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How-far Would *Plantago afra* L. Respond to Bio and Organic Manures Amendements

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Abstract: Two field experiments were conducted in the Experimental Farm Station of National Research Centre, at Shalakan Kalubia Governorate, Egypt, during the two consecutive seasons 2003/2004 and 2004/2005, to investigate the effect of three organic manures (FYM, poultry and commercial compost) and three biofertilizers (*Azotobacter chroococum*, yeast and EM) on *Plantago afra* L. The obtained results indicated that application of biofertilizers pronouncedly improved the effect of organic fertilization on growth, expressed as plant height, number of branches/plant and herb fresh and dry weight), yield (number of seeds and fruits/plant and seed yield/plant and/feddan which is a local area measurement equals 4200 m^2), chlorophyll, carotenoids as well as total flavonoids, mucilage, carbohydrate and N, P and K% in herb and seeds and fatty acid percent in seeds, and yield of fatty acids/plant and/feddan and increased their values. Nine components of fatty acids, 3 unsaturated and 6 saturated were identified in the *Plantago afra* L. seeds. The unsaturated fatty acids formed more than 60%, the main one was linolenic acid C18:3 (more than 40%); while the main constituent of the saturated acids was palmitic C16:0. The compost led to an increase in unsaturated acids, but FYM reduced them. Biofertilizers increased the unsaturated acids on the sake of the saturated ones.

Key words: *Plantago afra* L., organic manures, FYM, poultry, commercial compost, biofertilizers, *Azotobacter chroococum*, yeast, EM, growth, chemical composition

INTRODUCTION

Plantago afra L. (flohsamen, spanish psyllium) is a member of family Plantaginaceae, native to west Mediterranean countries[2]. It is an annual, erect glandular-hairy caulescent herb, with an erect branching stem. Fruit is membranous 2-celled and 2-seeded. Seeds silky to the touch, ovate to ovate-elongate, 1.3 – 3.7 mm long[1].

Plantago has a long history of popular traditional uses as medicine in the USA, Europe, India and China for treating various diseases varying from cold to cancer and viral hepatitis[2].

Plantago seeds are used in medicine almost exclusively in the treatment of chronic constipation and dysentery disorders. The efficiency of the drug would appear to be entirely due to the large quantity of mucilage in the seeds[3].Recently, the results of many investigations justified their effects as laxative, chronic and temporary constipation and soften the stool[4], and in treating cancers and infection diseases[5,6].

Application of different organic fertilizers had received increasing attention in the last two decades with an eye to put an end to the unversed uses of agrochemicals[7] and ensure safety for human health and environment in which we live[17]. They help in providing slow release of nutrients[9] and improve the physical characters of the soil[10]. Farmyard manure (FYM), poultry manure as well as organic compost is common in Egypt and widely used in farming of various fields and horticulture crops. Many researchers gained beneficial effects, when used different organic manures on several plants, as Khalil and El-Sherbeny[11] on the three *Mentha* species; El-Sherbeny *et al*[12] on *Sideritis montana*; Atta Alla *et al*[13] on *Capsicum annum* and Attia and Bardisi[14] on pea.

Biofertilizers are suitable amendments in improving physical, chemical and biological properties of the soil[15] They can provide to small and marginal farmers economically viable weapon to attain the ultimate goal of increasing crop productivity[16]. Their high cost could be compensated by the premium price of the product, especially in an export oriented crops[17].

The coincident application of organic manuring and biofertilizers is frequently recommended for improving

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biological, physical and chemical properties of the soil, in addition to getting highly clean agricultural yield[18], as well as improving growth, yield and chemical constituents on lemongrass[19]; on anise[20] and [21] on *Phllanthus niruri*.

For implementing of this concept, the present work was designed to study the response of *Plantago afra* L. to biofertilizers or and organic manures, under Egyptian conditions.

MATERIALS AND METHODS

Two field experiments were consummated in the Farm Station of National Research Centre, at Shalakan Kalubia Governorate, Egypt, during the two successive seasons of 2003/2004 and 2004/2005.

The aim of this study was to investigate the effects of the three organic manure Farmyard manure, poultry manure and organic compost (a product of Green Valley for Organic Products Co., SAE, Egypt). Individually or in combination with three biofertilizers, provided from General Organization for Agriculture Equalization Fund (G.O.A.E.F.), namely; *Azotobacter chroococum*, active yeast and Effective microorganisms (EM), on the growth, plant and seed constituents and yield of *Plantago afra* L.

The physical and chemical properties of the soil of the experiment are shown herein after: -

Parameters	First season	Second season
Sand (%)	48.8	50.8
Silt (%)	28.0	26.0
Clay (%)	23.2	23.2
Soil texture	Sandy loam	Sandy loam
pH	8.20	8.05
E.C. (mmohs/cm)	0.68	0.88
Soluble ions (soil paste) meq/litre		
Ca^{++}	1.10	1.19
Mg^{++}	0.89	0.76
Na^{+}	2.22	2.31
K^{+}	0.18	0.21
Co_3^{--}	0.15	0.21
HCo_3^{-}	0.68	0.66
Cl^{-}	2.00	2.32
So_4^{--}	1.12	1.14
Available elements (ppm)		
Total N	130	160
P	20.1	38.2
K	222.4	223.8
Fe	80	71
Mn	7.1	8.9
Zn	0.95	1.10
Cu	2.02	1.91

The soil of the investigation was divided into plots of 5.25 m^2 (3.0 X 1.75 m), surrounded with a belt one meter width. The soil was well prepared and the organic manures were added at the rate of 8 kg/m^2 as well as calcium superphosphate (15.5% P_2O_2) at the rate of 150 k/feddan during the preparation of the soil. After one week *Plantago afra* L. seeds were sown in hills 30cm apart on rows 60 cm in between and covered with a thin layer of the soil, then irrigated. Three weeks later, the developed plants were thinned to leave one plant per hill. The seeds of Azotobacter treatments only were inoculated with the bacteria directly before sowing.

Yeast and EM were applied as foliar sprays on foliage at two times at the rate of 3 g/liter, the first after one month from sowing, the other two months later.

The layout of the experiment was split plot design with three replications, where organic manures were devoted to the main plot and biofertilizers in the sub-plots.

While the analysis of the three organic manures were the following:-

Parameters	FYM	Poultry	Compost
Weight of one m^3 (kg)	611	493	521
Wet. (%)	40	30	35
O.M. (%)	55	72.9	70.0
pH	7.5	7.60	7.24
E.C. (mmohs/cm)	1.41	2.13	2.10
C/N ratio	22:1	19:1	23:1
Organic carbon (%)	31.6	26.10	25.8
N %	1.4	1.4	1.2
P %	0.76	0.82	2.41
K %	0.29	0.59	0.80
Mg %	--	--	--
Fe ppm	513	952	790
Mn ppm	96.0	189.2	190
Cu ppm	34.75	45.20	37.1
Zn ppm	47.2	65.5	65.0

At the end of the experiment, the following data were recorded in both seasons:

1- Plant growth: included: plant height (cm) from surface of the soil to plant apex, number of branches/plant, fresh and dry weight of plant herb (g).
2- Yield: number of fruits/plant, number of seeds/fruit, weight of 100 seeds (g), yield (g/plant) and (kg/feddan).

In the second season, samples of fresh herb were used to determine: chlorophyll a, b and carotenoids using the method reported by Moran[22].

Dry herb and seeds were used to determine: total carbohydrates, total lipids, total flavonoids, N, P and K (%) and Fe, Mn and Zn (ppm) using the methods of[23]. Mucilage was determined according to the method described by Smith and Montgomery[24].

Fatty acids methyl ester were prepared using benzene: methanol: concentrated sulphoric acid (10: 86: 4) and methylation was carried out for one hour at 80-90 °C [25]. The methyl esters prepared from oil samples and standard materials were analyzed by a Pye Unicum gas chromatograph equipped with a dual flam ionization detector. The separation of fatty acid methyl esters was conducted with column SP-2310, 55% Cyanopropyl phenyl silicone (1.5 X 4mm). Column was used with a temperatures program of 70-190 °C at 8 min. The injector and detector temperature were mined at 250 and 300 °C, respectively. The pressure of the carrier gas (nitrogen) was 18 kg/cm2, chart speed 0.35 cm/min. The relative percent of each compound was determined according to the peak area using a Varian 4270 integrator. The identification of fatty acids were determined by matching their retention times (Rt) with those of authentic samples under the same conditions. Yield of fatty acids was estimated per plant and per feddan.

The recorded data were averaged and the averages except those of fatty acid components were statistically analyzed[26], where the means were compared at the 5% level using the L.S.D. method.

RESULTS AND DISCUSSIONS

In general, the results revealed that all the tested biofertilizers pronouncedly improved the effects of the organic manures on the plant growth, yield, constituents and oil characters, as the resulting values surpassed those of the organic manures only. Such increments were significant in most cases at both seasons. Such results would be reasonable since biofertilizers were suggested to promote Co_2 evolution rate, which is effective in improving net photosynthesis[27,28], and increasing the production of plant growth substances[29]as well as promoting root regeneration[30,15] added that biofertilizers are suitable amendments in improving physical, chemical and biological properties of the soil.

Plant growth (Table 1): Poultry manure significantly increased plant height in the first season, over the other two organic manures, while in the second season insignificant differences occurred among them. As for, biofertilizers, both yeast and Azotobacter in the first season while the EM in the second one led to significant increment in plant height. But for the interaction, poultry manure X yeast in the first season and X EM in the second one significantly produced the tallest plants.

Concerning number of branches/plant, the compost in the first season and poultry manure in the second one, led significantly to the largest number. Applying yeast to the organic manures significantly increased such parameter in both seasons. As for the interaction, poultry manure X yeast significantly resulted the more branches in both seasons.

The maximum values of fresh and dry weights were significantly produced by compost in both season, except for the dry weight at the first season. As for biofertilizers, yeast caused significantly the heaviest fresh and dry weights in the first season, but in the second one the significant heaviest fresh and dry weights resulted due to azotobacter as well as yeast for dry herb weight.

Such results coincide with the findings of many researchers as[13]on *Capsicum annum* L. var santaka and [31]on garlic Vs. Balady and Chinese, comparing more than one organic manure. Also, the results on biofertilizers are in the same line of those of Migahed *et al*[29] Mir *et al*[32]on Indian mustard; on celery and Attia and Abdel Azeem[33] on *Lawsonia inermis* who reported that azotobacter treatment gave the best growth and heaviest plants.

Yield (Table 2): It is clear that Farm yard manure (FYM) significantly yielded the largest number of fruits/plant, number of seeds/plant and seed yield/feddan than the other two organic manures, during both seasons; producing 466.0 and 508.0 fruit/plant, 5534.8 and 6202.6 seed/plant and 316.0 and 378.59 kg/feddan in the first and second seasons, respectively. Inoculating *Plantago afra* L. seeds with azotobacter led to the maximum values of the aforementioned parameters. Such increments were significant in the case of number of seeds/plant and seed yield/feddan in both seasons. However, number of seeds/plant and weight of 100 seeds showed insignificant differences at both two seasons.

In this concern, many researchers obtained higher yield and fruit number/plant were obtained on Capsicum annum[13] and Lawsonia inermis[33] when FYM and/or azotobacter was used.

Chemical constituents in the herb (Table 3): Organic manures showed insignificant effect on chlorophylls (a, b and total). Whereas, azotobacter treatment significantly increased such parameters than other treatments. The interaction showed insignificant differences. [34] on gladiolus mentioned that azotobacter increased chlorophylls content.

Total carotenoides were significantly increased due to compost manure and yeast biofertilizer. However, interaction had inconsistent effect.

Concerning total flavonoids in herb, FYM among organic manures and EM among biofertilizers significantly produced the largest content. However, the compost X EM treatment gave the highest content among all treatment. Such increase was significant than most treatments.

Table 1: Effect of organic manures and or biofertilizers on growth of *Plantago afra* L., during 2003/2004 and 2004/2005 seasons

Treatments		Plant height		No. of branches		Herb			
						Fresh weight		Dry weight	
Manure	Biofertelizer	F.S.	S.S.	F.S.	S.S.	F.S.	S.S.	F.S.	S.S.
FYM	O	39.6	47.9	20.5	16.5	88.4	91.8	33.2	33.1
	EM	41	54.2	21.4	22.4	88.4	102.7	33.6	34
	Yeast	49	50.2	19.8	18.5	89.8	99.3	33.8	33.7
	Azoto	48	48.4	22.4	16.4	93.5	111.4	35.2	35.6
	Mean	44.4	50.2	21	18.5	90	101.3	34	34.1
Poultry	O	46	47	20	21.2	88.4	94.2	33.1	32.5
	EM	56.5	55.4	20	22	90	98.6	34.1	33.3
	Yeast	73.2	50	30.1	22.4	108.4	105.1	35.3	34.8
	Azoto	67.5	48	21.5	21.7	103	100.4	33.5	34.1
	Mean	60.8	50.1	22.9	21.8	97.5	99.6	34	33.7
Compost	O	41.5	48.5	25.4	19.5	78.3	106	27	34
	EM	41.5	49.2	27.5	18.6	116.4	115.7	37.2	36.4
	Yeast	42.5	48.5	26.3	22.4	119.8	120.7	38.2	38.5
	Azoto	48	51.3	27.5	21.6	92.2	118.2	34.4	37.5
	Mean	43.4	49.4	26.7	20.5	101.7	115.2	34.2	36.6
Mean	O	42.4	47.8	22	19.1	85	97.3	31.1	33.2
	EM	46.3	52.9	23	21	98.3	105.7	35	34.6
	Yeast	54.9	49.6	25.4	21.1	106	108.4	35.8	35.7
	Azoto	54.5	49.2	23.8	19.9	96.2	110	34.3	35.7
L.S.D. at 0.05	Manures	4.3	N.S.	2.2	1.1	6.4	2.3	N.S.	0.7
	Biofertilizers	7.3	1.5	1.2	1.2	8.7	4.3	2.9	0.5
	Interaction	6.1	1.8	1.2	1.4	2.1	2.2	1.2	0.4

F.S. = First season; S.S. = second season; EM= Effective micro-organisms; Azot. = *Azotobacter chreococum*.

Table 2: Effect of organic manures and biofertilizers on yield of *Plantago afra* L., during 2003/2004 and 2004/2005 seasons.

Treatments		No. fruits/plant		No. seeds				Weight of 100 seeds(g)		Yield			
				/fruit		/plant				g/plant		kg/fed.	
Manures	Biofertilizers	F.S.	S.S.	F.S.	S.S.	F.S.	S.S.	F.S.	S.S.	F.S.	S.S.	F.S.	S.S.
FYM	O	337.5	488.4	11.4	11.3	3847.5	5518.9	0.236	0.2356	9.08	13	201.6	288.6
	EM	417	520.3	12.1	12.6	5045.7	6555.8	0.2373	0.2345	11.97	15.37	265.7	341.2
	Yeast	512.5	491.5	12.1	12.5	6210.3	6143.8	0.2367	0.2433	14.68	14.95	325.9	331.9
	Azoto	597	531.6	11.8	12.4	7044.6	6591.8	0.2404	0.3	16.94	19.78	376.1	439.1
	Mean	466	508	11.9	12.2	5834.8	6202.6	0.2376	0.2534	13.17	15.78	292.3	350.2

Table 2: Continued.

Poultry	O	332.5	499.5	11.3	12.3	3757.3	6143.9	0.2341	0.2366	8.8	14.54	195.4	322.8
	EM	511.5	505.1	11.6	12.5	5933.4	6313.8	0.2388	0.2345	14.17	14.81	314.6	328.8
	Yeast	483	493.8	12.2	12.5	5892.6	6172.5	0.2399	0.2365	14.14	14.6	313.2	324.1
	Azoto	350.8	469.2	12.3	12.6	4314.8	5911.9	0.2403	0.2337	10.37	13.82	230.2	306.8
	Mean	419.5	491.9	11.9	12.5	4974.5	6135.5	0.2383	0.2359	11.87	14.44	263.5	320.6
Compost	O	360	487.6	11.6	11.2	4176	5461.1	0.2365	0.2351	9.88	12.84	219.3	258.1
	EM	372	455.2	12.2	12.2	4538.4	5553.4	0.2411	0.2347	10.94	13.03	242.9	289.3
	Yeast	376	460.4	15.5	12.4	4700	5709	0.2408	0.2366	11.32	13.51	251.5	299.9
	Azoto	485.6	501.3	12.4	12.4	6021.4	6216.1	0.2381	0.237	14.34	14.73	318.4	327
	Mean	398.4	476.1	12.2	12.1	4859	5734.9	0.2391	0.2569	11.62	13.53	257.9	293.6
Mean	EM	343.3	491.8	11.4	11.6	3926.9	5708	0.2355	0.2358	9.25	13.4	205.4	289.8
	Yeast	433.5	493.5	12	12.4	5172.5	6141	0.2391	0.2346	12.36	14.35	274.4	319.8
	Azoto	457.2	481.9	12.3	12.5	5598	6008.4	0.2391	0.2388	13.38	14.35	297	318.6
	Mean	477.8	500.7	12.2	12.5	5793.6	6240	0.2396	0.2569	13.88	16.11	308.2	357.6
L.S.D. at	Manures	52.4	12.6	N.S.	N.S.	84.7	102.4	N.S.	N.S.	N.S.	1.3	11.23	9.535
0.05	Biofertilizers	96.2	10.8	N.S.	N.S.	91.3	32.3	N.S.	N.S.	1.8	0.8	5.95	3.873
	Interaction	91.5	15.5	N.S.	N.S.	100.5	93.2	N.S.	N.S.	1.6	2.4	43.73	8.821

F.S. = First season; S.S. = second season; EM= Effective micro-organisms; Azot. = *Azotobacter chreococum*.

Table 3: Effect of organic manures and biofertilizers on some chemical constituents of *Plantago afra* L., plant herb during 2004/2005 season.

Treatments		Chl. a mg^{-1}	Chl.b mg^{-1}	Tolal chl. mg^{-1}	T.Carotenoides mg^{-1}	T.flavonoids	Mucilage	T. Carbohydrate %	N	P	K
Manures	Biofertilizers										
FYM	O	1.48	1.00	2.48	1.16	1.320	5.0	22.2	2.18	0.31	1.17
	EM	1.61	1.05	2.66	1.22	1.223	5.3	22.3	2.14	0.38	1.18
	Yeast	1.58	1.08	2.66	1.40	1.252	5.0	22.8	2.2	0.41	1.17
	Azoto	1.64	1.06	2.70	1.34	1.244	5.2	22.5	2.18	0.37	1.12
	Mean	1.58	1.05	2.63	1.28	1.26	5.13	22.45	2.18	0.37	1.160
Poultry	O	1.48	1.02	2.50	1.15	1.222	5.0	21.6	2.00	0.36	1.12
	EM	1.60	1.09	2.69	1.34	1.241	5.9	22.5	2.16	0.36	1.14
	Yeast	1.55	1.11	2.66	1.40	1.248	5.2	22.8	2.17	0.41	1.16
	Azoto	1.61	1.07	2.68	1.36	1.246	5.3	21.6	2.20	0.41	1.16
	Mean	1.56	1.07	2.63	1.31	1.24	5.35	22.13	2.13	0.39	1.145
Compost	O	1.56	0.95	2.51	1.18	1.223	5.3	22.0	2.04	0.33	1.13
	EM	1.56	1.06	2.62	1.35	1.322	5.5	22.7	2.08	0.34	1.15
	Yeast	1.56	1.06	2.62	1.33	1.235	5.2	22.5	2.00	0.37	1.18
	Azoto	1.60	1.12	2.72	1.40	1.230	5.4	22.3	2.06	0.40	1.16
	Mean	1.57	1.05	2.62	1.32	1.25	5.35	22.38	2.05	0.36	1.155

Table 3: Continued.

Mean	O	1.51	0.990	2.497	1.163	1.255	5.100	21.933	2.073	0.333	1.140
	EM	1.59	1.067	2.657	1.303	1.262	5.560	22.500	2.127	0.360	1.157
	Yeast	1.56	1.083	2.647	1.377	1.245	5.133	22.700	2.123	0.397	1.170
	Azoto	1.62	1.083	2.700	1.367	1.240	5.300	22.133	2.147	0.393	1.147
LSD at 5%	Manures	N.S.	N.S.	N.S.	0.01	0.006	N.S.	0.080	0.002	N.S.	0.020
	Biofertilizers	0.06	0.01	0.021	0.011	0.003	0.03	0.035	N.S.	N.S.	0.011
	ManuresXBio	N.S.	N.S.	0.053	N.S.	0.022	0.015	N.S.	N.S.	0.001	0.004

F.S. = First season; S.S. = second season; EM= Effective micro-organisms; Azot. = *Azotobacter chreococum*.

Mucilage content in herb was not affected by organic manures. While, EM significantly surpassed other biofertilizers treatments in producing the largest content of mucilage. Poultry manure X EM resulted the highest content among all treatments.

Carbohydrates percentage in the plant herb were significantly increased in plant due to compost manure as well as yeast when compared to other organic manures and biofertilizers. Compost combined with yeast treatment was significantly by the best interaction treatment. In this connection, El-Sherbeny *et al*[12] on *Sideritis montana* and Ali[35] on iris mentioned that compost pronouncedly improved carbohydrates in leaves. Naguib[19] had good carbohydrates content in lemongrass leaves as a result of applying yeast.

FYM significantly produced the largest N% among organic manure, however, the differences among biofertilizers or the interaction did not reach the level of significantly. Phosphorus % showed insignificant differences due to organic manures or biofertilizers, while the FYM X yeast and poultry manure X yeast or azotobacter gave the highest P% which was significantly higher than most of the other treatments. Potassium percent favoured the compost manure as well as yeast among organic manures and biofertilizers, respectively. Hence, compost X yeast treatment significantly produced the highest percentage of K in the leaves among all treatments.

Such results would be reasonable since many researchers stated that organic manures provide plants with their nutritional requirements and they serve as a source of food for micro-organisms which help in releasing more nutritional elements[36, 37].

Chemical constituents in the seeds (Table 4): Total carbohydrate percentage in seeds were evidently increased due to the poultry manure. Such increase was insignificant when compared to the FYM; but they were significantly more than of the compost. Meanwhile, azotobacter significantly resulted the highest percentage when compared to most biofertilizers. As for the interaction between the two factors, poultry manure X azotobacter treatment resulted seeds significantly containing the highest percentage of carbohydrates.

Compost manure, as well as azotobacter significantly raised the mucilage (%) than other organic manures and biofertilizers, respectively. So, compost X azotobacter treatment recorded the significantly highest percentage of mucilage among all treatments.

Neither organic matter nor biofertilizers nor their interaction showed significant effect on total flavonoides in seeds of *Plantago afra*.

Differences between fatty acids percentage due to organic manures were insignificant. While yeast caused the significant increase over other biofertilizers. Meanwhile, poultry manure X yeast treatment led to the highest fatty acid (%) in seeds (8.60%) which significantly surpassed the percentage of all other treatments.

The yield of fatty acids per plant or per faddan attained similar trend to that of seed yield in the second season, i.e., FYM and azotobacter were significantly the best organic manure and biofertilizer, respectively.

However, the significant larger yield of fatty acids (1.65g/plant and 39.677 kg/feddan) was produced by the FYM X azotobacter treatment. Such increase might be due to the large yield of seeds/plant or faddan more than to the fatty acids.

Organic manures had insignificant effect on N % in seed of *P. afra*. However, azotobacter gave the significant increase in such element than the other biofertilizers. Yet, azotobacter X FYM significantly resulted the highest percentage of N among all treatments.

Phosphorus % was significantly affected by the two factors or their interaction.

Both poultry and compost manures significantly registered the high percentage of potassium in seeds, as compared to the FYM manure. Yeast gave the significant highest K%; whereas the interaction showed insignificant differences in such parameter.

Table 4: Effect of organic manures and biofertilizers on some chemical constituents of *Plantago afra* L., seed, during the 2004/2005 season.

Treatmets	Biofertilizers	T. Carbohydrate	Mucilage %	T. flavonoids	Total lipids %	Total lipids g/plant	Total lipids kg/fed.	N %	P %	K %	Zn	Fe ppm	Mn
FYM	O	28.52	22.0	2.206	8.34	1.083	26.026	2.31	0.41	1.07	406.7	100.4	137.4
	EM	29.30	22.0	2.286	8.47	1.299	31.251	2.84	0.45	1.10	486.1	125.8	141.2
	Yeast	30.25	22.4	2.293	8.50	1.271	30.494	2.35	0.49	1.14	491.6	120.6	140.5
	Azoto	31.45	20.5	2.288	8.36	1.650	39.677	2.82	0.44	1.16	501.3	117.5	166.2
	Mean	29.88	21.73	2.268	8.42	1.328	31.877	5.66	136.01	12.07	50.57	8.96	186.7
Poultry	O	29.42	21.2	2.283	8.48	1.18	28.318	2.38	0.42	1.16	386.8	110.6	153.6
	EM	30.42	23.4	2.292	8.55	1.233	29.584	2.44	0.44	1.20	422.8	133.4	170.3
	Yeast	30.00	22.5	2.293	8.60	1.266	30.381	2.40	0.42	1.20	477.2	138.2	165.5
	Azoto	31.50	22.0	2.292	8.54	1.256	30.13	2.65	0.48	1.20	495.0	126.3	174.8
	Mean	30.34	22.28	2.290	8.54	1.233	29.595	2.47	0.44	1.19	445.45	127.13	166.05
Compost	O	29.60	21.0	2.253	8.42	1.081	25.945	2.22	0.40	1.15	431.8	111.6	140.8
	EM	23.58	21.5	2.285	8.44	1.1	26.401	2.24	0.40	1.20	494.2	118.5	161.7
	Yeast	29.46	22.0	2.291	8.48	1.132	27.49	2.50	0.44	1.22	460.0	130.5	166.4
	Azoto	30.86	30.6	2.299	8.50	1.252	30.053	2.82	0.48	1.18	466.7	124.7	153.8
	Mean	28.38	23.78	2.282	8.46	1.145	27.468	2.46	59.20	5.01	15.57	3.32	819.35
Mean	O	29.18	21.40	2.25	8.41	1.132	27.166	2.303	0.41	1.13	408.4	107.5	143.9
	EM	27.77	22.30	2.29	8.49	1.223	29.241	2.507	0.43	1.17	467.7	125.9	157.7
	Yeast	29.90	22.30	2.29	8.53	1.224	29.379	2.417	0.45	1.19	476.3	129.8	157.5
	Azoto	31.27	24.37	2.29	8.47	1.365	32.744	2.763	0.47	1.18	487.7	122.8	164.9
LSD at 5%	Manures	1.04	0.363	N.S.	N.S.	0.067	1.312	N.S.	N.S.	0.003	0.6	6.14	6.75
	Biofertilizers	1.61	0.921	N.S.	0.01	0.102	2.035	0.023	N.S.	0.001	0.11	2.61	3.66
	ManuresXBio.	1.84	1.151	N.S.	0.04	0.091	3.495	0.016	N.S.	N.S.	0.16	3.89	8.22

EM= Effective micro-organisms; Azot.= *Azotobacter chreococum*.

FYM manure significantly produced the highest zinc content among organic manures. While poultry manure gave the significant best content of Fe and Mn. As for biofertilizers, azotobacter was significantly the best for highest content of Zn and Mn, but the significantly highest Fe content resulted due to yeast. Concerning the interaction, FYM X azotobacter significantly produced the highest content of Zn, Fe and Mn, respectively, among all treatments.

Fatty acids components (Table 5): In general, nine fatty acids were identified constituting about 98.3% of the total acids against about 1.7% were not identified. The unsaturated acids comprising about 66.35%, were linolenic C18:3 comprising about 43.34, linoleic C18:2 about 12.0% and oleic C18:1 which compared about 10.64 of all the fatty acids. While, the saturated acids composed about 31.94% were palmitic C16:0 (11.65%), stearic C18:0 (6.01%), myristic C14:0 (5.25%), lauric C12:0, (4.78%), caprylic C10:0 (4.03%) and caproic C8:0 (0.05%). Such percentages were affected by organic manures and biofertilizers treatments.

FYM manure increased the identified fatty acids% in the seeds (99.22%) against 97.84% and 97.82% for poultry and compost manures. However, biofertilizers showed inconsistent effect for such parameter. FYM had a marked effect on increasing saturated fatty acids, but decreased the unsaturated ones. Such result was concommitant with decreases in both linolenic and linoleic acids (41.29 and 10.45, respectively) against the increase in palmitic, stearic

Table 5: Effect of organic manures and biofertilizers on seed oil components of Plantago afra L. seeds, during the 2004/2005 season.

	FYM				Poultry				Fatty acids%			
	O	Yeast	Azoto	EM	O	Yeast	Azoto	EM	O	Yeast	Azoto	EM
Caproic C8	0.11	0.02	0.01	0.04	0.02	0.04	0.11	0.05	0.03	0.03	0.06	0.08
Caprylic C10	5.63	3.04	2.87	4.22	5.08	4.03	4.46	4.11	4.15	5.23	2.37	3.29
Lauric C12	4.66	5.26	3.90	4.62	7.35	5.22	5.60	3.75	3.30	3.94	4.75	5.10
Myristic C14	3.98	6.17	7.15	5.69	5.20	6.10	4.85	5.62	4.96	6.32	6.19	4.22
Palmitic C16:0	17.11	13.50	12.08	15.15	8.42	10.22	13.51	9.92	12.68	8.51	7.29	9.50
Stearic C18:0	5.90	6.94	6.11	6.30	5.61	5.34	4.82	7.80	7.13	4.92	6.36	5.16
Oleic C18:1	11.58	13.46	12.25	12.14	9.50	9.69	7.50	10.00	10.20	9.68	13.17	12.35
Linoleic C18:2	8.75	10.41	12.30	10.36	15.18	14.15	9.06	12.31	13.28	14.31	11.25	13.04
Linolenic C18:3	42.17	40.28	42.22	40.50	42.12	43.55	46.20	44.85	40.47	45.84	47.44	44.68
Total saturated F.A.	37.39	34.93	32.12	36.02	31.68	30.95	33.35	31.25	32.25	28.95	27.02	27.35
Total unsaturated F.A.	62.50	64.15	66.77	63.00	66.80	67.39	62.76	67.16	63.95	69.83	71.86	70.07
Identified acids	99.89	99.08	98.89	99.02	98.48	98.34	96.11	98.41	96.20	98.78	98.88	97.42

EM= Effective micro-organisms; Azot = *Azotobacter chreococum*.

and myristic fatty acids, which comprised about 14.46, 6.31 and 5.7%, consecutively.

The compost gave an adverse trend, as it increased unsaturated fatty acids (68.93%) especially linolenic and linoliec to about 44.61 and 12.97%, respectively, but reduced saturated fatty acids (28.89%) because of the low percentages of palmitic and stearic (9.49 and 5.89%, respectively). Biofertilizers showed an inconsistent effect on fatty acid components.

As for the interaction, the highest saturated fatty acids percentages (27.02 and 36.02%, respectively) occurred due to the compost X azotobacter and FYM X EM treatments, consecutively. Whereas, the lowest and highest unsaturated fatty acids percentages (62.50 and 71.66%, successively) resulted from FYM only without biofertilizers and compost X azotobacter, respectively.

Conclusion: From the foregoing results, it might be concluded that application of biofertilizers and organic manures markedly improved growth, yield, plant constituents and seed, oil and fatty acid percent and yield, as well as, the percentage of unsaturated fatty acids in seeds of *Plantago afra* L.

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