

Biological activity

The biological activity in the rhizosphere of pea plants, as affected by various treatments, are expressed on the base of total microbial count and some of enzymes activities as tabulated in Table. 6. The addition of organic fertilizers at different forms or rates stimulated the microbial count as compared with mineral fertilizers. The total microbial count, at 30 DAS, ranged from 70.51 x 10^6 to 230 x 10^6 cfu/g dry soil against 60 x 10^6 cfu/g dry due to the application of organic fertilizers and mineral fertilizers, respectively. Such values progressively raised to 100 x 10^6 to 260 x 10^6 cfu/g dry soil against 90 x 10^6 cfu/g at 60 DAS, respectively.

Table 6: The biological activity in the rhizosphere of pea plants, as affected by various treatments.

Parameters	Total microbial count (10^6cfu/g dry soil)		Nitrogenase (nmoleC_2H_4/g dry soil/h)		Dehydrogenase (µgTPF/g dry soil/day)		Total phosphatase acid & alkaline. (mg PNP/g dry soil)	
Treatments	**30 *DAS**	**60 DAS**	**30 DAS**	**60 DAS**	**30 DAS**	**60 DAS**	**30 DAS**	**60 DAS**
T1	60.00	90.00	0.19	0.21	6.31	10.41	0.21	0.35
T2	90.00	120.63	1.30	1.50	10.91	13.12	0.31	0.41
T3	100.00	130.00	3.66	3.94	33.46	35.67	0.73	0.82
T4	70.51	100.00	1.99	2.31	25.61	27.41	0.27	0.55
T5	97.00	124.00	3.20	3.51	31.51	34.21	0.51	0.61
T6	98.00	118.00	3.40	4.61	44.51	50.11	0.41	0.71
T7	110.00	135.00	3.97	4.15	46.31	49.62	0.65	0.80
T8	85.00	120.00	2.51	3.52	43.10	44.00	0.39	0.65
T9	108.00	129.00	3.31	3.55	44.60	46.70	0.59	0.79
T10	180.40	205.60	5.55	6.55	52.61	55.81	1.65	1.82
T11	210.00	229.00	6.23	7.15	61.00	63.30	1.93	2.11
T12	176.00	200.00	7.52	7.81	59.31	60.23	2.01	2.23
T13	190.00	225.00	7.91	8.02	66.30	69.11	2.64	2.83
T14	230.00	260.00	7.54	7.86	65.21	67.21	2.63	2.84
T15	225.00	235.36	7.25	7.42	60.20	62.80	2.40	2.71
L.S.D at 0.05 %			**1.678**	**1.666**	**2.3817**	**1.864**	**0.205**	**0.264**

***DAS:** Days after sowing.

The compost tea affected the biological activities in a non-significant pattern compared with humic substances where they applied individually with mineral fertilizers at different concentrations (T2 to

T9). However, the combined application (T10 to T15) of compost tea and humic significantly increased the biological activities especially at low rates of mineral fertilizes.

Furthermore, as the rate of mineral fertilizers increased (50, 75 to 100% of NPK) the biological status revealed a depletion either in the total microbial count or the enzyme activities. Studies have shown that different fertilization treatments had different effects on soil bacterial community diversity and that chemical fertilizers lead to reduced community diversity (Marschner *et al*., 2003; Geisseler and Scow 2014; Pan *et al.,* 2014). While organic fertilizers could increase bacterial community diversity (Manna *et al.,* 2007; Berthrong *et al.,*2013; Sapp *et al.,* 2015).. Also, the results of Sellamuthu and Govindaswamy (2003). revealed that soil application of humic substances recorded maximum bacteria, fungi and actinomycetes in the sugarcane rhizosphere. They attributed the increase in population might be due to the presence of applied humic substances in the root zone, which favors the microbial growth in the rhizosphere.

The abovementioned increments in the microbial account were associated with an increase in the overall physiological activity as indicated by dehydrogenase and specifically nitrogen fixation as indicated by nitrogenase activity as well as phosphate availability as indicated by total phosphatase activity. The value ranged from 1.3 to 7.91 and 1.50 to 8.02 nmole C_2H_4/g dry soil/h, 10.91 to 66.30 and 13.12 to 69.11 µgTPF/g dry soil/day as well as 0.31 to 2.64 and 0.41 to 2.84 mg PNP/g dry soil for nitrogenase, dehydrogenase as well as total phosphatase at 30 and 60 DAS, respectively. According to Caldwell (2005). The soil enzyme activities and mainly rhizosphere enzymes may well serve as indicators of microbial functional diversity. Moreover, higher activity of several enzymes can be interpreted as a greater functional diversity of the microbial community in the rhizosphere (Gianfreda 2015). The obtained results showed a vital role of organic matter added to the soil. In this concern, Gianfreda and Ruggiero (2006). Stated that the soils with a long history of continuous corn monoculture, without proper amendment with organic matter, showed low organic matter contents and low dehydrogenase, invertase, arylsulphatase, and β-glucosidase as compared with continuous corn-fertilized soils.

Nodulation status

The nodulation status could reveal a potential impression about the symbiotic nitrogen fixation. The nodulation status of pea plants, as affected by mineral and/or organic fertilization, is presented as nodules number or nodules dry weight (Table 7).

Table 7: Effect compost tea and humate potassium and/or *Rhizobiu*m on the nodulation status of pea plants.

Parameters / Treatments	Number of nodules /plants		A dry weight of nodules (mg/plant)	
	30 *DAS	60 DAS	30 DAS	60 DAS
T1	6	9	70	87
T2	9	11	82	90
T3	8	12	80	91
T4	10	15	84	95
T5	13	16	87	96
T6	11	17	85	94
T7	17	19	88	98
T8	15	16	87	97
T9	18	20	89	99
T10	21	23	108	120
T11	24	25	112	123
T12	22	24	149	156
T13	25	28	175	190
T14	26	29	180	193
T15	22	25	165	180
L.S.D at 0.05 %	**4.536**	**2.697**	**6.3388**	**5.673**

*** DAS:** Days after sowing.

The absolute addition of a full dose of mineral fertilizers reduced nodulation on pea plants while that organic fertilizers either different forms (compost tea or humic substances) or rates (50 or 100%) have fostered nodulation on the base of nodules number or nodules dry weight. The values due to full dose of mineral NPK at 60 DAS reordered 9 nodules and 87 mg per plant for nodules number and nodules dry weight, respectively. While that due to the application of organic one both of nodules number and noduls dry weight were increased and reach to 11 to 29 nodules / plant and and 90 to 193 mg per plan respectively. The nodulation status has improved in response to low rates of mineral fertilizers (50% NPK) compared to 75% NPK or a full dose. The humic substances application revealed stimulation of nodulation as compared with compost tea at all rates. However, the maximum values either for the number or dry weight of nodules were recorded where compost tea combined with humic substances at a high rate (T14) and 50 % NPK with non-significant with 57% NPK treatments. The negative effect of mineral fertilizers on nodulation status and symbiotic nitrogen fixation has reported in various kinds of literature (Abdel Wahab and Abd-Alla 1996; Goss *et al.,* 2002; Argaw 2017). On the other hand, the positive effect of organic matter application has stated in many studies (Tan and Tantiwiramanond 1983; Lawson *et al.,* 1995; Ditta *et al*., 2018; Zhang *et al.,* 2019).

Nutrient status

The nutrient status of pea seeds and straw including nitrogen N%, phosphorus P% and potassium K% as influenced by the treatments are represented in

Table 8 as percentages. The combined addition of compost tea and humic acid with half dose or 75% of NPK revealed improvement in the nutrition status, in seed and straw of pea plants, against the full dose of NPK or individual treatments of compost tea or humic substances. A non-significant variation in between 50% treatments and 75% treatments due to the application of different organic fertilizer forms. The highest values were 4.05 and 1.25%, 1.54 and 1.39% or 1.98 and 1.3% in seeds and straw for nitrogen, phosphorus or potassium, respectively, due to combined effect of humic substances and compost tea. On the other hand, the values were 3.68 and 0.98%, 0.88 and 0.56% or 1.06 and 0.78% in seeds and straw for NPK percentages where the absolute full dose applied.

Regarding the role of humic substances (Pinton *et al*., 1999 and Noroozisharaf and Kaviani 2018). reported that it has a role in the incorporation of nitrate uptake of through interaction with plasma membrane H+-ATPase as well as it can increase the solubility phosphorus compounds in soil with its chelating capacity.

Table 8: Effect compost tea and humate potassium on NPK percentages pea seeds and straw

Parameters	N %		P %		K %	
Treatments	**Seeds**	**Straw**	**Seeds**	**Straw**	**Seeds**	**Straw**
T1	3.68	0.98	0.88	0.56	1.06	0.78
T2	2.72	1.00	0.86	0.50	1.10	0.85
T3	2.80	1.10	0.89	0.65	1.18	0.88
T4	3.76	1.00	0.90	0.70	1.20	0.89
T5	3.90	1.11	0.93	0.78	1.23	0.92
T6	2.68	0.87	0.76	0.48	1.12	0.81
T7	2.75	0.88	0.78	0.53	1.14	0.84
T8	3.00	1.00	0.85	0.66	1.16	0.86
T9	3.28	1.06	0.90	0.73	1.20	0.89
T10	3.10	1.18	1.53	1.22	1.88	1.00
T11	3.99	1.25	1.44	1.25	1.98	1.20
T12	3.20	0.99	1.50	1.28	1.70	1.30
T13	4.01	1.16	1.54	1.39	1.58	1.25
T14	4.05	1.11	1.43	1.35	1.55	1.14
T15	3.90	1.08	1.35	1.25	1.60	1.10
L.S.D at 0.05 %	**1.7119**	**0.1745**	**0.2935**	**0.2894**	**0.2039**	**0.277**

Humic substances could be able to incite enzymes such as glutamate dehydrogenase, nitrate reductase and glutamine synthetase which connected to N assimilation pathways in addition to the ability to act as natural chelates for cationic micronutrients (Varanini and Pinton 1995; Canellas *et al.,* 2013; Hernandez *et al.,* 2015). Furthermore, humic substances are stimulate microbial activity (Table 8) which in turn enhances water soluble P and total N content (Busato *et al.,* 2012).

The compost tea affected the biological activities in non-significant pattern compared with humic substances where they applied individually with mineral fertilizers by different concentrations (T2 to T9).However, the combined application (T10 to T15) of compost tea and humic substances significantly increased the biological activities especially at low rates of mineral fertilizes. Considering the efficacy of compost tea (Kim *et al.*, 2015). Stated that the nutrients in compost tea have been detected in plant roots as early as one hour immediately after application. Consequently, the water-based compost tea enhanced the uptake and accumulation of nutrient elements in the plant (Rodríguez-Ortíz *et al.,* 2006). Also, microbial communities present in compost tea may induce disease resistance as well as stimulate nutrient uptake and plant growth (Scheuerell and Mahaffee 2002; Ingham 2005).

Yield attributes

The yield of pea under the influence of the treatments is presented in Table (9) on terms of seed and straw yield as well as total protein in seeds.

Table 9: Effect of compost tea and humate potassium on seed yield, straw yield and weight of 100 seeds pea plant.

Parameters / Treatments	Pea yield (ton /feddan)	Straw yield (ton /feddan)	Total protein in seeds (%)
T1	3.32	4.63	23.92
T2	2.78	3.86	17.68
T3	3.42	4.94	18.20
T4	3.05	4.27	24.44
T5	4.28	6.31	25.35
T6	2.83	3.91	17.42
T7	3.29	4.50	17.88
T8	2.99	4.25	19.50
T9	3.32	4.26	21.32
T10	3.52	4.45	20.15
T11	4.02	5.70	25.94
T12	3.47	4.91	20.80
T13	4.31	6.35	26.07
T14	4.32	6.32	26.33
T15	3.49	4.97	25.35
L.S.D at 0.05 %	**1.3685**	**1.7624**	**1.795**

1 feddan = 0.42 hectares = 4200 m^2

The data reveals that half the dose of NPK in combined addition of 50% of humic substances and compost tea yielded the highest seed and straw yield as well as total protein percent in seeds. The full dose recorded 3.32 and 4.63 ton/feddan as well as 23.92% total protein in seeds. On the other hand, the combined addition of humic substances and compost tea recorded 3.49 to 4.32 ton/feddan and 4.45 to 6.35 ton/feddan for pea seeds and straw yield, respectively. The total protein parallelly ranged from 20.15 to 26.33% duo to the combined application of compost tea and humic substances.

The yield improvement in response to compost derivatives, compost tea and humic substances, which characterized by the presence of plant nutritive macro and microelements, including potassium, calcium, magnesium and plants, has been largely linked to the presence of hormone-like molecules, including gibberellins, indoleacetic acid and cytokinins (Ertani *et al.,* 2013; Zhang *et al.,* 2014). Our results are in harmony with Badawi e*t al.* (2014); Kim *et al.* (2015); Ali *et al*. (2018).

Conclusion

It could be concluded that the combination treatment between compost tea and humic substances with half dose of NPK fertilizer, followed by the same combination with 75% NPK enhancing the most studied characters of peas. This will contribute to, lowering pollution with NPK fertilizers, and decreasing the costs by using friendly organic fertilizer with the environment, and to compensate NPK fertilizer.

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