

PERFORMANCE OF N, P, AND K PLANT UPTAKE, AS EFFECTED BY APPLICATION BOTH COMPOST TEA, VERMICOMPOST TEA, AND RHIZOBIA FOR FABA BEAN PLANT

Hussein, Mona, H.A.* and Abo-Taleb, H.H.

Soil, Water and Environment Research Institute, Agricultural Research Center Giza, Egypt.

Received: Dec. 22 , 2022

Accepted: Mar. 29, 2023

ABSTRACT: Two field experiments were conducted in clay soil at own farm, Monufia governorate during the two successive seasons of 2020/2021 and 2021/2022 to study the effect of using some organic components as organic fertilizers and or growth, promoting substances on growth, yield and yield components of faba bean plants. Inoculated faba bean with rhizobial inoculation were treated with compost tea or vermicompost tea at two rates (5 and 10 L.fed⁻¹) in combination with 1/3 N-fertilizer from the recommend dose. Vegetative growth, yield and yield components parameters, i.e., plant height, number of branches, plant dry weight, nodules dry weight, number of nodule, N, P, and K uptake (%) and number, weight of pods as well as seed yield and protein contents were also, determined. The obtained results indicated that application of both compost tea and vermicompost tea rerates up to 10 L, fed⁻¹ had a positive effects on all tested parameters and caused significant increases when compared to untreated treatment. Using vermicompost tea at rate of 10 L. fed⁻¹ with inoculated faba bean plant in combination with 1/3 N fertilizer dose is the best treatment for achieving better crop growth and yield of faba bean plants with reduced N-fertilizer uses as well as environment pollution.

Key words: Faba bean plants (*Vicia faba L.*), vegetative growth, yield and yield components, organic components, organic fertilizers, growth promoting, vermicompost, N-fertilizer.

INTRODUCTION

Faba bean (*Vicia faba L.*) is a major legume crop widely cultivated in many countries and in Egypt for food and feed purposes and its importance comes from the high value of seed protein contents. The use of plant growth promoting rhizobacteria (PGPR), including N₂-Fixing bacteria as a biofertilizer was suggested as sustainable to improve plant nutrient and production (Vessey, 2003).

Biological nitrogen fixation, especially rhizobia inoculation with legumes crops-symbiotic nitrogen fixation– is one of the alternative and the promising technologies which plus an important role in reducing the consumption of chemical N-fertilizes, increasing soil fertility, decreasing the production coasts and produce a safe food as well as decreasing environment pollution (Herridge *et al.*, 2008).

Application of organic farming treatments which avoids or largely excludes the use of

synthetically produced fertilizers, pesticides, and growth regulators such as compost and vermicompost or its extracts (teas) had an ability to convert nutrients from unavailable to available forms to maximize the nutrient uptake (Watson *et al.* 2002). Use of PGPR as biofertilizer and organic fertilizers or substances in agriculture is becoming popular nowadays for not only in order to reduce the cost of chemical fertilizers but also to decrease the adverse effects of chemical fertilizers on soil and air environment and to ensure more crop productivity under sustainable agricultural systems (Verma, *et al.* 2013). Compost tea and vermincompost tea produce one products derived from accelerated biological degradation of organic wastes by aerobic fermentation by using microorganisms at case of compost and microorganisms plus earthworms at case of vermin compost (Poking, 1995 and Simon *et al.*, 1999). Many studies were reported that application of biofertilizer in combination with organic fertilizer on faba bean

plant led to improve vegetative growth and increase both yield and yield components under different soil conditions (El-Habbasha, *et al.*, 2007, Metwali, *et al.*, 2015 and Siam *et al.*, 2016). This work aim to study the effect of combined applications of biofertilizer with compost tea or vermicompost tea and Rhizobium inoculation on growth, yield and yield component of faba bean plants.

MATERIALS AND METHODS

Field experiment were carried out in clay soil at own farm, Menyofia governorate during the two successive seasons of 2020 and 2021, to investigate the effects of using both compost tea and vermicompost tea on growth, yield and yield components of faba bean plant some mechanical, physical and chemical of soil properties were found at Table (1), according to (Jackson, 1973).

Seed of faba bean (*Vicia faba*) cultivar namely Giza 8436 was kindly provided from legumes Dept. Res., Agronomy- field crops inst. ARC, Egypt.

Bacterial inoculum, with biofertilizer N₂-fixing bacteria by using composite inoculum from mix two rhizobial strains manly ICORDA 441 and Bennie Sew F1 belong to *Rhizobium leguminosarum biovicia* applied as peat – inoculant (seed inoculation,) at rate of 4g per 100g seeds. This inoculant was kindly obtained from Bio-fertilizers Production Unit of soil, water and environment research Institute. (SWERI) ARC, Giza Egypt.

Organic treatments: Both compost tea and vermicompost tea are the products derived from accelerated biological degradation of organic wastes by interaction between microorganisms as such (compost tea) or incombination with earthworms (vermicompost tea) and soaking in water (1: 10) using, as foliar application at two rates 5 and 10 L per fadden adding at 40 and 60 days after planting. Some chemical properties of both compost tea and vermicompost tea were presented in Table (2) according to (page *et al.*, 1982).

Table (1): Some chemical, physical and mechanical properties of experimental soil.

Properties	Value
Carouse sand%	2.75
Fine sand%	21.1
Silt%	36.47
Clay%	39.67
Calcium carbonate%	0.70
Texture	Clay loam
SP%	53.12
pH	7.62
E.C.d 5 m	0.57
O.M%	0.68
T.N %	0.070
Soluble Cations (megl⁻¹)	
Ca ⁺⁺	2.70
Mg ⁺⁺	1.80
Na ⁺	1.22
K ⁺	0.19
Soluble anions (meg²⁻¹)	
Co ⁺⁺	0.00
Hco ⁻	1.70
Cl ⁻	2.09
So ₄ ⁻	2.12

Table (2): Some chemical properties of compost tea and vermicompost

Properties	Value of compost tea	Value of vermi compost
PH	8.41	8.60
E.C (d 5 m ⁻¹)	2.83	3.11
Available N-NH ₄ ppm	7.85	9.31
Available N-No ₃ ppm	22.75	36.81
Total Nitrogen ppm	751	836
Total Phosphors ppm	10200	13500
Total Potassium ppm	12400	15400
Fe ppm	12.70	15.30
Zn ppm	6.70	9.70
Mn ppm	2.90	3.30
Cu ppm	1.40	1.70

Chemical fertilizer: Nitrogen fertilizer was applied in the form of ammonium sulphate (20.5% N) at the two rates (20 and 60 Kg N fed⁻¹), and divide into two doses. All others practices were applied as recommended according to the Ministry of agriculture, Egypt.

Treatments

Six treatments with three replications were arranged in complete randomized block design (RCBD) The experimental plot size was (3 x 3-5 = 10-5m²).

as follows:

- 1- Full does of mineral nitrogen fertilizer (60 kg N fet⁻¹) (T1)
- 2- Rhizobium inoculation + 1/3 N fertiliser (T2)
- 3- T2+Compost tea (5L fed⁻¹) + 1/3 N fertiliser (T3)
- 4- T2+Compost tea (10 L fed⁻¹) + 1/3 N fertiliser (T4)
- 5- T2+Vermicompost tea (5L fed⁻¹) + 1/3 N fertiliser (T5)
- 6- T2+Vermicompost tea (10L fed⁻¹) 1/3 N fertiliser (T6)

Measurements and collecting data

Vegetative growth i.e., (75 day after planting) ten plants were randomly taken for each replicate to determine plant height, number of branches,

plant dry weight, N,P and K uptake (%), as well as to determine number of nodules, nodules dry weight and plant N content. At harvest time i.e., (120 days after planting) ten plant were taken to determine pods number and weight, seed yield (g plant), seed index, seed yield Kg plot⁻¹,seed yield (ton feed⁻¹), seed protein content (%) and N,P and K contents according two (A.O.A.C.2003).

Statistical analyses

Statistical analyses of the results were performed using analysis of variance ANOVA and least significant difference (LSD) was calculated (Steel and Torrie 1980).

RESULTS AND DISCUSSION

Nodulation status

Data in Table (3) reveal that the experimental site had a few values of native rhizobia and the inoculated plant and received full nitrogen fertilizer dose recorded the lowest values for nodule number 7 nodule plant⁻¹ with nodule dry weight (31.0 mg plant⁻¹). Rhizobial inoculation with specific rhizobial strains in combination with 1/3 N. fertilizer dose led to scrod significant increases between various applied treatments and recorded higher, values of nodule (42 to 58) and nodule dry weight (173.4 to 237.2) among the

two tested seasons. Application of vermicompost tea as foliar application at the two rates gave the highest values for the two tested treatments and the highest values were found at the inoculated faba bean plants and received vermicompost (rote 2)+ 1/3N-fertilizer and gives 58 and 237.2 for nodule number dry weight, respectively at the second season. N-content (mg plant⁻¹) in Table 3 reported that plant N content was affected by the two different rates (5 and 10 L. fed⁻¹) for both compost tea and gave highest values when compared with inoculated faba bean plants + 1/3 N-fertilizer dose. Application of vermicompost tea at the two rates gave highest values when compared to those obtained by using compost tea through the two tested seasons. The highest plant N-content value was found at the inoculated faba bean plant with 1/3 N fertilizer in combination with 10 L. fed⁻¹ of vermicompost tea and gives 1186.5 and 1261.1 first and second seasons, respectively.

These data are in agreement with those obtained by (Reminder and Chandra 2008, Saleh *et al.*, 2008 and Rabab-Ismael *et al.*, 2018), who reported that, application of rhizobia inoculation in combination with some organic treatment

under low amount of N-mineral fertilizer led to give positive affect on nodulation states as well as plant N-content and recorded significant increased when compared with other tested treatments.

Vegetative growth

Data in Table (4) showed that application of both compost tea and vermicompost tea treatments in combination with inoculated faba bean plants 1/3N fertilizer dose led to record significant increases at plant height, number of branches and plant dry weight when compared with inoculated plants+ 1/3N treated plants as well as gave highest value as compared to un inoculated plants and received full dose of mineral fertilizer, during the two tested seasons. Inoculated faba bean plants + 1/3 N and record vermicompost tea at rate of 10 L fed⁻¹ gave highest value for plant height (143.15 -147.75), Number of branches (4.3 -4.3) and plant dry weight (39.4- 40.55) during first and second seasons, respectively and recorded significant increase when compared to the treatments which received full dose of mineral fertilizers among the two tested seasons.

Table (3): Number of nodules, dry weight of nodules and plant N- content of inoculated faba bean plants as effect by the applications of both compost and vermicompost tea, rhizobial inoculation as with N Fertilizers levels under field condition during 2020 and 2021 seasons.

Parameters	Number of nodules (no. plant ⁻¹)			Dry weight of nodules (mg-plant ⁻¹)			Plant N- Content (mg, plant ⁻¹)		
	S ₁	S ₂	X	S ₁	S ₂	X	S ₁	S ₂	X
T1 F.N (cont.)	7	6	7	31.7	30.3	31.0	1187.5	1243.9	1215.9
T2 1/3 N	42	45	44	173.4	178.2	175.8	835.8	889.3	862.3
T3 1/3 N+Compst-T ₁	47	49	48	197.4	201.3	199.4	859.1	941.6	900.4
T4 1/3 N+Compst-T ₂	49	15	50	205.7	219.3	212.5	974.7	1011.7	993.2
T5 1/3 N +Vermi T ₁	52	55	54	211.3	224.7	218.0	1064.5	1121.0	1092.8
T6 1/3N +Vermi T ₂	55	58	57	217.6	237.2	227.4	1186.5	1261.1	1223.8
LSD 0.05	5.0	7.0	-	15.2	22.3	-	124.7	154.8	-

S₁: first season S₂: second season X: means or averaged)

Table (4): Plant height, number of branches and plant dry weight of inoculated faba bean plants as effect by the applications of both compost and vermicompost tea ,rhizobial inoculation as with N Fertilizers levels under field condition during 2020 and 2021 seasons.

Parameters	Plant height cm (cm plant ⁻¹)			Number of branches (no.plant ⁻¹)			Plant dry weight (g. plant ⁻¹)		
	S ₁	S ₂	X	S ₁	S ₂	X	S ₁	S ₂	X
T1 F.N (cont.)	141.11	141.82	139.47	4.1	4.2	4.2	37.11	38.75	37.93
T2 1/3 N	104.82	112.35	111.1	2.7	2.9	2.8	28.72	30.35	29.54
T3 1/3 N+ Compost	121.37	125.72	123.55	3.8	3.9	3.9	29.22	31.81	30.52
T4 1/3 N + Compost	125.35	131.93	128.44	3.8	3.9	3.9	32.93	33.95	33.44
T5 1/3 N+ Vermi	131.42	139.77	135.59	4.0	4.1	4.0	35.72	37.12	36.42
T6 1/3 N+ Vermi	143.15	147.72	145.44	4.3	4.3	4.3	39.42	40.55	39.99
LSD 0.05	7.82	9.36	-	0.13	0.15	-	2.45	3.41	-

S₁: first season S₂: second season X: means or averaged)

N, P and K uptake (%) are found in Table (5), the obtained data demonstrated that highest values were recorded for N, P and K (%) uptake with the inoculated + 1/3 N pants and treated with compost tea or vermicompost tea as compared to the inoculated plant and received 1/3 N but there was no significant differences were found between them. The inoculated plants and received full mineral fertilizers dose gives significant increases when compared with the inoculated pants and received 1/3 N + compost tea. Application of vermicompost tea at the two differences rates i.e., (5 and 10 L. fed⁻¹) resulting no significant differences as compared to the fertilized faba bean plants with full dose of N. mineral fertilizer.

Harvest stage

Data in Tables (6 and 7) showed that Pods number and weight and, seed yield g plant⁻¹. (Kg) plot⁻¹ and ton fed., seed protein contents as well as seed index. The obtained results cleared that applications of rhizobial inoculation in combination with compost tea or vermicompost tea with 1/3 N fertilizer dose led to significant differences between various tested treatments when composed to un inoculated faba bean plants + 1/3 N. mineral fertilizer. Pods number ranged from 43 to 63 and pod weight from 142.6 to 231.7 and the highest values were found at the treatment which received full dose

of mineral fertilizer gives 69 and 244.9 for pods number and pod weight, respectively. In the same time There was no significant differences for the above mentioned traits were found when compared to inoculated plants + 1/3 N. and received vermicompost tea at rate of 10 L fed⁻¹ during the two tested seasons. The same way, was obtained at seed yield g/plant⁻¹ as shown in Table (6) and applied the two vermicompost tea at (10 L. fed⁻¹) + 1/3 N, had no significant values as compared to fertilizer faba beam with full dose of mineral fertilizers.

Data in Table (7) clear that the seed index, seed yield Kg plot, seed yield ton. fed and seed protein contents (%) were affected by the applications of both rhizobial inoculation and, the two different rats of compost and vermicompost tea and led to recorded significant increased when compared to inoculated faba bean Pants + 1/3N only. The highest values of seed index gave (88.3), seed yield Kg plant⁻¹ was (6.6 kg/plant), seed yield ton. fed⁻¹ was (2.64) and seed protein content (24.75%) were found at the un inoculated plants and received full dose of mineral fertilizer at second season. In the same time there was no significant increased were found when compared to the inoculated faba bean plants +1/3 N. and received foliar application with vermicompost tea at rate of 10 L. fed⁻¹ during both seasons.

Data in Table (8) showed that N, P and K (%) contents of faba bean seed gave lowest values of N,P and K seed content with the inoculated faba bean plant and gave a fertilizer with 1/3 N. dose and these values were 3.18, 0.374 and 4.11% as a mean for the two tested season, respectively. Application of both compost and vermicompost tea, led to scored highest values and significantly increased when compared to untreated plants and these values ranged from 3.49, 3.81, 0.392 and 0.462 for N,P and K as a mean for the two tested seasons, respectively. The highest values were (3.46), (0.452) and (4.81) for N, P and K with the uninoculated and fertilized faba bean plants with full dose of N. mineral fertilizer and there was no

significant increased were found when compared to inoculated +1/3 N faba plants and received vermicompost tea at (10 Lfed⁻¹). The obtained results are in horminy with (Saleh *et al.*, 2008, Mnbage *et al.*, 2014, Samch *et al.*, 2017, Rabab Ismael *et al.*, 2018 and Noura- Bechtaoul *et al.*, 2020) who reported that applications of bio and organic fertilizers treatment on faba bean plants had a activation effect on nodule status ,biological nitrogen fixing, plant content vegetative plant growth (plant height, number of branches and plant dry weight), plant value nutrition and yield parameters such as number and weight, seed index and seed yield parameters.

Table (5): N,P and K uptake (%) of inoculated faba bean plants as effect by the applications of both compost and vermicompost tea , rhizobial inoculation as with N Fertilizers levels under field condition during 2020 and 2021 seasons.

Parameters	Plant N % up take			Plant P % up take			Plant K % up take		
	S ₁	S ₂	X	S ₁	S ₂	X	S ₁	S ₂	X
T1 F.N (cont.)	3.20	3.21	3.21	0.241	0.253	0.247	3.35	3.41	3.38
T2 1/3 N	2.91	2.93	2.92	0.217	0.222	0.220	3.21	3.29	3.25
T3 1/3 N+ Compost	2.94	2.96	2.95	0.219	0.227	0.223	3.28	3.47	3.38
T4 1/3 N+ Compost	2.96	2.98	2.97	0.231	0.235	0.233	3.1	3.17	3.09
T5 1/3 N+ Vermi	2.98	3.02	3.00	0.238	0.243	0.241	3.12	3.22	3.17
T6 1/3 N+ Vermi	3.01	3.11	3.06	0.240	0.249	0.245	3.25	3.35	3.30
LSD 0.05	0.22	0.17	-	0.07	0.18	-	0.13	0.17	-

S₁: first season S₂: second season X: means or averaged)

Table (6): Pods number, Pods weight and Seed yield per plant of inoculated Faba bean plants as effect by the applications of both compost and vermicompost tea , rhizobial inoculation as with N Fertilizers levels under field condition during 2020 and 2021 seasons.

Parameters	Pod number (No. plant ⁻¹)			Pod weight (g.plant ⁻¹)			Seed yield (g. plant ⁻¹)		
	S ₁	S ₂	X	S ₁	S ₂	X	S ₁	S ₂	X
T1 F.N (cont.)	62	69	66	220.0	224.9	232.5	103.7	106.2	104.9
T2 1/3 N	43	45	44	142.6	149.7	146.2	68.3	71.7	70.0
T3 1/3 N+ Compost	49	52	51	169.2	184.5	176.9	84.4	92.0	88.2
T4 1/3 N+ Compost	53	57	55	186.9	193.9	190.4	93.2	96.7	94.4
T5 1/3 N+ Vermi	57	59	58	202.3	219.4	210.9	99.4	101.7	100.6
T6 1/3 N+ Vermi	60	63	62	212.7	231.7	222.2	101.8	105.6	103.7
LSD 0.05	3.7	3.9	-	37.1	41.7	-	7.3	8.9	-

S₁: first season S₂: second season X: means or averaged)

Table (7): Seed index, Seed yield per plot and Seed yield ton fed-1 and Seed Protein Content % of inoculated faba bean plants as effect by the applications of both compost and vermicompost tea, rhizobial inoculation as with N Fertilizers levels under field condition during 2020 and 2021 seasons.

Parameters	Seed index (100 seeds g ⁻¹)			Seed yield (kg. plot ¹)			Seed yield (Ton fed. ¹)			Seed Protein Content %		
	S ₁	S ₂	X	S ₁	S ₂	X	S ₁	S ₂	X	S ₁	S ₂	X
T1 F.N (cont.)	84.9	88.3	86.6	6.3	6.6	6.5	2.52	2.64	2.58	24.38	24.75	24.57
T2 1/3 N	81.3	85.7	83.5	3.1	3.5	3.3	1.24	1.45	1.32	19.44	20.25	19.85
T3 1/3 N+ Compost	83.1	87.3	85.2	4.6	5.3	5.0	1.84	2.12	1.98	21.81	22.25	22.03
T4 1/3 N+ Compost	83.7	85.2	88.5	5.3	5.7	5.5	2.12	2.28	2.20	22.19	22.56	22.38
T5 1/3 N+ Vermi	83.9	87.2	85.6	5.9	5.2	5.6	2.36	2.08	2.22	22.50	23.25	22.88
Inco 1/3 N+ Vermi	84.3	88.2	86.3	6.2	6.5	6.4	2.48	2.60	2.54	22.81	23.81	23.31
LSD 0.05	1.07	1.11	-	0.87	0.93	-	0.46	0.52	-	2.25	1.13	-

S₁: first season S₂: second season X: means or averaged)

Table (8): N.P and K seed faba bean content (%) inoculated faba bean plants as effect by the applications of both compost and vermicompost tea , rhizobial inoculation as with N Fertilizers levels under field condition during 2020 and 2021 seasons.

Parameters	Seed N % content			Seed P % content			Seed K % content		
	S ₁	S ₂	X	S ₁	S ₂	X	S ₁	S ₂	X
T1 F.N (cont.)	3.90	3.96	3.93	0.422	0.482	0.452	4.75	4.81	4.78
T2 1/3 N	3.11	3.24	3.18	0.345	0.403	0.374	4.01	4.21	4.11
T3 1/3 N+ Compost	3.49	3.53	3.51	0.392	0.411	0.402	4.23	4.37	4.30
T4 1/3 N+ Compost	3.55	3.61	3.58	0.397	0.432	0.415	4.35	4.41	4.38
T5 1/3 N+ Vermi	3.66	3.72	3.66	0.403	0.441	0.422	4.42	4.53	4.48
T6 1/3 N+ Vermi	3.65	3.81	3.73	0.411	0.463	0.437	4.55	4.62	4.598
LSD 0.05	0.33	0.27	-	0.37	0.29	-	0.18	0.21	-

S₁: first season S₂: second season X: means or averaged)

Conclusions

Field experiment lay out through the two successive seasons have demonstrated that nodule status, N, P and K uptake and faba bean yield and yield components could be significantly affected and improved by the applications of rhizobial inoculation in combination with N. mineral fertilizers at (1/3N) with foliar application of both compost

tea and or vermicompost tea. The results of this study indicate that possibility of using vermicompost tea at rate of 10 L. fed. for achieving better crop growth and yield of faba bean plants with reduced usage of N-fertilizer as well as environmental pollution.

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كفاءة امتصاص عناصر النتروجين والفوسفور والبوتاسيوم فى محصول الفول البلدى نتيجة استخدام كلا من الكمبوست تى والفيرم كمبوست تى والريزوبيا

منى حسين عبدالفتاح حسين، حاتم حسين أبو طالب يوسف

معهد بحوث الأراضى والمياه والبيئة- مركز البحوث الزراعية -الجيزة - مصر.

الملخص العربى

اجريت تجربة حقلية فى اراض طينية فى مزرعة خاصه بمحافظة المنوفية خلال موسمى (٢٠٢٠/٢٠٢١ و ٢٠٢١/٢٠٢١) وذلك بهدف دراسة تأثير استخدام بعض المكونات العضوية كأسمدة عضوية او مواد منشطة للنمو على النمو والحصاد و مكوناته لمحصول الفول البلدى . تم اسخدام كل من شأى الكمبوست وشأى الفيرموكمبوست بمعدلات ٥ و ١٠ لتر للفدان مع نباتات الفول الملقحة ببيكتريا الريزوبيا فى وجود ٣/١ الجرعة السمادية من الجرعة الموصى بها للسماد النتروجينى . تم تقدير بعض القياسات فى مرحلة النمو الخضرى وكذا مرحلة الحصاد وذلك مثل ارتفاع النباتات والتفرع ووزن النبات الجاف وعدد العقد الجذرية ووزنها الجاف و محتوى العناصر (النتروجين - الفوسفور - البوتاسيوم) وايضا عدد ووزن القرون وحصاد البذور مع حساب نسبة البروتين . اظهرت النتائج المتحصل عليها ان تطبيق كل من شأى الكمبوست و شأى الفيرموكمبوست بمعدلات حتى ١٠ لتر للفدان الى وجود تأثير ايجابى وايضا تسجيل زيادات معنوية مقارنة بالمعاملات الغير مضاف اليها . أدى تطبيق واستخدام شأى الفيرموكمبوست بمعدل ١٠ لتر للفدان مع نباتات الفول الملقحة فى وجود ٣/١ الجرعة السمادية النتروجينية للحصول على جرعة الاسمدة النتروجينية للحصول على افضل نمو خضرى وحصاد وايضا تقليل اسخدام الاسمدة النتروجينية وايضا خفض التلوث البيئى .