EFFECT OF GREEN WASTE COMPOST RATES AND DIFFERENT BIO-FERTILIZERS ON THE VEGITATIVE GROWTH, SEED YIELD AND ACTIVE CONSTITUENTS OF *PLANTAGO OVATA*, FORSK PLANTS

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ABSTRACT

The present investigation was carried out in Experimental Station and Laboratory of the Fac. Agric., Mansoura Univ., during two successive seasons of 2002/03 and 2003/04 to study the effect of green waste compost at the rate of (10, 20, and 30 m^3/fed.) and bio-fertilizers (microbein, phosphorein and rhizobacterein) on the vegetative growth, flowering, seed production and mucilage content of Plantago ovata Forsk plants.

The results indicated that green waste compost (GWC) rates had a positive effect on plant height, number of tillers and spikes, plant dry weight, seed yield per plant and plot as well as mucilage content and percentage when compared with each other. The best results were of plants which received the medium GWC rate (20 m^3/fed).

The inoculating with rhizobacterein bio-fertilizer gave the tallest plants, while the inoculating with microbein gave the highest number of tillers and spikes, plant dry weight, seed yield per plant and plot as well as mucilage content and percentage.

The combined treatment of the medium GWC rate and rhizobacterein inoculating gave the tallest plants, while the combined treatment of the medium GWC rate and mcrobein gave the highest number of tillers and spikes, plant dry weight, seed yield per plant and plot as well as mucilage content and percentage. Also, the combined treatment of the medium GWC rate and phosphorein gave the heaviest 1000 seed weight. The application of green waste compost at 20 m3 / fed combined with microbein at 400 g/fed can be recommended for the best results on growth, flowering, seed yield and mucilage content.

INTRODUCTION

Plantago ovata Forsk (Fam. *Plantaginaceae*) is known as white or blonde psyllium, Indian plantago or Isabgol. Indian dominates the world market in the production and export of psyllium. Mucilage (main active component) swells with water to keep the embryo adequately wetted during germination. For humans, the mucilage, chemically colloidal polysaccharides consisting mostly of xylose, arainose, and galacturonic acid, is used as a major ingredient in a number of commercial laxative products. The main effect for humans is relief of choronic constipation (Mathur *et al.*, 1990 and Wolever *et al.*, 1991).

Organic materials in the form compost and green manure are added to soils to improve their physical and chemical properties and increase plant production (El-Mahrouk, 2000 and Saadawy *et al.*, 2005).

Thomas and Ozores (2000) reported that the use of organic materials as N source is being considered as a best management practice (BMP) for N management because organic N is released to the plant more gradually than water-soluble. Deepti *et al.*, (2003) found that plant height and dry matter yield (grain and straw) increased with the application of the organic and inorganic amendments either singly or in combination on *Plantago ovata*. EL-Keltawi *et al.*, (2003) reported that application of the organic wastes increased the anthocyanin, protein, phosphorus and potassium content of roselle sepals plants. Ozores-Hampton (2004) evaluated the changes in the chemical and biological properties of soil in response to compost use. Soil pH, OM, C, K, Ca, Mg, Cu, Fe, Mn and Zn were higher in the composted areas compared with the non-composted areas, EC values in composted areas were double comparing to those in non-composted areas. Most importantly, application of compost enhanced the overall soil microbial activity as determined by total microorganisms number, SRD (species richness diversity) of six functional groups including heterotrophic aerobic bacteria, anaerobic bacteria, fungi, actinomycetes, pseudomonas and nitrogen fixing bacteria, in the all participating farms. The greatest soil quality improvement was seen in soils receiving the highest rates of compost for the longest time. Saadawy *et al.*, (2005) recommended the use of straw or compost of many crops such as broad bean, bagasse and rice as cheap natural media instead of the expensive imported peat moss. Scheuerell *et al.*, (2005) observed that suppression of seedling damping-off disease caused by *Pythium spp.* and *Rhizoctonia solani* is a potential benefit of formulating soilless container media with compost.

Biofertilizers are microbial inoculants used for application to seed or soil to increase soil fertility (Alaa EL-Din, 1982).

Nofal *et al.*, (2001) stated that inoculation with *Azotobacter* and *Azospirillum* in the presence of full dose of NPK (300 kg ammonium sulfate + 300 kg superphosphate + 80 kg potassium sulfate per fed) gave the highest N, P and K % of *Ammi visnaga* leaves. Shalan *et al.*, (2001) claimed that inoculating *Matricaria chamomilla* with phosphorein improved growth and essential oil yield per plant than control plants. Abd EL-Latif (2002) reported that the mixture of 1 kg / fed nitrobein + 1 kg / fed. phosphorein with

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caraway seed before sowing gave the highest fruit yield as well as the highest essential oil content. Abo EL-Ala (2002) showed that root colonization of marjoram and basil with N_2-fixers and P-dissolving bacteria improved oil yield. Eid and EL-Ghawwas (2002) studied the effect of two kinds of biofertilizers (microbein and nitrobein) at the rate of 4 g/plot (9 m^2), used three times, the first one was after one week from transplanting and the others were after every cut of marjoram plant. The data showed that, microbein with third mowing gave an increase of plant height and dry weight of plant. Abdel-Kader and Ghaly (2003) showed that inoculation of coriander plants with nitrobein substituted the effect of 25 % of the mineral N fertilizer used to improve growth of the plant, yield of fruits and essential oil yield of fruits. Hafez (2003) stated on borage, that nitrobein 55 % *Azotobacter chroococcum* and 45 % *Azospirillum lipoferum* containing one gram of 107 cells at 600 g / kg seeds enhanced greatly plant height, number of branches and leaves and branches fresh and dry weights, compared with control. Kandeel and Sharaf (2003) stated that pre-sowing inoculation of marjoram with *Azotobacter chroococcum* + *Bacillus circulans* + Vesicular arbuscular mycorrhizae + half dose of recommended NPK gave the highest oil percentage and oil yield per fed as well as the N, P and K % in plant herb. Eisa (2004) reported that biofertilizers (microbein, nitrobein and phosphorein) increased the essential oil content per plant and oil yield per fed, compared with uninoculated plants of *Salvia officinalis*. EL-Fawakhry and EL-Tayeb (2004) concluded that nitrobein gave the highest values in the most of studied characters (plant height, fresh and dry weight of stem and leaves, leaves area and number of leaves per plant) of *Euphorbia pulcherrima*. Also, the highest content of total chlorophylls in the leaves was achieved. nitrobein could decrease mineral N to 50 % of the suitable dose for the best growth and flowering with minimum environmental pollution. Massoud *et al.*, (2004) showed that nitrobein plus phosphorein gave significant increase in plant height, number of branches, plant fresh and dry weight and total carbohydrates of thyme plants. Yousef (2005) stated that biofertilizers (microbein and nitrobein) raised the essential oil percentage of *Melissa officinalis*.

EL-Ghadban *et al.*, (2002) reported that marjoram plants amended with the highest level of compost (15 m^3/fed) either alone or in conjugation with a mixture of N_2 fixing bacteria showed considerable increments in growth characters and contents of N, P and K as well as essential oil percentage and also components of oil compared with the mineral fertilization treatment.

The present study was carried out as one of trials to achieve the role of biofertilizers and organic materials for safety production combined with safety environment at the same time.

MATEIRALS AND METHODS

The present study was conducted during the two successive seasons of 2002/03 and 2003/04 at the Experimental Station and Laboratory of the Vegetable Crops and Ornamental Plants Dept., Faculty of Agriculture, Mansoura Univ., Egypt.

Seeds of Isabgol (*Plantago ovata* Forsk), were secured from Firma Müggenburg, Hamburg, Germany.

Field was divided into 2m ^{2} (2x1 m) plots, each plot contained 5 rows, 15 cm apart. Seeds were inoculated with biofertilizers and mixed with sand at the rate of 400 g/fed. (0.2 g/plot) and mixed with sand at the rate of (5g/ plot) on October 15th in both seasons. The examined biofertilizers (microbein, phosphorein and rhizobacterein) were provided by the General Organization for Agriculture Equalization Fund (G.O.A.E.F.), Ministry of Agriculture, Egypt. The Nile compost (commercial green waste compost) was obtained from Egyptian Company for Agriculture Residues Utilization (ECARU), Egypt. Green waste compost was at 10, 20 and 30 m^3/fed (0.005, 0.010 and 0.015 m^3/plot/season).

Table (1): The chemical and physical properties of the used green waste compost in both seasons (2002/03 and 2003/04).

Properties	Levels in compost
Dry matter (kg/m3)	500
Humidity (%)	20.0
pH (in 1:5)	8.14
EC (1:5) dSm-1	4.38
Water capacity (%)	260
Total nitrogen (%)	1.87
Organic matter (%)	57.35
Total carbon (%)	33.26
C/N ratio	17.8 : 1
Total phosphate (%)	1.47
Total potassium (%)	1.23

Biofertilizers were provided by the General Organization for Agriculture Equalization Fund (G.O.A.E.F.), Ministry of Agriculture, Egypt.
The examined biofertilizers were rhizobacterein, phosphorein and microbein at a rate of 400 g / fed (0.2 g / plot / season).

Data recorded :

A. Vegetative growth : Thirty plants were chosen randomly for each character recorded after about 90 days from sowing as the following.

1. Plant height (cm).
2. Number of tillers and spikes per plant.
3. Dry weight per plant (g).

B. Seed yield (g): At harvest date (during the last week of March), the following seed yield evaluations were recorded:

1. Seed yield per plant and plot.
2. Weight of 1000 seeds.

C. Analysis:

1- Constituents of seeds: mucilage content (g / 10 g seeds) according to EL-Mahdy and EL-Sebaiy method (1984).

2- Chemical analysis of NPK: was determined according to Peter, (1968); Jackson, (1967) and Black, (1965).

Soil analysis: Soil samples were taken for chemical and mechanical analysis before sowing in the two seasons (Tables 2 and 3).

Table (2): Mechanical and chemical analysis of experimental soil before the application of any fertilizers (organic and bio for the first season (2002).

Mechanical analysis (%)		**Chemical analysis (ppm)**		**Soluble cations and anions (meq / 100 g soil)**	
Coarse sand	0.98	Available N	55	Cations	
Fine sand	23.50	Available P	2.8	Ca++	0.49
Silt	30.96	Available K)	590	Mg++	0.37
Clay	44.56			Na+	0.39
		Organic matter %	1.15	K+	0.03
		EC* (dSm-1)	1.25	Anions	
		pH**	8.25	CO3--	0.02
		CaCO3 %	0.84	HCO3-	0.52
				SO4--	0.48
				Cl-	0.26

* 1 : 5 soil : water extraction ** 1 : 2.5 soil : water extraction

Table (3): Mechanical and chemical analysis of the second experimental field after the application of green waste compost and bio fertilizers at the end of the first season (2003).

Properties \ Compost	**10 m³ / fed**	**20 m³ / fed**	**30 m³ / fed**
Mechanical analysis			
Coarse sand (%)	1.95	1.35	1.71
Fine sand (%)	18.83	19.92	18.35
Silt (%)	26.12	30.10	27.18
Clay (%)	53.10	47.92	51.96
Chemical analysis			
Available N (ppm)	78	97	103
Available P (ppm)	6.2	6.2	6.5
Available K (ppm)	780	798	833
Organic matter (%)	2.46	2.73	2.98
EC* (dSm-1)	1.88	2.19	2.66
pH**	7.95	7.89	7.82
CaCO3 %	3.62	3.85	2.95
Soluble cations (meq / 100 g soil)			
Ca++	0.44	0.40	0.58
Mg++	0.24	0.13	0.83
Na+	1.29	1.65	1.27
K+	0.03	0.07	0.08
Soluble anions (meq / 100 g soil)			
CO3--	0.00	0.00	0.00
HCO3-	0.52	0.39	1.16
SO4--	0.85	0.98	0.92
Cl-	0.63	0.88	0.68

* 1 : 5 soil : water extraction ** 1 : 2.5 soil : water extraction.

Experimental design and statistical analysis :

A factorial experiment in a randomized complete block design including 10 treatments (3 C. x 3 bio + control) with 3 replicates was adapted, according to Cochran and Cox (1957). The treatment means were compared using the least significant differences (L.S.D) at 0.05 procedures as mentioned by Gomez and Gomez, (1984).

RESULTS AND DISCUSSIONS

I- Plant growth characters

1. Plant height :

Effect of green waste compost (GWC) :

The data in Table (4) showed that plant height of Isabgol was significantly affected by green waste compost (GWC) doses in both seasons. The highest values were recorded (36.97 and 39.45 cm) when plants received the medium GWC dose (20 m3/fed). The favorable effect of medium GWC dose on plant height might be attributed to improving root rhizosphere condition and hence the accumulation of nutrient materials and metabolic activity. Also, GWC supplied Isabgol plants with potassium which is a demand for promotion of the growth of meristematic tissues, as well as enhancing cell turgor, extention and size. The above results were in agreement with those obtained by Deepti *et al.*, (2003) on *Plantago ovata*.

Effect of biofertilizers :

Data presented in the same Table detected that the biofertilization treatments gave significant increase in the plant height higher than the control during both growing seasons. The increment in plant height may be attributed to the production of growth promotive substances from nitrogen fixing bacteria. In addition, applying biofertilizer enhanced the microorganisms living in the soil working on the organic form of nutrients such as nitrogen converts it to mineral form. Thus, reflexed to increase the uptake of nutrients from soil by roots of plant and so plant height was increased (Lampking, 1990). These results agreed with the findings reported by Nofal *et al.* (2001) on *Ammi visnaga* and Abdel-Kader and Ghaly (2003) on coriander.

Effect of the interaction between green waste compost (GWC) and biofertilizers

The interaction between GWC doses and different biofertilizers presented in Table (4) revealed that plant height was significantly affected by the most interaction treatments in both seasons. The plants which received the medium GWC dose and inoculated with rhizobacterein recorded the highest values (38.72 and 40.98 cm), respectively.

Table (4): Effect of the green waste compost (GWC), biofertilizers and their interactions on plant height (cm) of *Plantago ovata* during the two seasons of 2002/03 and 2003/04.

Treatments \ Characters		Plant height (cm) 1st season	Plant height (cm) 2nd season
GWC (m^3/fed)			
10		31.90	32.82
20		36.97	39.45
30		35.39	36.59
L.S.D at 5 %		0.38	0.41
Biofertilizers			
Control		33.41	34.39
Microbein		35.14	36.18
Phosphorein		34.28	35.08
Rhizobacterein		35.85	36.73
L.S.D at 5 %		0.44	0.47
Interactions			
10 m^3/fed (GWC)	Control	30.80	31.66
	Microbein	32.77	33.73
	Phosphorein	31.81	32.56
	Rhizobacterein	32.83	33.91
20 m^3/fed (GWC)	Control	34.96	36.16
	Microbein	38.41	39.83
	Phosphorein	35.89	36.82
	Rhizobacterein	38.72	40.98
30 m^3/fed (GWC)	Control	34.18	35.35
	Microbein	36.13	37.96
	Phosphorein	35.15	36.17
	Rhizobacterein	36.90	38.39
L.S.D at 5 %		0.76	0.82

2. Number of tillers and spikes per plant :

Effect of green waste compost (GWC) :

Data shown in Table (5) pointed out significant differences in number of tillers and spikes per plant as affected by the different GWC doses in both seasons. The plants that received the medium GWC dose had the largest number of tillers / plant (5.23 and 8.44) and spikes / plant (14.16 and 17.63). The positive effect of GWC on number of tillers and spikes might be related to the improvement of physical conditions of the soil, which provided energy for micro-organisms' activity and increased the availability and uptake of nutrients, which were positively reflected on the number of tillers. These results were in line with those of El-Ghadban *et al.*, (2002) on marjoram.

Effect of biofertilizers :

It was clear from data in the same Table that all biofertilizers increased number of tillers and spikes per plant significantly when compared with the control in both season. The plants inoculated with microbein recorded the largest number of tillers / plant (4.78 and 7.74) and spikes / plant (13.59 and 17.94) in both seasons, respectively. The synergistic effect of biofertilization may be due to the increase in soil content of nitrogen as a result of N fixation and phosphorus from phosphate dissolving bacteria as well as growth promoting substances, vital enzymes and hormonal stimulatory effects on plant growth which produced by the bacteria (Sakr, 2005). These results were in accordance to those obtained by Abd El-Latif (2002) on *Carum carvi* and Massoud *et al.*, (2004) on thyme.

Table (5): Effect of green waste compost (GWC), biofertilizers and their interactions on number of tillers and spikes per plant of *Plantago ovata* during the two seasons of 2002/03 and 2003/04.

Treatments \ Characters		Number of tillers / plant		Number of spikes / plant	
		1st season	2nd season	1st season	2nd season
GWC (m^3/fed)					
10		2.86	4.73	8.46	10.17
20		5.23	8.44	14.16	17.63
30		4.42	7.25	13.00	15.99
L.S.D at 5 %		0.18	0.25	0.34	0.38
Biofertilizers					
Control		3.52	5.91	10.20	11.92
Microbein		4.78	7.74	13.59	17.94
Phosphorein		3.88	6.47	11.29	13.16
Rhizobacterein		4.51	7.34	12.42	15.53
L.S.D at 5 %		0.21	0.29	0.39	0.44
Interactions					
10 m^3 / fed (GWC)	Control	2.23	3.63	6.63	9.30
	Microbein	3.43	5.84	9.90	13.13
	Phosphorein	2.62	4.25	8.10	10.80
	Rhizobacterein	2.97	5.10	9.23	12.43
20 m^3 / fed (GWC)	Control	4.40	6.36	12.35	15.20
	Microbein	6.88	9.25	16.90	21.00
	Phosphorein	4.90	7.06	13.50	16.20
	Rhizobacterein	5.70	8.96	14.65	18.03
30 m^3 / fed (GWC)	Control	3.87	6.00	11.60	13.55
	Microbein	6.03	8.13	14.97	17.80
	Phosphorein	4.10	6.15	12.27	14.96
	Rhizobacterein	4.97	7.15	13.36	16.13
L.S.D at 5 %		0.36	0.49	0.67	0.76

Effect of the interaction between green waste compost (GWC) and biofertilizers :

It can be observed from data in Table (5) that in the first season, the plants that received the medium GWC dose and inoculated with microbein formed the largest number of tillers (6.88) and spikes (16.90) per plant. The results of the second season were in a parallel line with those of the first one.

3. Plant dry weight :

Effect of green waste compost (GWC) :

The collected data in Table (6) cleared that the plant dry weight (g) was significantly affected by GWC doses in both seasons. The promotive effect of GWC doses may be due to increase of nutrients in the soil. This increase can encourage the plant growth, which increased the photosynthetic rates leading to an increase in the assimilation rates and hence the dry weight per plant was increased. The above mentioned results followed the same trend of these obtained by El-Ghadban *et al.*, (2002) on marjoram.

Table (6): Effect of green waste compost (GWC), biofertilizers and their interactions on plant dry weight (gm) of *Plantago ovata* during the two seasons of 2002/03 and 2003/04.

Treatments \ Characters		Plant dry weight (g / plant) 1st season	2nd season
GWC (m^3 / fed)			
10		3.73	3.94
20		4.61	5.28
30		4.33	4.71
L.S.D at 5 %		0.09	0.05
Biofertilizers			
Control		3.94	4.01
Microbein		4.62	5.51
Phosphorein		4.00	4.50
Rhizobacterein		4.39	4.94
L.S.D at 5 %		0.10	0.55
Interactions			
10 m^3/ fed (GWC)	Control	3.42	3.66
	Microbein	3.99	4.32
	Phosphorein	3.61	3.83
	Rhizobacterein	3.79	4.14
20 m^3 / fed (GWC)	Control	4.12	4.47
	Microbein	5.15	5.71
	Phosphorein	4.31	4.69
	Rhizobacterein	4.75	5.34
30 m^3 / fed (GWC)	Control	4.00	4.26
	Microbein	4.72	5.05
	Phosphorein	4.19	4.56
	Rhizobacterein	4.49	4.86
L.S.D at 5 %		0.17	0.10

Effect of biofertilizers :

Data in the same Table revealed that the plant dry weight was significantly affected by the different biofertilizers during the two growing seasons. The heaviest dry weight (4.62 and 5.51 g / plant) were of plants inoculated with microbein. The promotive effect of biofertilizers may be related to their role in increasing plant growth and photosynthetic rates leading to an increase in the assimilation rates, and so dry weight was increased. These results were in agreement with those obtained by El-Fawakhry and El-Tayeb (2004) on *Euphorbia pulcherrima* and Sakr (2005) on senna.

Effect of the interaction between green waste compost (GWC) and biofertilizers :

It was clear from the data presented in Table (6) that a significant interaction effect was observed between GWC and biofertilization treatments on plant dry weight in both seasons.

II. Seed yield:

1. Seed yield per plant and plot :

Effect of green waste compost (GWC) :

The obtained data in Table (7) showed significant differences among GWC doses in both seasons. The plants which received the medium GWC dose recorded the heaviest seed yield per plant (5.02 and 6.09 g) and plot (209.68 and 255.78 g) in both seasons, respectively. The positive responses induced by GWC doses might be due to the increase in the nutrient elements in the soil. This increase may encourage the whole haulm growth, which increases the photosynthetic rates leading to an increase in the assimilation rates and hence seed production. The obtained results were in accordance with the findings of Deepti *et al.*, (2003) on *Plantago ovata.*

Effect of biofertilizers :

The collected data in the same Table cleared that seed yield per plant was significantly affected by different biofertilizers inoculation in both seasons. The heaviest seed yield per plant (4.95 and 5.98 g) and plot (199.82 and 248.63 g) resulted from plants inoculated with microbein biofertilizer in the two seasons, respectively. These increments might be attributed to the non-symbiotic bacteria present in microbein which have beneficial effects on plant growth by different mechanisms e.g., enhanced N2-fixation on increased N assimilation, as well as enhancing minerals uptake, improving root growth and functions and supplying more N and P requirements (Bashan and Holguin, 1997). The obtained results were in harmony with those reported by Khalil and El-Aref (2001) on wheat and Abd El-Latif (2002) on caraway.

Table (7): Effect of green waste compost (GWC), biofertilizers and their interactions on seed yield per plant and plot (g) of *Plantago ovata* during the two seasons of 2002/03 and 2003/04.

Treatments \ Characters		Seed yield per plant (g)		Seed yield per plot (g)	
		1st season	2nd season	1st season	2nd season
GWC (m^3/fed)					
10		3.55	4.07	137.57	164.22
20		5.02	6.09	209.68	255.78
30		4.32	5.62	194.82	231.82
L.S.D at 5 %		0.04	0.04	3.57	3.75
Biofertilizers					
Control		3.81	4.38	155.49	177.83
Microbein		4.95	5.98	199.82	248.63
Phosphorein		4.01	5.00	170.27	201.30
Rhizobacterein		4.52	5.47	189.19	221.33
L.S.D at 5 %		0.05	0.04	4.12	4.32
Interactions					
10 m^3 / fed (GWC)	Control	3.02	3.78	121.74	153.87
	Microbein	3.81	4.90	170.80	199.51
	Phosphorein	3.51	4.08	134.82	167.14
	Rhizobacterein	3.67	4.26	157.95	178.35
20 m^3 / fed (GWC)	Control	4.19	4.98	192.94	232.39
	Microbein	5.68	6.38	223.85	271.37
	Phosphorein	4.40	5.71	207.26	245.03
	Rhizobacterein	5.12	5.90	214.66	258.33
30 m^3 / fed (GWC)	Control	4.01	4.68	181.73	217.25
	Microbein	4.55	5.87	207.80	249.02
	Phosphorein	4.26	5.64	189.73	226.71
	Rhizobacterein	4.63	5.77	199.97	234.30
L.S.D at 5 %		0.08	0.07	7.13	7.5

Effect of the interaction between green waste compost (GWC) and biofertilizers :

Concerning the interactions between all studied factors, data presented in Table (7) revealed that seed yield per plant and plot were significantly affected by the interaction treatments in both seasons.

2. 1000 seeds weight :

Effect of green waste compost (GWC) :

Data presented in Table (8) indicated that the 1000 seeds weight was significantly affected by GWC doses. In the first season, plants treated with the medium GWC dose had the significantly highest values (1.85 g /1000 seeds), which resembles about 17 % more than those of plants that received the low GWC dose since had the lowest values (1.58 g/1000 seeds). This means that the suitable GWC dose gave more weight and size for each seed. Regarding the high dose, it appeared that the response was so close to the medium dose, in this concern. However, the differences were statistically significant. The results of the second season followed the same trend. These results were in harmony with those of Rizk (2002) who concluded that the green waste compost (commercial Nile compost) application resulted the best values of plant growth, yield parameters and heaviest 100 dry seeds of *Vigna sinensis*.

Table (8): Effect of green waste compost (GWC), biofertilizers and their interactions on 1000 seeds weight (g) of *Plantago ovata* during the two seasons of 2002/03 and 2003/04.

Treatments \ Characters		1000 seeds weight (g) 1st season	1000 seeds weight (g) 2nd season
GWC (m^3 / fed)			
10		1.58	1.66
20		1.85	1.94
30		1.82	1.91
L.S.D at 5 %		0.02	0.01
Biofertilizers			
Control		1.64	1.70
Microbein		1.84	1.96
Phosphorein		1.88	2.00
Rhizobacterein		1.79	1.85
L.S.D at 5 %		0.02	0.01
Interactions			
10 m^3 / fed (GWC)	Control	1.58	1.70
	Microbein	1.81	1.91
	Phosphorein	1.86	1.93
	Rhizobacterein	1.68	1.79
20 m^3 / fed GWC)	Control	1.78	1.84
	Microbein	1.86	2.01
	Phosphorein	1.92	2.04
	Rhizobacterein	1.81	1.89
30 m^3 / fed (GWC)	Control	1.76	1.80
	Microbein	1.84	1.94
	Phosphorein	1.87	2.01
	Rhizobacterein	1.80	1.85
L.S.D at 5 %		N.S	N.S

Effect of biofertilizers :

Data in the same Table point out significant increase in 1000 seeds weight as affected by the different biofertilizers inoculation. The plants inoculated with phosphorein biofertilizer gave the highest values (1.88 and 2.00 g/1000 seeds) in both seasons, respectively. The heaviest increase in 1000 seeds weight with phosphorein inoculation might be due to that phosphorus encouraged plant to stimulate flowering and improve quality and quantity of the seeds and it is necessary for protoplasm formation and yield (Ali, 2001). These results were in agreement with those obtained by Tomar *et al.*, (1996) on *Cicer arietinum.*

Effect of the interaction between green waste compost (GWC) and biofertilizers :

The data in Table (8) showed variable differences in 1000 seeds weight. Plants which received the medium GWC dose and inoculated with phosphorein gave the highest values (1.92 and 2.04 g / 1000 seeds), in both seasons, respectively.

III. Active constituents:

1. Mucilage content in seeds :

Effect of green waste compost (GWC):

Data presented in Table (9) indicated in the first season that fertilizing plants with the medium GWC dose produced the highest mucilage content and percentage (3.54 g / 10 g seeds and 35.4 %), while fertilizing plants with the low GWC dose gave the lowest values (3.04g and 30.4 %) in this concern. The results of the second season had a similar trend. The favorable effect of the medium suitable GWC dose on mucilage content may infer that GWC enabled Isabgol plants to absorb efficiently water and available nutrients from soil, leading to growth, encourage photosynthetic activity and accumulation of carbohydrates. These findings agreed with the work of Deepti *et al.*, (2003) on *Plantago ovata.*

Effect of biofertilizers :

Data in the same Table revealed that, the plants inoculated with microbein biofertilizer had the highest mucilage content and percentage (3.5 g and 35 %) in the first season. The second season results were similarity with the first one. It may be noticed that the differences among all biofertilization treatments were significant in both seasons. The increase in mucilage content with biofertilizers may be due to the role of P and K. Since, potassium is necessary for the synthesis of carbohydrates (Mengel and Kirkby, 1982), while phosphorus is an important factor influencing the rate of photosynthesis and higher activity of various enzymes of carbohydrate metabolism (Rao *et al.*, 1990). Moreover, these results were in agreement with the results obtained by Maheshwari *et al.*, (2003) on blond psyllium and Ahmed (2005) on okra.

Effect of the interaction between green waste compost (GWC) and biofertilizers :

Concerning the interaction effect between GWC doses and the different biofertilizers (Table, 9), it was noticed that plants which received the medium GWC dose and inoculated with microbein biofertilizer recorded the highest mucilage content and percentage (3.59g and 35.9 % and 3.71 g and 37.1 %) in the first and second seasons, respectively. Statistically the differences were significant among all interaction treatments in both seasons.

Table (9): The mucilage content (g), percentage (%) and their interactions in seeds of *Plantago ovata* in response to green waste compost (GWC) and biofertilizers in the two seasons of 2002/03 and 2003/04.

Treatments \ Characters		Mucilage content (g / 10 g)		Mucilage percentage (%)	
		1st season	2nd season	1st season	2nd season
GWC (m^3 / fed)					
10		3.04	3.19	30.4	31.9
20		3.54	3.63	35.4	36.3
30		3.39	3.45	33.9	34.5
L.S.D at 5 %		0.03	0.01		
Biofertilizers					
Control		3.15	3.28	31.5	32.8
Microbein		3.50	3.94	35.0	39.4
Phosphorein		3.30	3.45	33.0	34.5
Rhizobacterein		3.21	3.32	32.1	33.2
L.S.D at 5 %		0.03	0.02	---	---
Interactions					
10 m^3/fed (GWC)	Control	2.95	3.07	29.5	30.7
	Microbein	3.19	3.30	31.9	33.0
	Phosphorein	3.11	3.23	31.1	32.3
	Rhizobacterein	3.06	3.10	30.6	31.0
20 m^3/fed (GWC)	Control	3.20	3.29	32.0	32.9
	Microbein	3.59	3.71	35.9	37.1
	Phosphorein	3.53	3.60	35.3	36.0
	Rhizobacterein	3.30	3.39	33.0	33.9
30 m^3/fed (GWC)	Control	3.19	3.20	31.9	32.0
	Microbein	3.42	3.53	34.2	35.3
	Phosphorein	3.36	3.42	33.6	34.2
	Rhizobacterein	3.26	3.30	32.6	33.0
L.S.D at 5 %		0.05	0.03	---	---

2. N, P and K percentages :

Effect of green waste compost (GWC) :

Green waste compost (GWC) induced variable N, P and K (%) in both seasons as presented in Table (10). The high GWC dose gave considerably the highest nitrogen (1.83 and 1.96 %), phosphorus (0.39 and 0.47 %) and potassium (2.45 and 2.49 %) in the both seasons, respectively. These results were in agreement with the findings of EL-Desuki *et al.*, (2001) on sweet fennel.

Effect of biofertilizers :

As shown in the same Table inoculating Isabgol with the different bio fertilizers increased nitrogen, phosphorus and potassium percentages significantly in comparison to the control in both seasons. The inoculating with rhizobacterein gave the highest nitrogen percentages (1.99 and 2.11%), while inoculating with phosphorein gave the highest phosphorus percentages (0.45 and 0.49 %) and potassium (2.43 and 2.50 %) in both seasons, respectively. The obtained results were in agreement with those obtained by Mahfouz (2003) and Massoud (2007) on marjoram, and Yousef (2005) on *Melissa officinalis*.

Table (10): Effect of green waste compost (GWC), biofertilizers and their interactions on the leaves NPK percentages (%) of *Plantago ovata* during the two seasons of 2002/03 and 2003/04.

Treatments	Characters	N (%)		P (%)		K (%)	
		1st season	2nd season	1st season	2nd season	1st season	2nd season
		GWC (m^3 / fed)					
10		1.52	1.62	0.31	0.35	2.27	2.35
20		1.74	1.81	0.37	0.42	2.41	2.45
30		1.83	1.96	0.39	0.47	2.45	2.49
L.S.D at 5 %		0.030	0.022	0.017	0.013	0.013	0.016
		Biofertilizers					
Control		1.10	1.18	0.30	0.35	2.31	2.35
Microbein		1.88	2.00	0.36	0.43	2.40	2.46
phosphorein		1.21	1.29	0.45	0.49	2.43	2.50
Rhizobacterein		1.99	2.11	0.32	0.37	2.37	2.40
L.S.D at 5 %		0.034	0.025	0.019	0.015	0.015	0.018
		Interactions					
10 m^3/fed (GWC)	Control	0.93	1.05	0.25	0.30	2.22	2.28
	Microbein	1.72	1.81	0.32	0.37	2.29	2.39
	Phosphorein	1.66	1.77	0.39	0.44	2.35	2.40
	Rhizobacterein	1.10	1.15	0.27	0.31	2.25	2.31
20 m^3/ fed (GWC)	Control	1.15	1.20	0.33	0.36	2.35	2.38
	Microbein	1.92	1.99	0.37	0.43	2.43	2.47
	Phosphorein	1.22	1.26	0.46	0.49	2.45	2.50
	Rhizobacterein	2.06	2.18	0.34	0.38	2.40	2.43
30 m^3/fed (GWC)	Control	1.23	1.29	0.34	0.39	2.37	2.40
	Microbein	2.00	2.20	0.38	0.49	2.48	2.52
	Phosphorein	1.25	1.32	0.49	0.55	2.50	2.57
	Rhizobacterein	2.12	2.31	0.35	0.42	2.45	2.47
L.S.D at 5 %		0.06	0.04	0.03	0.03	0.03	0.03

Effect of the interaction between green waste compost (GWC) and biofertilizers :

It was quite clear from results in Table (10) that the nitrogen, phosphorus and potassium percentages of Isabgol were affected by the interaction between GWC doses and biofertilizers. The high GWC dose combined with rhizobacterein inoculation gave the highest percentages of N (2.12 and 2.31 %), while the same dose combined with phosphorein inoculation gave the highest percentages of P (0.49 and 0.55 %) and potassium (2.50 and 2.57 %) in the two seasons, respectively. These results were in agreement with those obtained by El-Ghadban *et al.*, (2002) who reported that compost at 15 m3 / fed with N_2 fixing bacteria showed considerable increments in N, P and K of marjoram.

The application of green waste compost at 20 m^3 / fed combined with microbein can be recommended for the best results of vegetative growth, flowering, seed yield and mucilage content. It may be noted that this treatments minimize the pollution of the agricultural environments at the same time.

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الملخص العربى

تأثيرالمخلفات النباتية الخضراء(الكمبوست) والأسمدة الحيوية المختلفة على النمو الخضرى والمحصول والمكونات الفعاله لنباتات القاطونة

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أجرى هذا البحث بمحطة أبحاث ومعمل كلية الزراعة جامعة المنصورة خلال موسمى الزراعة المتتاليين ٢٠٠٢/٢٠٠٣ & ٢٠٠٣/٢٠٠٤ لدراسة تأثير الكمبوست بمستويات (١٠ ، ٢٠ ، ٣٠ م٣/ فدان) والأسمدة الحيوية (ميكروبين، فوسفورين، ريزوباكترين) على النمو الخضرى و الزهرى ومحصول البذور والمكونات الفعالة فى نباتات القاطونة.

أظهرت النتائج أن لمعدلات الكمبوست الثلاثة تأثير موجب على كل من إرتفاع النبات وعدد الخلفات والنورات والوزن الجاف للنبات وأعلى محصول للنبات والوحدة التجريبية من البذور وكذلك أعلى محتوى للبذور من المادة الفعالة (ميوسيلاج). وكان أفضل المعدلات لتحقيق أفضل النتائج هو المعدل الثانى (٢٠ م٣ / فدان).

أدت المعاملة بسماد الريزوباكترين الحيوى الى الحصول على أطول النباتات بينما أدت المعاملة بالميكروبين الى الحصول على أكبر عدد من الخلفات والنورات وكذلك الوزن الجاف للنبات بالاضافة الى أعلى محصول للنبات والوحدة التجريبية من البذور وأعلى محتوى من المادة الفعالة (ميوسيلاج).

أدت معاملة التفاعل بين المعدل الثانى للكمبوست (٢٠ م٣/ فدان) والمعاملة بالريزوباكترين الى الحصول على أطول النباتات بينما أدى التفاعل بين معدل الكمبوست الثانى والمعاملة بالميكروبين الى الحصول على أكبر عدد من الخلفات والنورات وكذلك الوزن الجاف للنبات وأعلى محصول بذرى للنبات والوحدة التجريبية وأعلى محتوى من المادة الفعالة (ميوسيلاج) وأدى التفاعل بين معدل الكمبوست الثانى والمعاملة بالفوسفورين الى الحصول على أعلى وزن للألف بذرة.

وبالتالى يمكن التوصية بإضافة الكمبوست بمعدل ٢٠م٣ / فدان والميكروبين بمعدل 400 جرام/ فدان للحصول على أفضل النتائج للنمو الخضرى و الزهرى ومحصول البذور والمحتوى من المكونات الفعالة (ميوسيلاج) فى نباتات القاطونة.