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Comparative Study of Organic and Mineral Fertilization on *Plantago arenaria* Plant

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Abstract: A greenhouse experiment was conducted to determine the effect of three levels of compost tea (100, 200 and 300ml\L compost) and two levels of mineral fertilizer (100, 100, 50 and 200, 200, 50 NPK) or their combinations on yield and chemical constituents of *Plantago arenaria*. The various fertilizers levels caused significant promotion for herb fresh and dry weight, mucilage content as well as P, K, Fe, Cu, Zn and Mn. Highest level of organic and mineral fertilizers increased significantly total carbohydrates content. The substituted part of the mineral fertilizer with organic manure gave in general more beneficial effect as discussed in the results.

Key words: Plantago arenaria, fertilization, compost, mucilage, macro and micro nutrients

INTRODUCTION

Plantago arenaria belongs to the family *Plantagenaceae* is an annual herb cultivated as a medicinal plant in recent decades. Its seeds contain mucilage, fatty acids, large quantities of albuminous matters, a pharmacologically incentive glycosides and a plantiose sugar. *Plantago arenaria* has been used as a safe and effective laxative for thousand of years in Western herbal medicine[1] The dried seed husks are demulcent, emollient and purgative[2,3]. The seed and husks contain high level of fiber; they expand and become highly gelatinous when soaked in water.

On the other hand, the intensive cropping systems with fertilizer responsive crops that rely on high input of inorganic fertilizers often lead to non-sustainability in production and also pose a serious threat to soil health. Application of organic sources of nutrients with no or very little use of inorganic fertilizers is rapidly gaining favour. Integrated nutrient management with both organic and inorganic fertilizers was investigated. Kolodziej[4]. Studied the effect of four levels of mineral fertilization on *Plantago lanceolata L* through three cones years. Plantain cultivation without application of mineral fertilization produced significantly lower yields of leaves, characterized however by the highest active substances content and better sanitation. Along with increasing mineral fertilization level there was observed an increase of yields of leaves. Mandal *et al.*[5] showed that application of different doses of inorganic nutrients had considerable influence on growth, yield and downy mildew interaction in isabgol *plantago ovata* for 2 consecutive years. The highest N supply (60 kg ha^{-1}) caused more than 65% increase in disease severity compared with the control. The highest seed yield was obtained from 60 kg N ha^{-1}. Total sugar concentration in leaf tissue increased with the application of N, but the concentration of phenol decreased. On the other hand, growth of the plant was positively influenced by N.

The compost tea is a highly concentrated microbial solution produced by extracting beneficial microbes from vermicompost and\or compost .It is a source of foliar and soil organic nutrients, contain chelated micronutrients for easy plant absorption and the nutrients is in a biologically available form for both plant and microbial uptake.

Thus, this investigation was conducted to study the optimum dose of compost tea applied substitute with part of mineral fertilization to obtain the highest production of vegetative growth and flowering as well as chemical constituents of *Plantago arenarea.*

MATERIAL AND METHODS

The present investigation was carried out at the screen of National Research Centre, Dokki, Cairo, Egypt, during two successive seasons 2005\2006 and 2006\2007. to study the response of *Plantago arenaria* to various levels of organic mineral fertilizer as well as the influence of the substitute different rates of mineral fertilizer with organic one on the growth and chemical constituents.

The seeds were obtained from conservator El-jardins Botanious D-Nancy in France and were sown in pots (30cm, diameter filled with 12 kg soil) on first

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week of December for both seasons. The physical and chemical properties of experimental soil were determined using methods of Chapman and Prett[6] and the data are shown in table (1). After three weeks of sowing the plants were thinned twice.

The mineral fertilizer was added after two months from sowing at two levels of N: P: K as 100:100:50 and 200:200:50 Kg/ Feddan ammonium sulphat, super phosphate and potassium sulphat, respectively.

The organic fertilizer Compost tea was obtained from (Soil fertility Lab. Sekem Academy for Science) and was added after two months of sowing at two levels 100ml\L and 200ml\L. The physico-chemical properties of organic compost tea are shown in table (2).

The experiment divided into twelve groups included the following treatments;

- Treat.1: Control (unfertilized plants).
- Treat 2: Compost tea at 100 ml\L. (F1)
- Treat 3: Compost tea at 200ml\L. (F2)
- Treat 4: Compost tea at 300ml\L. (F3)
- Treat 5: Mineral fertilizers NPK at level 100:100:50. (F4)
- Treat 6: Mineral fertilizers NPK at level 200:200:50. (F5)
- Treat 7: 1\2 (NPK at 100:100:50) + compost tea 100ml\L. (F6)
- Treat 8: 1\2 (NPK at 200:200:50) + compost tea 200ml\L. (F7)
- Treat 9: 1\2 (NPK at 100:100:50) + compost tea 300ml\L. (F8)
- Treat 10: 1\2 (NPK at 200:200:50) +compost tea 100ml\L. (F9)
- Treat 11: 1\2 (NPK at 100:100:50) + compost tea 200ml\L. (F10)
- Treat 12: 1\2 (NPK at 200:200:50) + compost tea 300ml\L. (F11)

At the flowering stage (May 5 and 10 for first and second seasons, respectively) the plants were collected and plant height, number of flowers, number of tillers the fresh and dry weight of herb were recorded.

The chemical constituents of the dry herb were determined included:

- Total mucilage (mg\g) using methods describes by Karawya *et al.*[7]
- Total carbohydrates content and total soluble sugar were determined according to Dubois *et al*[8].
- Mineral content included,total nitrogen content using Kjeldahl method described by Bremner and Mulvancy[9], phosphors and potassium percentage estimated by method of Cottenie *et al*[10], Fe, Mn, Zn measured using atomic absorption spectrophotometer according to Chapman and Pratt[6].

The data obtained were subjected to stander analysis of variance procedure whereas values of LSD were obtained at 5% level as reported by Snedecor and Cochran[11].

RESULTS AND DISCUSSION

Plant Height: Data tabulated in Table (3) showed that plant height increased significantly as a result of fertilizer treatments. Increasing compost tea dosage significantly increased plant height up to 300 ppm. Application of mineral fertilizer significantly increased plant height comparing to control treatment. The maximum value of plant height was obtained as a result of application compost at 300ppm followed by $N_{100}P_{100}K_{50}$.

Number of Tillers or Flowers/plant: Fertilization treatments significantly increased number of tillers or flowers/plant as shown in Table (3). In this respect, $1/2(N_{100}P_{100}K_{50})$ + compost at 100 gave the highest mean values of tillers or flowers number/plant.

Herb Weight: The data presented in Table (3) evident that the all applied treatments in general significantly promoted effect on the accumulation of the fresh and dry herb weight .Meanwhile the two highs levels of compost tea gave more favorable effect on mass production compared with mineral fertilization levels. However the highest increment were recorded with application of 1\2 (100, 100, 50, NPK) +300ml\L compost tea which reached to 198.5% and 124.1% for herb fresh and dry weight over the unfertilized plants, respectively.Furthermore, the substituted part of mineral fertilizers with any of compost tea levels showed, in general, more production in fresh and dry herb weight the application of them individually.

Plant showed maximum value by treating plant with 1\2 (N100: P100: N50) combined with 300ml\L compost tea (848.3mg\plant), and this increment reached to 357.8% over the control treatment.

The positive effect of mineral fertilizer on Plantago species was reported with several researchers, i.e.;[12,13,14,15]. The beneficial effect of compost tea on herb yield may be due to its direct nutrition and\or its microbial functions. For its direct nutrition, the compost tea provides chelated micronutrients for easy plant absorption as well as nutrients in biological available from both plant and microbial uptake.

Table 1: Physical and chemical properties of experimental soil

Wet%	O.M %	pH	E.C mmohs/cm	C/N ratio	Organic carbon %	N %	P %	Mg %	Fe ppm	Mn ppm	Cu ppm	Zn ppm
35	70	7.24	2.1	23:01	25.8	1.2	0.8	-	790	190	73.1	380

Table 2: The physico-chemical properties and microbial population of organic compost tea

Bacterial Plate count (CFU/ml)	7.1×10^7	EC ds/m	0.923
Bacterial Direct count (Cell/ml)	6.4×10^8	pH	6.56
Spore forming bacteria (CFU/ml)	7×10^4	Mineral nitrogen ppm	249
Total fungi (CFU/ml)	1.1×10^4	Avilable phosphorus ppm	7.3
Actinomycetes (CFU/ml)	2.8×10^5	Avilable Potassium ppm	201
		Ca ppm	88
		Mg ppm	115
		Fe ppm	66
		Zn ppm	7.33

Table 3: Growth characters of *Plantago arenaria* as affected by organic and mineral fertilizer and the substituted of mineral rate by organic fertilizers (means of two successive seasons)

Treatments	Plant Height (cm)	No. of tillers	Herb Fresh wt (g/plant)	Herb Dry wt (g/plant)	No. of Flowers
Control	33.8	12.3	13.50	2.61	100.0
Compost tea 100 ml/l.	37.8	14.8	17.90	2.71	109.1
Compost tea 200 ml/l.	38.3	17.0	30.20	4.98	116.0
Compost tea 300 ml/l.	47.4	18.8	32.40	5.09	118.0
$N_{100}P_{100}K_{50}$	41.0	15.9	21.10	3.78	125.5
$N_{200}P_{200}K_{50}$	36.6	16.6	25.70	4.70	129.9
½($N_{100}P_{100}K_{50}$)+ Compost tea100	36.0	16.4	24.80	4.29	168.0
½($N_{100}P_{100}K_{50}$)+ Compost tea200	36.4	17.4	26.20	4.88	169.6
½($N_{100}P_{100}K_{50}$)+ Compost tea300	37.7	24.4	40.30	5.85	178.3
½($N_{200}P_{200}K_{50}$)+ Compost tea100	36.8	23.0	33.00	5.60	135.0
½($N_{200}P_{200}K_{50}$)+ Compost tea200	34.6	21.1	27.00	5.13	133.5
½($N_{200}P_{200}K_{50}$)+ Compost tea300	34.0	20.9	26.90	5.00	130.3
L.S.D. at 5%	2.3	1.9	2.80	1.60	3.6

In addition, its microbial functions, compost tea produced plant growth hormones, mineralize plant available nutrients and fixes nitrogen. Several investigators reported similar promotion effect for compost fertilizer on different plants such as[16] on *Organium majorana*, [17] on *Dracocephalum moldavica* and[18] on *Ruta graveolens*.

In this connection, Khalil[19] recorded that mucilage content in Plantago afra herb was not affected by organic manures, while adding the biofertilizers with organic manures producing the largest content of mucilage.

Mucilage Content: Mucilage content (mg/g and mg/plant) increased significantly by applied various levels of compost tea and / or NPK comparing to control treatment (Table, 4). Increasing the levels of the compost tea or NPK, significantly an increased mucilage content.

In contrary, Khalil[19] recorded that muculage content in *Plantago afra* herb was not affected by organic manures, while adding the biofertilizers with organic manures producing the largest content of mucilage.

The interaction between 1\2 (N200: P200: N50) and compost tea at 300 ml/L produced the highest of mucilage content (159 mg/ g) and this increament reached to 109.9% over the unfertilized treatment. Meantime, the mucilage content (mg/plant) showed its maximum value by treating plant with

Table 4: Total mucilage content (mg/g and mg/plant) of *Plantago arenaria* as affected by organic and mineral fertilizer and the substituted of mineral rate by organic fertilizers (means of two successive seasons)

Treatments	Mucilage (mg/g)	Mucilage (mg/plant)
Controll	71	185.3
Compost 100ppm	77	208.7
Compost 200ppm	94	468.1
Compost 300ppm	112	570.1
$N_{100}P_{100}K_{50}$	86	325.1
$N_{200}P_{200}K_{50}$	100	470.0
½($N_{100}P_{100}K_{50}$)+ Compost tea100	103	441.9
½($N_{100}P_{100}K_{50}$)+ Compost tea200	118	575.8
½($N_{100}P_{100}K_{50}$)+ Compost tea300	145	848.3
½($N_{200}P_{200}K_{50}$)+ Compost tea100	142	795.2
½($N_{200}P_{200}K_{50}$)+ Compost tea200	127	651.5
½($N_{200}P_{200}K_{50}$)+ Compost tea300	159	795.0
L.S.D. at 5%	3.4	7.9

Table 5: Total carbohydrate and total soluble sugars of *Plantago arenaria* as affected by organic and mineral fertilizer and the substituted of mineral rate by organic fertilizers (means of two successive seasons)

Treatments	Total carbohydrates %	Total soluble sugars %
Controll	46.25	35.42
Compost 100ppm	52.28	34.29
Compost 200ppm	46.04	37.54
Compost 300ppm	43.21	38.71
$N_{100}P_{100}K_{50}$	52.99	32.86
$N_{200}P_{200}K_{50}$	45.05	32.78
½($N_{100}P_{100}K_{50}$)+ Compost tea100	48.38	30.67
½($N_{100}P_{100}K_{50}$)+ Compost tea200	43.44	36.82
½($N_{100}P_{100}K_{50}$)+ Compost tea300	42.58	37.32
½($N_{200}P_{200}K_{50}$)+ Compost tea100	40.52	32.97
½($N_{200}P_{200}K_{50}$)+ Compost tea200	39.95	34.43
½($N_{200}P_{200}K_{50}$)+ Compost tea300	36.61	35.26
L.S.D. at 5%	2.3	1.67

1\2 (N100: P100: N50) combined with 300ml\L compost tea (848.3mg\plant). This increment reached 357.8% over the control treatment.

Total Carbohydrates Content(%): The effect of organic and inorganic fertilization significantly affected the total carbohydrates. the lowest levels of compost tea (100ml/l) significantly increased total carbohydrates comparing to unfertilized treatment. Increasing compost tea significantly decreased total carbohydrate. This was true up to 300 ml/ L level. This trend was the opposite of that of mucilage content (Table, 4). This observation may be attributed to the conversion of carbohydrate to mucilage

The results shown in Table (5) indicates that the lowest levels of the organic and the mineral fertilizers

Table 6: Macro and micro nutrients content of *Plantago arenaria* as affected by organic and mineral fertilizer and the substituted of mineral rate by organic fertilizers (means of two successive seasons)

Treatments	Macronutrients (%)			Micronutrients (ppm)			
	N	P	K	Fe	Cu	Zn	Mn
Controll	4.08	3.05	0.10	1575	15	125	65
Compost 100ppm	4.13	3.14	0.10	1600	35	140	65
Compost 200ppm	4.61	3.39	0.13	1650	40	170	70
Compost 300ppm	4.96	3.34	0.13	1650	40	175	70
$N_{100}P_{100}K_{50}$	5.65	3.48	0.16	1780	20	170	75
$N_{200}P_{200}K_{50}$	5.92	3.45	0.17	1805	35	195	90
½($N_{100}P_{100}K_{50}$)+ Compost tea100	4.93	3.12	0.12	1850	45	175	80
½($N_{100}P_{100}K_{50}$)+ Compost tea200	5.13	3.16	0.12	1880	45	175	85
½($N_{100}P_{100}K_{50}$)+ Compost tea300	5.24	3.35	0.17	1625	60	180	80
½($N_{200}P_{200}K_{50}$)+ Compost tea100	5.84	3.42	0.17	2050	62	200	80
½($N_{200}P_{200}K_{50}$)+ Compost tea200	6.02	3.42	0.17	2845	58	200	90
½($N_{200}P_{200}K_{50}$)+ Compost tea300	6.11	3.55	0.19	2225	60	215	95
L.S.D. at 5%	1.02	0.09	0.023	36.21	3.14	9.18	5.06

Table 7: The correlation between growth characters of *Plantago arenaria* and chemical constituents

	Herb fresh wt.(g/plant)X1	*Herb dry wt.(g/plant) X2*	*Mucilage (%) X3*	*Mucilage (mg/plant) X4*	*Total carbohydrate (%) X5*	*Total soluble sugars (%)X6*
X1	0.00	0.932**	0.736**	0.855**	- 0.534	0.380
X2		0.00	0.828**	0.923**	- 0.698*	0.270
X3			0.00	0.975**	- 0.847**	0.154
X4				0.00	- 0.824**	0.226
X5					0.00	- 0.311
X6						0.00

caused highest significant increment in total carbohydrates content, which recorded 13.1% and 14.6% for compost (100ml\L) and NPK (100,100,50).

In the other words, increasing the applied levels of both fertilizers negatively influenced on the accumulation of total carbohydrates content.

This could be explained by the fact that 100ml\L compost or NPK at100:100:50seem to be sufficient to produce the highest content of total carbohydrates and indicating that 200 and 300 ml\L compost or NPK at 200:200:50 stimulated the conversion of sugars to mucilage . The promotive effect of this character by low compost and mineral level may be due to the important role of nitrogen in metabolic processes like photosynthesis and carbohydrates synthesis. These results are in agreement with those of[20] on *Hysocyamus muticus*,[21] on *Verbascum thapsus* and[19] on *Plantago afra*.

As for the substituted various levels of compost with mineral fertilization, it could be concluded that the low level of mineral fertilizer 1\2 (NPK at 100:100:50) when coupled with the low level of compost tea (100ml\L) led to significant accumulation of carbohydrates, and this increment counted about 4.6% over the control treatment. On the other hand, the different substituted treatments recorded insignificant effect. This finding has been proved by the negative significant correlation between total carbohydrate and mucilage percentage, (Table 7). In addition to the negative correlation between total carbohydrate % and total soluble sugars %

Total Soluble Sugar Content (T.S.S): As shown in Table (5), the total soluble sugar in general take an opposite trend to that obtained with total carbohydrate content when *P.arenaria* plants fertilized with compost

or mineral or their substitution. Thus, the two highest levels of compost tea (200 and 300ml\L) produced the highest significant accumulation of T.S.S, while the two mineral fertilizer levels significant decreased T.S.S. For the substitution effect of mineral and organic fertilizer, the low mineral level 1\2 (N100 P100 K50) combined with highest compost level 300ml\L showed the significant increase for T.S.S.

In the respect, Salama *et, al*[21] on *Verbascum thapsus* stated that mineral nitrogen had a slight effect on total soluble sugars level with maximum decrease by the second nitrogen level(67 Kg N/Fed.).

Nutrients Content: From the data in Table (6) it can be noticed that the nutrients uptake in Plantago arenaria herb were significantly increased with applied different levels of compost tea, with one exception for nitrogen content. It is clear to notice that increasing compost levels or NPK levels caused a more accumulation in nutrient uptake. Thus compost at 300ml\L and NPK at ½ 200:200:50 caused the highest macro and micro nutrient content. Moreover, the two mineral fertilizer levels were more effective, in general than various compost tea levels for these characters.

Similar results were obtained with Herrera *et al,*[22] who indicated that N, P, K, Ca and Mg of thyme seedlings were increased with increasing compost ratio in growth media.

Also, El-Sherbeny *et al*[18], indicated that to produce Rata graveolens plants contained highest nutrients content, when treated with compost at 238kg N\hec.

Moreover, Kumawat *et al,*[23] on *Pantago ovata* Fork, revealed that the maximum NPK uptake by crop, were recorded under 60kgN\ha. However, the mineral or organic fertilization positively affected the initial development for several plants species which greatly influenced nutrient uptake (Sanchez and Saavedra[24], on *Plantgo albicans* and other species).

On the other hand, the higher mineral fertilizer combined with various compost tea levels showed the maximum values for macro and micro nutrient herb contents. Thus the maximum nitrogen value (6.02%) and Fe (2845ppm) were recorded with applied half (NPK at 200:200:50) combined with 200ml/L compost tea, while the highest P(3055%), K(0.19%), Zn(215ppm) and Mn (95ppm) were shown with 1\2 (NPK at 200:200:50) + 300ml\L compost tea.

Meanwhile, the maximum copper content was recorded with applied 1\2 (NPK at 200:200:50) + 300mlL compost. These results indicated that the substituted part of mineral manure with compost tea gave highest accumulation for various nutrients content. In this concern, Kandeel[25] on *Sweet basil*, revealed that 1\2, 3\4 dose of NPK (200,100 and 50 kg\Fed) with organic + biofertilizer recorded the highest value for growth characters and N, P, K contents, comparing with that treated with NPK alone. Moreover, Naguib and Aziz[20] indicated that application of compost, organic manure (chicken manure) either alone or in combination with NPK, were positively affected on N, P, K content of *Hyoscyamus muticus* plants. Similar results were obtained also with Ashorabadi *et al,*[26] on fennel plant and Anwar *et al,*[27] on French basil.

Conclusion: The previous findings indicated that the various levels of minerals or compost tea significantly improved herb yield, mucilage content, total carbohydrate content as well as nutrient content. Moreover, the substituted part of the mineral fertilizer with the organic fertilizer caused in general more promotion for the most previous characters, in addition to reduced the high dose of chemical fertilizers applied and prevent the environmental pollution as well as maintaining certain level of organic manure in soil physic-chemical conditions.

From the forgoing data it can be recommended to apply 1\2 (NPK at 100:100:50) with 300ml\L compost tea to obtain the good production yield with high active substance of Plantago arenaria plants.

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