EFFECT OF COMPOST AND DIFFERENT SOURCES OF BIOFERTILIZERS, ON BORAGE PLANTS (*Borago officinalis,* L.)

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Abstract

The experiments were conducted in the Baramoon Experimental Station. Dakahlia Governorate, Egypt, during two successive seasons of 2001/2002 and 2002/2003. The aim of this study is to investigate the response of Borage plants to nitrogen fixing bacteria plus phosphate dissolving bacterial fertilizers and their combinations. Moreover, investigating the effect of organic manure on growth and chemical composition of Borage seed oil. The levels of organic manure were 0, 12, 18 and 24 m^3/fed from compost. Strain of nitrogen fixing bacteriaa "*Azospirillum sp.*" Under the commercial name of "Nitrobein" and phosphate dissolving bacteria "*Bacillus megaterium*" under the commercial name of "phosphorein" were applied to Borage seedlings after one month of sowing. The soil inoculation was repeated twice every month. Results showed that biofertilization plus organic manure improved plant growth characters expressed as plant height, number of branches, fresh and dry weight/plant and /plot of both leaves and flowers, seed yield, fixed oil percentage and δ-Linolenic acid of different treatments. The best results were obtained by inoculation with Nitrobein plus phosphorein and organic manure at rate 24 m^3/fed combination due to the action of different bacteria strain on availability of the elements. Data also revealed that biofertilizer is a biological technique for reducing the dose of mineral fertilizer to Borage plants.

INTRODUCTION

Borage (*Borago officinalis,* L.) (Boraginaceae) is an annual herb, native to Europe, North Africa and Asia, Minor (Simon *et al.* 1984). Recent interest has focused on borage as a source of δ-linolenic acid, a precursor to prostaglandins (Carter, 1988) and as a treatment of a topic eczema (Wright and Burton, 1982). Borage seed, the richest known plant source of δ-Linolenic acid, contains 28 % - 38 % lipid, of which 17 % - 25 % is δ-Linolenic acid (Whipkey *et al.* 1988). Large scale field production of borage is problematic, however, due to its indeterminate growth and seed-shattering characteristics (Beaubaire and Simon, 1987). Gamma-linolenic acid is an omega- 6 essential fatty acid which has been identified as having several beneficial therapeutic effects, such as treatment of a topic eczema, diabetes, cyclic mastalgia, heart disease, arthritis and multiple sclerosis (El-Hafid *et al.* 1998).

In general, the incorporation of composted manure to soils can increase nutrient availability, cation exchange capacity and micronutrients. It contains high organic content, improves drought tolerance (Hotlink *et al.* 1991) and increases soil microbial activities (Meissner, 2000). Recently, results of Funt and Bierman (2000) on strawberry indicated that composted plant manure decreased soil bulk density and the percent water filled soil pore space in addition to increase soil respiration and biological activity.

Nitrogenous chemical fertilizers are commonly used in production of medicinal plants including Borage plants. Some investigators used different types of biofertilizers as alternatives for chemical fertilizers.

Numerous investigators stated out that biofertilization using different strains of bacteria induce stimulative effect on plant growth and productions by fixing atmospheric nitrogen (Awad, 1998). Certain bacteria can stimulate root growth considerably due to improving the mineral and water uptake (El-Mandoh and Abdel-Magid, 1996). Many of these bacteria diazotrophic bacteria (e.g., Azotobacter, Azospirillum, or *Pseudomonas sp.*). One of their major effects is enhancing root growth by producing phytohormones like IAA by *Azospirillum brasilense* (Martin *et al.* 1989), cytokinin by Azotobacter (Nieto and Frankenberger, 1990).

Phosphate dissolving bacteria plays a fundamental role in correcting the solubility problem in soil by transforming the insoluble phosphate to soluble forms by secreting organic acids such as formic, acetic, lactic, propionic, fumaric and succinic acids. Those acids lower the pH and bring the dissolution of bond forms of phosphate and render them available for growing plants (Ashour, 1998). Bacillus megaterium, was the important group in solubilization process of insoluble phosphorus in soils (El-Katkat, 1992).

The prepared biofertilizers or multiplication of various bacterial fertilizers have become recently new method which having a define role in plant growth and transformation nutrients (N, P and K) on plants. Gomaa (1989) found that the combination of biofertilizers led to increase in plant growth, N, P contents in the leaves, fruit yield and total dry weight of tomato plants than non-biofertilized control. He also added that inoculation tomato plants with mixture of nitrogen fixing bacteria and phosphate dissolving bacteria increased N and P contents in the leaves over inoculation with the nitrogen-fixing bacteria alone. Moreover, several investigators indicated that multi application of bacteria such as Azospirillum, Pseudomonas, Azotobacter and phosphate dissolving bacteria applications showed a significant efficiency in stimulating plant growth and uptake as well as tomato fruit yield with best quality than in case of single application (Hewedy, 1999).

The use of biofertilizers reduced rates of mineral fertilizers (Saber, 1994). Gomaa (1989) found that combinations of biofertilizer contain Azospirillum sp., Azotobacter sp. And phosphate dissolving bacteria increased plant growth, N, P contents in the leaves and fruit yield than uninoculated and received 100 % N, P and K recommendation only. Subbiah (1990) found that the inoculation with Azospirillum not only saved 50 % of the recommended N rate but also improved N efficiency on tomato plants. Hewedy (1999) found that inoculation tomato plants with either Bacillus megatrium, Azotobacter, Azospirillum or pseudomonas or their mixture in their mixture in the presence of 75 %from NPK mineral fertilizer recommendation, significantly increased plant growth, N, P contents of tomato leaves and produced higher fruit yield with higher quality comparing with the uninoculated plants in the presence of 100 % NPK fertilizer recommendation.

The aim of this work is to use composted manure, nitrogen fixing microorganisms or phosphate solubilizing microorganisms or their mixture as complete or partially alternative of chemical fertilizer for Borage plants to study their effects on the vegetative growth, herb yield, active ingredients, and some chemical compositions of the plants.

MATERIALS AND METHODS

These experiments were carried out during the two seasons of 2001/2002 and 2002/2003 in the Farm of Baramoon, Dakahlia Governorate. The seeds of *Borago officinalis,* L. were obtained from Horticultural Research Station in Sids. The seeds were sown on October 15^{th} in the two successive seasons. The area of each plot was (3 x 3.5 m), 10.5 m^2 including 5 rows, each row was 3.5 m long and 60 cm apart. Thinning to one plant per hole was made after one month from sowing. Complete randomized blocks design was adopted with three replicates each of (10.5 m^2). Distance between plants was 50 cm apart. Each plot contains 35 plants.

A randomized samples were obtained from the experimental soils pre application of biofertilizer to determine the physical and chemical contents according to the standard method described by Jackson (1967).

Table 1. The physical and chemical analysis of the experiment soils in both seasons of this study.

Season	Physical properties				Chemical properties						
	Clay %	Silt %	Fine sand %	Coarse sand %	T.S.S. %	O.M. %	E.C. dsm^{-1} at 25 °C	Total N %	Avial. P (ppm)	Exch. K (ppm)	pH (1:2.5) W/V
2001	62.9	20.31	12.31	1.71	0.46	1.52	1.31	0.19	17.32	563	7.8
2002	63.7	19.95	12.63	1.85	0.54	1.54	1.26	0.18	17.23	560	7.6

Table 2. Chemical analysis of the organic manures used during the experiment which was carried out in the Laboratory of Soil Department of Mansoura Agriculture collage.

Season	N%	P%	K%	Fe ppm	Mn ppm	Zn ppm	Cu ppm	Organic matter	Organic carbon	C/N ratio	Moisture %	pH
2001	5.36	3.14	1.4	18.0	2.0	200	10	56.3	32.6	1:6.1	14.5	6.5
2002	5.72	3.12	1.7	17.9	2.1	210	9.7	58.2	34.3	1:6.9	14.7	6.6

The experiment contained ten treatments with rates of organic manure and many strains of bacteria as follows:

1- Control (untreated plants).
2- Organic manure: composting residues or wastes of plants of experimental farm such as of bean, bea, or tomato plants (O.M.) which was fermented 9 months at rates of 12 m^3/fed, was added during soil preparation before sowing.
3- Organic manure at rates of 18 m^3/fed.
4- Organic manure at rates of 24 m^3/fed.
5- Inoculation with Azospirillum, nitrogen fixing bacteria under the commercial name of "Nitrobein" which is a biofertilizer containing live cells of efficient bacteria strains for N-fixation in cultivation for Agriculture Equalization Fund (G.O.A.E.F.), Ministry of Agriculture Egypt.
6- Inoculation with *Bacillus megaterium* var. phosphaticum, phosphate dissolving bacteria under the commercial name of "Phosphorein" adsorbed on peatmoss powder as carrier and obtained from Biofertilizers unit, Ministry of Agric. Egypt.

7- Other plants received mixtures or both Nitrobein and Phosphorein.
8- Plants received mixtures of Nitrobein, Phosphorein and organic manure at rate 12 m^3/fed.
9- Plants received mixtures of Nitrobein, Phosphorein and organic manure at rate 18 m^3/fed.
10- Plants received mixtures of Nitrobein, Phosphorein and organic manure at rate 24 m^3/fed.

The biofertilizers (Nitrobein) and (Phosphorein) was supplied at 7.5 kg/fed for both mixed with wet soft soil (1:10 ratio) into the root absorption zone of plant. After the inoculation, soil was irrigated. Other cultural practices were carried out according to the recommendations of Ministry of Agriculture and the following data were recorded:

1- Plant height in cm.
2- No. of branches/plant.
3- Dry weight of leaves/plant and /plot (g).
4- Dry weight of flowers/plant and /plot (g).
5- Seed yield/plant and /plot.
6- Fixed oil percentage.
7- δ -Linolenic acid of different treatments.

All data obtained were statistically analyzed according to the methods of Snedecor and Cochran (1980).

Different biomeasurements were estimated for the treatments, and obtained through three stages of growth as follows:

(Flowering stage): at beginning of flowering 135 days from sowing.

(Fruiting stage): at beginning of fruiting 180 days from sowing.

(Maturity stage): at maturity of seeds 217 days from sowing.

Extraction of fixed oil:

The oil was extracted from seeds by soxhlet apparatus and its methyl ester derivatives was prepared according to Johnson & Davenpart (1971). GLC analysis of the methyl ester of fatty acids was performed adopting the method of IUPAC (1978).

The present study was carried out to investigate the effect of compost of organic manure, different biofertilizer types as well as their combinations (and useful taking of wastes of farm) on the growth and yield of Borage plants, in order to reduce the production cost, reduce the environmental pollution and to improve soil fertility.

RESULTS AND DISCUSSION

Vegetative growth

1- Plant height and number of branches/plant:

Data in Tables (3 & 4) represents the effect of different methods of fertilization on plant height and number of branches/plant during both seasons. All methods in the different stages of the two seasons produced significant increments in both plant height and number branches/plant. It was found that plant height and No. of branches increased with increasing the dose of compost in both two seasons in three stages of growth. This increment was higher at dose 24 m^3/fed such recorded 109.3 cm at length and 20.1 branches/plant at maturity stage in both seasons. This increment may be due to the role of compost in improving soil structure and water holding capacity. Adding to that, compost contains a considerable amount of nutrients that can supply plant with nutrients. Also compost may exert direct enzymatic or hormonal effects on plant roots inducing growth promotion (Raviv, 1998). So, all treatments were more higher in length and No. of branches/plant in comparing with control plants.

Table 3. Effect of biofertilizer, compost and their combinations on plant height (cm) the of *Borago officinalis*, L. plants at different stages of growth during the two seasons 2001/2002 and 2002/2003.

Treatments	2001/2002 season			2002/2003 season		
	Flowering stage	Fruit stage	Maturity stage	Flowering stage	Fruit stage	Maturity stage
Control	33.6	88.1	92.2	34.1	87.9	92.4
Compost at 12 m^3/fed	39.2	92.6	98.6	38.2	92.1	98.7
Compost at 18 m^3/fed	40.6	95.3	102.1	40.1	96.7	102.2
Compost at 24 m^3/fed	45.9	90.1	109.3	44.2	99.2	107.2
Nitrobein	53.2	105.1	109.9	54.6	105.3	119.3
Phosphorein	42.8	97.6	106.1	42.8	98.1	105.2
Nitro.+Phos.	64.4	112.3	120.2	58.2	110.1	125.6
Nitro.+Phospho.+ Compost 12 m^3/fed	65.6	115.4	122.4	59.1	112.9	126.7
Nitro.+Phospho.+ Compost 18 m^3/fed	66.7	117.3	125.6	60.0	113.6	127.3
Nitro.+Phospho.+ Compost 24 m^3/fed	69.9	119.6	127.5	61.9	115.3	129.7
LSD at 5%	6.94	3.45	5.61	5.27	3.61	5.72

On the other hand, biofertilizer nitrobein, phosphorein and their interaction in the same table illustrated more significant results in both plant height and No. of branches than obtained in control plants. Nitrobein showed more increment in the three stages of growth than obtained when plants inoculated with phosphorein. Concerning the interaction effect between nitrobein and phosphorein, data showed the highest values of plant height and No. of branches/plant during the three stages, and the most was (120.2 and 125.6 cm) in length during maturity stage, while the most No. of branches recorded at fruit stage (25.1 and 25.2) interaction in both two seasons, respectively. These results were supported by Nieto and Frankenberger (1990).

Table 4. Effect of biofertilizer, compost and their combinations on number of branches/plant of *Borago officinalis*, L. plants at different stages of growth during the two seasons of 2001/2002 and 2002/2003.

Treatments	2001/2002 season			2002/2003 season		
	Flowering stage	Fruit stage	Maturity stage	Flowering stage	Fruit stage	Maturity stage
Control	12.0	15.1	13.2	12.9	12.1	12.6
Compost at 12 m^3/fed	13.9	13.7	13.8	14.8	13.9	14.6
Compost at 18 m^3/fed	15.6	16.7	16.6	16.7	16.9	15.1
Compost at 24 m^3/fed	19.1	20.2	20.1	14.2	20.7	20.6
Nitrobein	20.6	24.1	22.2	20.7	24.1	22.1
Phosphorein	19.8	20.3	20.2	19.7	20.4	20.1
Nitro.+Phos.	22.3	25.1	23.4	21.6	25.2	23.2
Nitro.+Phospho.+ Compost 12 m^3/fed	24.2	26.3	22.1	23.1	27.6	25.2
Nitro.+Phospho.+ Compost 18 m^3/fed	25.3	27.3	23.6	24.8	28.2	26.1
Nitro.+Phospho.+ Compost 24 m^3/fed	26.4	28.1	24.7	25.9	29.3	27.4
LSD at 5%	2.10	1.9	2.30	2.2	2.0	1.95

Inoculation with a mixture of nitrobein + phosphorein and different doses of organic manure (compost) at rate of 12, 18 and 24 m^3/fed interactions were the superior comparing with all previous treatments or its singly. These results hold true in the two growing seasons. The enhancing of these biofertilizing materials may be attributed to the ability of N-fixing bacteria to supply the plants with nitrogen and to release plants promoting substances which could stimulate absorption of nutrient and efficiency of nutrient metabolism. Also, such results of many investigators may explain the role of phosphate dissolving bacteria in availability of soil immobilized phosphorus. These results are in agreement with those obtained by Awad (1998), besides the role of compost manure increases nutrient availability, cation exchange capacity and micronutrients. It contains high organic content, improves drought tolerance as supported by Meissner (2000). For all mentioned reasons interactions nitrobein + phosphorein and compost especially at rate of 24 m^3/fed was the most superior in length and No. of branches/plant in the three stages in both seasons and the results were significant during the two seasons.

2- Dry weight of leaves or flowers/plant or /plot:

Data illustrated in Tables (5, 6, 7 and 8) showed the effect of compost at three rates (12, 18 or 24 m^3/fed) and different sources of biofertilizers nitrobein, phosphorein and interactions between them. Data reveals that, all studied growth characters such as dry weight of leaves or flowers/plant or /plot increased significantly due to the application of different levels of organic manure and different sources of biofertilizers and interactions during the three stages of growth in both growing seasons as compared with the control. In this respect, the highest increment in dry weight of leaves/plant when plants received 24 m^3/fed was (300 and 300.7 g during two seasons, respectively) while it was (10.500 and 10.525 kg/plot during two seasons, respectively). On the other hand, nitrobein and phosphorein interaction was more increasing (309.6 and 307.12 g/plant) and (10.836 and 10.749 kg/plot) as a source of biofertilizers. The heaviest dry weight of both leaves and flowers were produced by nitrobein + phosphorein + compost 24 m^3/fed, as well as, all treatments gave heavier leaves and flower dry weight more than the control.

On the other hand, nitrobein + phosphorein and compost 24 m^3/fed was the superior increment on both characters under studied during fruit stage in both seasons.

Obtained results may be due to the fact that the decomposition of organic matter decreased the pH value and consequently nutrients in the soil became more available to plant hence enhanced plant growth, besides utilization of biofertilization and interactions stimulated growth by enhancing root growth by producing phytohormones like IAA by *Azospirillum brasilense* (Martin *et al.* 1989). On the other hand, phosphate dissolving bacteria (*Bacillus megaterium*) transformed the insoluble phosphate to soluble forms by secreting organic acids which lower the pH and bring the dissolution of bond forms of phosphate and render them available for growing plants (Ashour, 1998). All treatments are significantly increased comparing with control during the two seasons.

Table 5. Effect of biofertilizer, compost and their combinations on dry weight of leaves/plant (g) of *Borago officinalis*, L. plants at different stages of growth during the two seasons of 2001/2002 and 2002/2003.

Treatments	2001/2002 season			2002/2003 season		
	Flowering stage	Fruit stage	Maturity stage	Flowering stage	Fruit stage	Maturity stage
Control	132.2	92.7	51.9	139.7	87.9	48.3
Compost at 12 m^3/fed	185.7	106.6	55.3	179.6	142.3	54.9
Compost at 18 m^3/fed	192.5	109.6	59.9	198.7	158.2	65.7
Compost at 24 m^3/fed	312.6	300.0	79.6	313.1	300.7	70.9
Nitrobein	329.6	304.1	82.7	319.2	305.6	73.1
Phosphorein	272.6	194.1	61.7	275.3	169.1	69.2
Nitro.+Phos.	335.6	309.6	89.9	325.6	307.1	78.6
Nitro.+Phospho.+ Compost 12 m^3/fed	350.6	348.6	140.2	348.6	332.6	119.6
Nitro.+Phospho.+ Compost 18 m^3/fed	360.2	355.3	148.3	350.7	342.6	140.6
Nitro.+Phospho.+ Compost 24 m^3/fed	370.8	358.6	160.9	360.9	352.7	162.7
LSD at 5%	9.23	8.75	9.71	8.92	8.61	9.23

Table 6. Effect of biofertilizer, compost and their combinations on dry weight of leaves/plot (kg) of *Borago officinalis*, L. plants at different stages of growth during the two seasons of 2001/2002 and 2002/2003.

Treatments	2001/2002 season			2002/2003 season		
	Flowering stage	Fruit stage	Maturity stage	Flowering stage	Fruit stage	Maturity stage
Control	4.627	3.245	1.817	4.890	3.077	1.691
Compost at 12 m^3/fed	6.500	3.731	1.936	6.286	4.981	1.922
Compost at 18 m^3/fed	6.738	3.836	2.097	6.955	5.537	2.300
Compost at 24 m^3/fed	10.923	10.500	2.786	10.959	10.525	2.482
Nitrobein	11.536	10.644	2.895	11.172	10.696	2.559
Phosphorein	9.541	6.794	2.156	9.636	5.919	2.440
Nitro.+Phos.	11.746	10.836	3.147	11.396	10.749	2.751
Nitro.+Phospho.+ Compost 12 m^3/fed	12.451	9.671	4.000	12.653	9.643	3.452
Nitro.+Phospho.+ Compost 18 m^3/fed	13.371	10.956	4.311	13.921	10.572	4.671
Nitro.+Phospho.+ Compost 24 m^3/fed	15.632	12.741	6.9 7 1	14.963	11.323	6.753
LSD at 5%	1.9	2.1	1.8	1.8	2.1	1.9

Table 7. Effect of biofertilizer, compost and their combinations on dry weight of flowers/plant (g) of *Borago officinalis*, L. plants at different stages of growth during the two seasons of 2001/2002 and 2002/2003.

Treatments	2001/2002 season			2002/2003 season		
	Flowering stage	Fruit stage	Maturity stage	Flowering stage	Fruit stage	Maturity stage
Control	12.7	98.6	28.7	13.1	92.6	26.7
Compost at 12 m^3/fed	21.0	151.0	43.8	23.1	154.1	45.6
Compost at 18 m^3/fed	21.6	271.3	76.9	23.7	275.1	79.2
Compost at 24 m^3/fed	27.9	288.7	85.7	28.2	288.1	87.3
Nitrobein	33.5	410.6	90.9	33.4	415.0	95.6
Phosphorein	21.8	281.4	82.1	23.4	283.2	82.7
Nitro.+Phos.	51.3	551.0	95.1	53.1	560.0	94.2
Nitro.+Phospho.+ Compost 12 m^3/fed	54.2	590.3	150.9	54.6	580.3	140.9
Nitro.+Phospho.+ Compost 18 m^3/fed	56.7	610.3	175.8	55.3	601.0	169.3
Nitro.+Phospho.+ Compost 24 m^3/fed	58.9	620.7	180.9	57.6	610.1	175.6
LSD at 5%	3.61	13.4	11.6	3.70	14.5	12.7

Table 8. Effect of biofertilizer, compost and their combinations on dry weight of flowers/plot (kg) of *Borago officinalis*, L. plants at different stages of growth during the two seasons of 2001/2002 and 2002/2003.

Treatments	2001/2002 season			2002/2003 season		
	Flowering stage	Fruit stage	Maturity stage	Flowering stage	Fruit stage	Maturity stage
Control	0.445	3.451	1.005	0.459	3.241	0.935
Compost at 12 m^3/fed	0.735	5.285	1.533	0.809	5.394	1.596
Compost at 18 m^3/fed	0.756	9.496	2.692	0.830	9.629	2.772
Compost at 24 m^3/fed	0.977	10.084	3.000	0.987	10.084	3.056
Nitrobein	1.173	1.437	3.182	1.169	1.453	3.346
Phosphorein	0.763	10.094	2.874	0.819	9.912	2.895
Nitro.+Phos.	1.796	19.285	3.329	1.859	19.600	3.297
Nitro.+Phospho.+ Compost 12 m^3/fed	1.892	20.660	5.282	1.911	20.311	4.932
Nitro.+Phospho.+ Compost 18 m^3/fed	1.985	21.361	6.153	1.936	21.035	5.926
Nitro.+Phospho.+ Compost 24 m^3/fed	2.062	21.725	6.332	2.016	21.354	6.146
LSD at 5%	0.6	1.7	0.02	0.07	1.40	0.60

Seed yields per plant and per plot:

Data in Table (9) presents that seed yields per plant and per plot clearly emphasized that all treatments enhanced efficiency of seed yields per. plant and per plot. All results emphasized significant differences when compared with control. The highest result was obtained when plants treated with compost 24 m^3/fed, interacted with nitrobein and phosphorein per plant and per plot followed by nitrobien and phosphorein interaction solely. Comparing compost rates to control, we find that 24 m^3/fed released more significant increment. Furthermore, associated effect of compost and different sources of biofertilizations in this respect was favourable than using them solely.

Table 9. Effect of biofertilizer, compost and their combinations on seed yields per plant and plot (g) of *Borago officinalis,* L. plants during two seasons 2001/2002 and 2002/2003.

Treatments	2001/2002 season		2002/2003 season	
	Seed yield /plant (g)	Seed yield /plot (g)	Seed yield /plant (g)	Seed yield /plot (g)
Control	4.495	157.32	4.123	144.305
Compost at 12 m^3/fed	4.971	173.99	4.720	165.200
Compost at 18 m^3/fed	5.122	179.27	5.233	183.155
Compost at 24 m^3/fed	6.231	218.09	6.521	228.235
Nitrobein	6.976	244.16	7.112	248.920
Phosphorein	5.491	192.18	5.920	207.200
Nitro.+Phos.	7.231	253.09	7.971	278.985
Nitro.+Phospho.+Compost 12 m^3/fed	8.765	306.77	8.345	292.075
Nitro.+Phospho.+Compost 18 m^3/fed	9.732	340.62	8.652	302.820
Nitro.+Phospho.+Compost 24 m^3/fed	10.967	383.85	8.973	314.055
LSD at 5%	1.610	6.20	1.52	5.61

Fixed oil:

Fixed oil was extracted from the seeds obtained from different treatments greatly the percentage of fixed oil as shown in Table (10) during two seasons. Interaction of nitrobein, phosphorein and compost indicated the most values comparing with control and remain of the treatments, wherever same interaction had the highest detected when plants received the rate 24 m^3/fed of compost followed by interaction of nitrobein and phosphorein. The obtained values ranged between 22.38 to 47.9 % in first season and 23.76 to 47.8 % in second season. These results were parallel to that obtained for the seed yield. All results were significant comparing with control in both seasons.

δ-Linolenic acid of different treatments:

Table (11) illustrated the composition of the fatty acids of seeds of borage received compost at rates 12, 18, 24 m^3/fed, nitrobein, phosphorein and different interactions between some treatments. The table showed that palmitic, oleic, linoleic and δ-linolenic acid are the dominant acids in the seeds. δ-linolenic acid was the most value in plants received interaction of nitrobein, phosphorein and compost rate of 24 m^3/fed followed by interaction of nitrobein and phosphorein solely. The obtained values ranged between 23.46 to 27.9 %. On the other hand, δ-linolenic acid was much lower in plants received different rates of compost. Nothing have been reported in the literature concerning the effect of compost or biofertilizers on the different percentage of fatty acids of borage seeds.

Table 10. Effect of biofertilizer, compost and their combinations on fixed oil percentage of seed of *Borago officinalis*, L. plants during two seasons 2001/2002 and 2002/2003.

Treatments	2001/2002 season	2002/2003 season
Control	22.38	23.76
Compost at 12 m^3/fed	24.20	24.90
Compost at 18 m^3/fed	25.34	25.90
Compost at 24 m^3/fed	33.91	32.60
Nitrobein	35.81	36.70
Phosphorein	29.85	28.30
Nitro.+Phos.	43.90	44.10
Nitro.+Phospho.+Compost 12 m^3/fed	44.70	43.90
Nitro.+Phospho.+Compost 24 m^3/fed	45.60	45.90
Nitro.+Phospho.+Compost 18 m^3/fed	47.90	47.80
LSD at 5%	3.60	2.90

Table 11. Effect of biofertilizer, compost and their combinations on the percentage of fatty acids composition of seeds of *Borago officinalis*, L. plants during two seasons 2001/2002 and 2002/2003.

Treatments	Palmitic (C16:0)	Stearic (C18:0)	Oleic (C16:1)	Linoleic (C18:2)	α-Linolenic (C18:3)	δ-Linolenic (C18:3)
Control	7.9	0.31	12.8	26.0	0.24	23.46
Compost at 12 m^3/fed	8.2	0.98	13.6	29.5	0.25	19.1
Compost at 18 m^3/fed	9.01	1.40	13.9	31.5	0.29	19.9
Compost at 24 m^3/fed	11.8	2.90	17.1	35.1	0.80	22.2
Nitrobein	13.2	3.40	17.2	37.6	0.90	24.4
Phosphorein	10.6	2.60	15.6	32.1	0.30	17.3
Nitro.+Phos.	14.71	3.80	17.9	37.9	1.08	25.6
Nitro.+Phospho.+ Compost 12 m^3/fed	15.13	4.83	18.10	38.72	1.87	25.92
Nitro.+Phospho.+ Compost 18 m^3/fed	15.92	5.67	18.73	38.91	2.10	26.6
Nitro.+Phospho.+ Compost 24 m^3/fed	16.32	5.91	19.1	39.82	2.91	27.9

RECOMMENDATION

Organic manure (compost-wastes of farm) could be used to enhance the vegetative growth and a good borage seeds solely or interaction with many sources of biofertilizers such as nitrobein or phosphorein. Compost at 24 m^3/fed gave the highest seed yield and high yield of fixed oil and δ-linolenic percentage. The application of nitrobein, phosphorein and compost 24 m^3/fed mostly increased the main constituents in fixed oil obtained from borage seeds generally.

REFERENCES

1- Ashour, S.A. 1998. Influence of biofertilizers and phosphorus application on growth and yield of potato. J. Agric. Sci. Mansoura Univ., 23(7): 3351-3358.

2- Awad, N.M. 1998. The use of microorganisms in ecological farming systems. Ph. D. Thesis, Fac. Sci. Cairo Univ.

3- Beaubaire, N.A. and J.E. Simon 1987. Production of *Borago officinalis,* L. Acta. Hort., 208: 101-113.

4- Carter, J.P. 1988. Gamma-linolenic acid as a nutrient. Food Technol., 42: 72-82.

5- El-Hafid, R.; S.F. Blade and Y. Hoyano 1998. Seedind data and nitrogen fertilization effects on the performance of borage (*Borago officinalis,* L.). Industrial Crops and Products, 2002, 16(3): 193-199; 17 ref.

6- El-Katkat, M.B.O. 1992. Studies on dissolving phosphorus by some microorganisms. M. Sc. Thesis, Fac. Of Agric., Al-Azhar Univ.

7- El-Mandoh, |M.E. and M.N. Abdel-Magid 1996. Response of some sesame genotypes (*Sesamum indicum,* L.) to inoculation by different biofertilizers. Assiut J. of Agric., 27(1): 169-178.

8- Funt, R.C. and P. Bierman 2000. Compostedbyard wast improves strawberry soil quality and soil water relation. Acta. Hort., 517: 235-240.

9- Gomaa, A.M.H. 1989. Biofertilizers and increasing of crop production. M. Sc. Thesis, Fac. Of Agric., Cairo Univ.

10- Hewedy, A.M. 1999. |Influence of single and multibacterial fertilizer on the growth and fruit yield of tomato. Egypt J. Appl. Sci., 14(7): 508-523.

11- Hotlink, H.A.J.; Y. Inhar and M.J. Bolhm 1991. States of compost-amended potting mixes naturally suppressive to soil born diseases of floriculture crops. Plant diseases, 23: 869-873.

12- IUPAC 1978. Gas liquid chromatography of fatty acid methyl esters procedure 2-302 standard methods for the analysis of oils "Fats and derivatives" 6th ed., pp. 103-108 Pergamon Press, Oxford.

13- Jackson, M.L. 1967. Soil Chemical Analysis. Printic-Hall of India private limited New Delhi, P. 115.

14- Jahnson, A.R. and J.B. Davenpart 1971. In "Biochemistry and methodology of Lipids" P. 35 John Wiley and Sons Inc., New York.

15- Martin, P.; A. Glatzle; W. Kolb; H. Omay and V. Schmidt (1989). N_2-fixing bacteria in the rhizosphere : Quantification and hormonal effects on root development. Z. Pflanzenernahr. Bodenk, 152: m237-245.

16- Meissner-Smejkal, G. 2000. Soil microbial activities in organic and conventional vegetable gardening –a sensitive instrument of horticultural research. Acta. Hort., 513: 145-152.

17- Nieto, K.F. and J.W.T. Frankenberger 1990. Influence of adenine, in solently alchohol and Azotobacter chrococcum on the growth of Raphanus sativus. Plan Soil, 127: 147-157.

18- Raviv, M. 1998. Horticultural uses of composted material. Acta Horticulturae, 469: 225-234.

19- Saber, M.S.M. 1994. Bio-organic farming. Farming Press bokk, UK. 50 p.

20- Simon, J.E.; L.E. Craker and A. Chadwick 1984. Herbs: an indexed bibliography, 1971-1980. The scientific literature on selected herbs, and aromatic and medicinal plants of the temperate zone. Archon Books. Hamden, Conn. P. 12.

21- Snedecor, G. and W. Cochran 1980. Statistical Methods. 7th ed. Iowa State Univ . Ames. Iowa, USA.

22- Subbiah, K. 1990. Nitrogen and Azospirillum interaction on fruit yield and nitrogen use efficiency in tomato. South Indian Hortic., 38: 342-344.

23- Whipkey, A.; J.E. Simon and J. Janick 1988. In vivo and in vitro lipid accumulation in *Borago officinalis,* L. J. Amer Oil Chem. Soc., 65: 979-984.

24- Wright, S. and J.L. Burton 1982. Oral evening-primrose seed oil improves a topic eczema. Lancet ii, 8308: 1120-1122.

دراسة تأثير استخدام كمبوست نباتى ومصادر مختلفة للتسميد الحيوى على نبات البوراج

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يعتبر نبات البوراج مصدر رئيسى لحمض جاما ـ لينولينك وهو المركب السابق لتكوين هرمون البروستاجلندين الذى يعتبر علاجا لكثير من الأمراض مثل (topic eczema) أرتكريا، (diabetes)مرضى السكر، (cyclic mastalgia) آلام الصدر فى النساء، (heat diseases) أمراض القلب، (arthritis) إلتهاب المفاصل، (multiple sclerosis) تيبس الخلايا بأماكن مختلفة بالجسم.

أجريت تجربتان حقليتان فى مزرعة البرامون بمحافظة الدقهلية ــ مصر خلال موسمى ٢٠٠١/٢٠٠٢ ، ٢٠٠٢/٢٠٠٣ لدراسة تأثير إضافة مستويات مختلفة من السماد العضوى (صفر ، ١٢ ، ١٨ ، ٢٤ م^{٣} كمبوست للفدان) ، وكذلك استخدام مصادر مختلفة للتسميد الحيوى منها النتروبين المثبت للأزوت الجوى والفوسفورين الميسر لعنصر الفوسفور على النمو الخضرى ومحصول البذور والزيت الثابت لنبات البوراج وأهم مكوناته وكانت أهم النتائج المتحصل عليها فى مراحل النمو الآتية: الأولى فى بداية مرحلة التزهير (بعد ٣٥ يوم من الزراعة) ، الثانية فى مرحلة الإثمار (بعد ١٨٠ يوم من الزراعة) ، الثالثة فى مرحلة النضج وتكوين البذور (بعد ٢١٧ يوم من الزراعة) هى كالآتى:

١ــ أدى استخدام الكمبوست بتركيزات ١٢ ، ١٨ ، ٢٤ م^{٣}/فدان إلى زيادة معنوية فى طول النبات وعدد الأفرع الجانبية والوزن الجاف للأوراق والأزهار على نبات البوراج وفى القطعة التجريبية وكذلك زيادة انتاج البذور فى النبات وفى القطعة التجريبية كما زادت نسبة الزيت الثابت وكانت أحسن المعاملات هى عند إضافة ٢٤ م^{٣}/فدان.

٢ــ أدى استخدام النتروبين والفوسفورين والتفاعل بينهما إلى زيادة معنوية فى كل الصفات تحت الدراسة إلا أن استخدام التفاعل بين النتروبين والفوسفورين أعطى أفضل النتائج عن استخدام النتروبين والفوسفورين كل منهما منفردا.

٣ــ كانت أحسن المعاملات هى الاستخدام المشترك لكل من الكمبوست بجرعاته الثلاثة ١٢ ، ١٨ ، ٢٤ م^{٣}/فدان مع كل من النتروبين والفوسفورين وكانت المعاملة الأفضل على الإطلاق هى استخدام النتروبين مع الفوسفورين مع الكمبوست ٢٤ م^{٣}/ف حيث أعطت أفضل النتائج بمقارنتها بكل المعاملات على نباتات البوراج.

٤ــ أما بالنسبة للزيت الثابت فكان المركب الرئيسى هو حمض جاما ــ لينولينك وهو الهدف من الدراسة فقد زادت نسبته عند استخدام الأسمدة الحيوية بينما أظهر انخفاضا مع الجرعات الثلاثة من الكمبوست وعاود الزيادة عند استخدام المتفاعلات ما بين التركيزات الثلاثة من الكمبوست مع كل من تفاعل النتروبين والفوسفورين فكانت أحسن النتائج عند استخدام النتروبين مع الفوسفورين مع الكمبوست ٢٤ م^{٣}/ف.