EFFECT OF BIO AND NITROGEN FERTILIZERS ON OKRA

ABD-ALLAH, S. A. M., S. M. A. MANSOUR AND RAWHIA M. WAHBA

Horticulture Research Institute, A.R.C., Egypt

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Abstract

Two field experiments were conducted during the two successive summer seasons of years 2002 and 2003 at Sabahia Horticulture Research Station, Alexandria. This study aimed to evaluate the inoculation of the bio-fertilizer Microbein with the application of different nitrogen fertilizer rates on two varieties of okra (Sabahia 1 and Sabahia 2). The applied N rates were 0, 10, 20, and 30 Kg N/fed, which performed 0%, 25%, 50%, and 75% of the recommended N dose, while the control was 40 Kg N/fed. (100% of the recommended N dose) without Microbein.

Generally, increasing N fertilizer rate led to increased values of most studied characters. Inoculation of okra seeds with the bio-fertilizer Microbein and application of N fertilizer at 30 Kg N/feddan (75% of the recommended dose) compensated to - in some characters surpassed - application of N fertilizer only at 40 Kg N/feddan (100% of the recommended dose). Concerning okra varieties , Sabahia 1 had higher mean values than Sabahia 2 for yield of edible pods/plot in the two successive seasons of the investigation. Meanwhile, Sabahia 2 exceeded Sabahia 1 for plant height and seed germination (%) in both seasons. However, the two okra varieties differed in their response to fertilization treatments at the two seasons of the experiments.

Key words : Bio-fertilizer, Microbein

INTRODUCTION

The need for increased food production in most developing countries becomes an ultimate goal, to meet the dramatic expansion of their populations. The use of bio-fertilizers in agriculture production became unavoidable to minimize the use of large doses of chemical fertilizers that cause environmental pollution. The positive interaction between plants and rhizosphere microorganisms can improve plant nutrition, nitrogen fixation, plant tolerance to environmental stresses and bio-logically control pathogens. These would reduce chemical fertilizers and pesticides needs. It is often assumed that enhancement of plant growth after inoculation is a direct response to the introduced microorganisms. Improvements in seed germination, plant growth or yield after soil or seed inoculation have been attributed solely to N2 fixation (Mishustin, 1970).

Bio-fertilizers drew the attention as a partial good alternative to N fertilizer application. In addition, bio-fertilizers have many merits i.e. supply part of plant N requirement by 25% increase the availability of nutrients, reduce the environmental pollution, control the vegetative growth, and improve the yield potential of olive transplants (Ragab, 1998). Microbein is as nitrogenous bio-fertilizer, produced by Ministry of Agriculture, containing nitrogen-fixing bacteria like Rhizobium. Abdalla *et al.* (2001) reported that Microbein improved the vegetative growth of the pepper plants compared with the control (no bio-fertilizer). Also, application of Microbein significantly increased dry weight / plant, leaf area and leaf area index of cotton plants (El-Shazly and Darwish, 2001)

Okra is a multipurpose use crop with tender and delicious pods. In West Africa, leaves, buds and flowers of okra are, also, consumed. The dried seeds provide oil, protein, vegetable curd and a coffee additives or substitutes. Okra dry seeds are reported to contain 18-20% oil and 20-25% crude protein (Berry *et al.*, 1988). Foliage can be used for biomass and the dried stems serve as a source of paper pulp or fuel. Okra, to a certain extent, is used in canned, dehydrated or frozen forms. It has an average nutritive value of 3.21 that is higher than tomato, eggplant and most cucurbits except bitter gourd, so, it may be considered as one of the important vegetable crops in the tropical and subtropical regions of the world, especially in Egypt at the summer season (Sharma, 1993).

The present investigation was initiated to study the effect of Microbein as a bio-fertilizer accompanied with different rates of nitrogen on the yield and seed production of okra plants and its components to find out the best rate of N mineral fertilizer with Microbein to minimize economic losses and environmental pollution.

MATERIALS AND METHODS

Two field experiments were conducted during years 2002 and 2003 summer seasons at Sabahia Horticulture Research Station, Alexandria, Egypt. The experimental soil texture was coarse clay with shales. The soil pH was 8.14-8.24, the soil has 26.5 and 28.0 mg/l available N, 7.5 and 15.9 mg/l available phosphorus as well as 630 and 890 mg/l available potassium for the first and second seasons, respectively.

The experiments were laid out in a split plot design with four replications. Two okra varieties having high yield potential were randomly distributed in the main plots. These varieties were originated at Sabaheia Horticultural Research Station, Alexandria

(Ragheb *et al.,* 1995). These varieties were Sabahia 1 and Sabahia 2. They were developed by additional repeated self- selected six generations to insure more uniformity within the pedigree of each of them. The sub-plots were devoted to involve five treatments as follows: 1) MN0 = Microbin + zero N, 2) MN1 = Microbin + 10 kg N/fed (25% of recommended dose), 3) MN2 = Microbin + 20 kg N/fed (50% of recommended dose), 4) MN3 = Microbin + 30 kg N/fed (75% of recommended dose) and 5) N4 = 40 kg N/fed (100% of recommended dose).

Phosphorus at a rate of 30 Kg P_2O_5 (add as super phosphate) and potassium at a rate of 30 Kg K per feddan (add as potassium sulphate) were added during seedbed preparation as a general application. Nitrogen as ammonium sulphate (20.6 %) was divided into two equal doses, the first dose being applied just before seeding, irrigation and the second one at mid-flowering stage. Seeds were inoculated just before sowing with bio-fertilizer Microbein. Microbein is a commercial multi-strain of N fixing bacteria (*Azotobacter spp* + *Azosprillum spp* + *Bacillus megatherian* + *Bacillus polymyxa*) produced by the General Organization for Agriculture Equalization Fund, Ministry of Agriculture. The carriers in Microbein are Peatmoss , Charcool and Vermiculite.

Seeds of okra were planted in a single row, 4m long, 0.7 m wide and hills 30 cm apart at the rate of 4 seeds per hill. Each plot contained 5 rows for yield of edible pods and 5 rows for seed yield. The plot area was 14 m^2 for each. Sowing date was on May 4th and 3rd for the first and second seasons, respectively. Three weeks later, seedlings were thinned and the strongest one being remained in each hill.

Other cultural practices were carried out as recommended for the conventional okra planting.

Recorded measurements:

1. Vegetative growth characters and yield components:

Harvesting took place during the period from mid of June up to mid of September. Pods were picked with all pedicels in the morning every 3 days and subjected, as soon as possible, to the following records: Total edible yield (Kg/plot) and number of pods/ plant were taken for 25 pickings. Leaf area (cm^2) per plant was determined in mid season for each sample by the disk method (Bremner and Taha, 1960). Plant height (cm) and number of branches / plant were taken at the end of picking.

2. **Chemical constituents of edible pods:**

Pod dry matter (%) was measured as the average of three different pickings and expressed as dry weight / fresh weight x 100. Mucilages content (mg/100g) in fresh edible pods was determined as described by Woolf *et al.* (1977). Nitrate was estimated as mentioned by Bremner (1965) and nitrite was determined as described by Chapmand and Pratt (1961), both of them were estimated in dry edible pods (mg/100g).

3. **Seed yield and its components:**

Number of mature pods/pant, Number of seeds/pod, total seed yield (Kg/plot), seed germination (%)and seed index were recorded.

Statistical procedures:

Simple statistical analysis of split plot design, according to Snedecor and Cochran (1980), was done to find out the significance of the studied characters and to compare between means by least significant difference test (LSD) at 0.05% rate of significance.

RESULTS AND DISCUSSION

1- Effect of bio and nitrogen fertilizer rates on vegetative growth characters and yield components.

Data in Table 1 show that vegetative growth characters of okra i.e., number of branches / plant, plant height, and leaf area were significantly improved as N fertilizer rate increased in both seasons without any significant differences among the last three higher N rates. These results indicated that inoculated okra seeds with the bio-fertilizer Microbein and application of N fertilizer at 20 or 30 Kg N/feddan (MN2 or MN3, respectively) was equivalent to the application of N fertilizer only at 40 Kg N/feddan (N4). In this respect, Hamissa *et al.* (2000) found that cotton plant height at harvest had a significant increase due to seed inoculation with bio-fertilizer. Furthermore, El-Shazly and Darwish (2001) reported that application of Microbein significantly increased leaf area/plant of cotton in the first season of their investigation. These increases may be due to the ability of the microorganisms to produce growth regulator substances i.e., Indole Acetic Acid (IAA), Gibbrelic Acid (GAs), and Cytokinones (CKs). These growth substabce play an important role in plant growth through promoting photosynthesis, translocation and accumulation of dry matter within different plant parts (Megahed and Mohamed, 2001). Moreover, Awad *et al.* (2002) suggested that treating potato seed tubers with Microbein before planting increased significantly vegetative growth.

Concerning the yield, application of N fertilizer, only at 40 Kg N/feddan (N4), produced the highest values of edible pods yield (11.91 and11.08 Kg/plot, in the first and the second seasons, respectively), (Table 1). The two fertilization treatments MN3 and N4 were about the same in both seasons as well. On the other hand, the highest values of number of edible pods/plant were obtained by the fertilization treatment MN3 in both seasons, this treatment and N4 were similar. These findings may be due to Microbein acted mainly in increasing the availability of nitrogen, and consequently increasing their absorption by the plant. It is well known that nitrogen plays a main role in the plant development and production. It is present in chlorophyll molecule and a component of all proteins (Abd-Alla *et al.,* 2001). In this regard, Rizk (2002) reported that application of Microbein resulted in the highest value of growth characters of eggplant, yield and its components.

The two okra varieties significantly varied in some traits. The mean value of plant height was higher for Sabahia 2 than for Sabahia 1 in both seasons. Meanwhile, Sabahia 1 gave higher yield of pods than Sabahia 2 in both seasons. However, Sabahia 1 had the highest leaf area and number of pods/plant in the second season and in the first season, respectively (Table 1). Moreover, the two okra varieties differed in their response to fertilization treatments in number of branches / plant and leaf area in the second season only.

Table 1. Effect of bio and nitrogen fertilizer rates on the vegetative growth characters and yield components of okra .

characters	No. of branches/plant			Plant height (cm)			Leaf area/plant (cm2)			Yield of pods(Kg/plot)			No. of pods/plant		
Okra varieties	Sabahia1	Sabahia2	Mean	Sabahia1	Sabahia2	Mean	Sabahia1	Sabahia2	Mean	Sabahia1	Sabahia2	Mean	Sabahia1	Sabahia2	Mean
							1st season								
Fertilization treatments															
MN0	5.0	4.6	4.8	103.7	124.9	114.3	2313	2513	2413	9.54	6.94	8.24	34.3	25.9	30.1
MN1	5.3	4.9	5.1	99.5	127.1	113.3	3054	2860	2957	11.09	7.99	9.54	41.5	27.2	34.4
MN2	5.9	5.0	5.5	108.0	147.3	127.7	3895	3409	3652	13.44	8.04	10.74	45.1	31.6	38.3
MN3	5.7	5.7	5.7	106.5	139.5	123.0	4308	4116	4193	13.61	10.01	11.81	46.5	36.3	41.7
N4	6.0	5.3	5.6	110.3	137.8	124.0	4191	4194	4212	13.85	9.97	11.91	46.6	34.6	40.6
Mean	5.6	5.1		105.6	135.3		3552	3419		12.31	8.59		42.8	31.1	
LSD 0.05															
O. V.		ns			27.16			ns			0.42			7	
Fer. treat		0.47			10.52			876			0.95			2.9	
O.V.XFer.		ns			ns			ns			ns			ns	
							2nd season								
Fertilization treatments															
MN0	6.4	6.3	6.4	113.4	157.1	168.0	4351	4239	4295	9.48	7.16	8.32	26.3	23.7	25.0
MN1	6.7	8.1	7.4	128.1	160.7	142.6	4413	4702	4558	10.01	8.48	9.25	25.5	23.9	24.2
MN2	9.2	9.1	9.2	138.8	172.7	156.6	6090	5535	5812	9.75	9.75	9.75	22.5	25.0	23.8
MN3	9.3	9.0	9.2	151.1	174.4	155.9	5966	5680	5823	11.56	10.19	10.88	28.8	30.0	29.4
N4	11.1	6.7	8.9	151.3	172.0	161.6	7682	7483	6060	10.86	11.31	11.08	29.0	25.3	27.2
Mean	8.6	7.8		136.5	167.4		5700	4919		10.33	9.38		26.4	25.4	
LSD 0.05															
O. V.		ns			1.79			329			0.92			3.96	
Fer. treat		0.86			8.26			435			0.91			2.56	
O.V.X Fer		1.22			ns			615			ns			ns	

M= bio-fertilizer Microbein ns=not significant

N 0, 1, 2, 3, 4 = Nitrogen fertilizer at 0, 10, 20, 30, 40 Kg /fed, respectively

2- Effect of bio and nitrogen fertilizer rates on chemical constituents of edible pods

Data in Table 2 indicate that fertilization treatments caused significant differences for all studied characters in both studied seasons except for dry matter percentage in the second season. Dry matter percentage was about the same by applying different fertilization treatments except for N4, which had the lowest value in the first season. These findings indicated that chemical fertilizer, only, gave lower effect than chemical and bio-fertilization together. In this respect, Ahmed *et al.* (1997) reported that applying the bio-fertilizer, compared with the chemical fertilizer, tended to increase the dry matter content in the different groundnut plant organs.

Concerning the concentration of mucilage in fresh pods, the data in Table 2 were about the same by applying fertilization treatments except for MN2, which produced the lowest value compared with the other treatments in the first season. Meanwhile, in the second season, the treatment MN3 gave the highest significant mean value compared with the other treatments.

Concentration of nitrate in dry edible pods increased significantly as N fertilizer rate was increased in both seasons. Chemical fertilizer (N4), only, compared with the other treatments, gave the highest significant mean value for this trait in both seasons. Concerning the concentration of nitrite in dry edible pods, the data obtained revealed a trend similar to that of nitrate in the first season, but in the second season, there were no significant differences among the treatments MN2, MN3, and N4. In this regard, Kawther *et al.* (2002) reported that the most promising treatment was bio-fertilizer combined with 50% recommended dose of nitrogen fertilizer which satisfied the objective of producing high yield with low nitrate and nitrite rates and save about 50% of the cost of nitrogen fertilizer.

The two okra varieties significantly varied in concentration of mucilage in the second season, Sabahia 2 being higher than Sabahia 1. On the other hand, the two okra varieties differed in their response to fertilization treatments in the concentration of mucilage in both seasons and concentration of nitrate in the second season only.

Table 2. Effect of bio and nitrogen fertilizer rates on the chemical constituents of edible pods.

Characters	Dry matter (%)			Mucilage in fresh pods (mg/100g)			Nitrate in dry pods (mg/100g)			Nitrite in dry pods (mg/100g)		
Okra varieties	Sabahia1	Sabahia2	Mean	Sabahia1	Sabahia2	Mean	Sabahia1	Sabahia2	Mean	Sabahia1	Sabahia2	Mean
1st season												
Fertilization treatments												
MN0	12.26	11.69	11.98	5.56	3.20	4.38	391.0	392.1	391.5	1.52	1.37	1.45
MN1	12.34	12.26	12.30	4.48	4.40	4.44	412.2	439.1	425.7	1.74	1.55	1.65
MN2	12.78	12.02	12.40	3.41	4.35	3.88	498.2	512.0	505.1	2.61	2.39	2.50
MN3	12.03	12.12	12.08	4.07	5.59	4.83	581.2	602.4	591.8	2.32	2.41	2.37
N4	11.59	11.62	11.61	3.89	6.51	5.19	672.1	654.2	663.2	2.95	2.79	2.87
Mean	12.20	11.95		4.28	4.81		511.0	519.9		2.23	2.10	
LSD 0.05												
O. V.		ns			ns			ns			ns	
Fer. treat		0.69			1.03			22.2			0.42	
O.V. X Fer.		ns			1.46			ns			ns	
2nd season												
Fertilization treatments												
MN0	9.15	8.93	9.04	2.13	3.80	2.97	391.7	393.9	392.8	1.49	1.39	1.44
MN1	9.13	9.01	9.07	4.67	5.67	5.17	411.5	422.0	416.7	1.72	1.76	1.74
MN2	9.40	8.94	9.17	3.40	6.80	5.10	494.9	564.5	529.7	2.56	2.81	2.69
MN3	9.97	9.07	9.52	6.40	6.60	6.50	573.0	593.9	583.4	2.45	2.68	2.51
N4	9.49	9.37	9.43	5.33	6.00	5.67	695.1	709.9	702.5	2.87	2.81	2.84
Mean	9.43	9.06		4.39	5.77		513.2	536.8		2.20	2.29	
LSD 0.05												
O. V.		ns			0.37			ns			ns	
Fer. treat		ns			0.47			16.10			0.48	
O. V. X Fer.		ns			0.66			22.77			ns	

M= bio-fertilizer Microbein ns=not significant

N 0, 1, 2, 3, 4 = Nitrogen fertilizer at 0, 10, 20, 30, 40 Kg /fed, respectively

3- Effect of bio and nitrogen fertilizer rates on Seed yield and its components

All tested fertilization treatments caused significant differences for every studied character except for seed index in the first season (Table 3). The highest numbers of both mature pods/plant and seeds/pod were given by treatments MN3 and N4 in both seasons. Likewise, treatments MN3 and N4 had the same results in both of seed yield/plot in the first season and weight of 100 seeds in the second season. However, the treatment MN3 surpassed N4 and significantly increased both of seed yield/plot in the second season and seed germination percentage in the first season. These results indicated that inoculated seeds of okra with the bio-fertilizer Microbein and application of N fertilizer at 30 Kg N/feddan (75% recommended dose) compensated to - in some chracters surpassed - application of N fertilizer only (without Microbein)at 40 Kg N/feddan (100 recommended dose). These findings may be attributed to: 1) the role of bio-fertilizer Microbein in increasing uptake of N, P, K and Mg as reported by Ragab (1998) in olive, 2) the role of bio-fertilizer in increasing the plant growth substances like IAA, GAs, and CKs which promote plant growth, cell division, encourage the photosynthesis and assimilates accumulation (Said, 1998), 3) the effect of Microbein in fixing nitrogen and release of phosphorus which plays an important role in plant development. In this respect, El-Shazly and Darwish (2001) showed that seed cotton yield/fed was significantly affected by Microbein in the second season only, where Microbein application increased seed cotton yield/fed by 1.4 kentars over the check (without Microbein).

The mean values of both number of mature pods/plant (13.9) and seed yield/plot (4.980 Kg) were higher in Sabahia 1 than Sabahia 2 in the second season. Meanwhile, Sabahia 2 had higher mean values of seed germination percentage in both seasons and number of seed/pod in the second season than Sabahia 1. On the other hand, the two okra varieties were different in their response to fertilization treatments, for number of mature pods/plant and seed germination percentage in the second season.

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Table 3. Effect of bio and nitrogen fertilizer rates on the seed yield of okra and its components.

characters	No. of mature pods/plant			No. of seeds / pod			Seed yield / plot (Kg)			Seed index (g)			Seed germination (%)		
Okra varieties	Sabahia1	Sabahia2	Mean	Sabahia1	Sabahia2	Mean	Sabahia1	Sabahia2	Mean	Sabahia1	Sabahia2	Mean	Sabahia1	Sabahia2	Mean
								1st season							
Fertilization treatments															
MN0	9.5	7.3	8.4	85.7	101.7	93.7	3.759	3.509	3.633	6.18	5.87	6.02	31.33	44.00	37.67
MN1	10.0	9.1	9.5	90.7	102.0	96.3	4.142	4.265	4.203	6.39	6.11	6.25	38.00	51.00	44.50
MN2	11.3	9.8	10.6	95.0	102.7	98.8	4.158	4.294	4.226	6.36	6.56	6.46	38.67	54.00	46.33
MN3	11.6	13.3	12.5	104.7	108.7	106.7	4.241	5.358	4.800	6.45	6.67	6.56	53.33	69.33	61.33
N4	11.4	10.8	11.1	108.0	119.7	113.8	5.041	4.664	4.852	6.43	5.58	6.51	43.33	60.00	51.67
Mean	10.8	10.1		96.8	106.9		4.268	4.418		6.36	6.36		40.93	55.67	
LSD 0.05															
O. V.		ns			ns			0.497			ns			5.17	
Fer. treat		1.5			11.2			0.426			ns			6.77	
O.V.XFer.		ns			ns			ns			ns			ns	
								2nd season							
Fertilization treatments															
MN0	11.8	9.4	10.6	90.0	94.0	92.0	4.410	3.434	3.922	5.45	5.59	5.52	25.67	51.33	38.50
MN1	12.4	9.8	11.1	92.7	102.3	97.5	4.580	3.661	4.121	6.07	5.77	5.92	29.67	56.00	42.83
MN2	13.6	12.0	12.8	94.0	102.7	98.3	5.270	3.909	4.589	6.14	6.26	6.20	31.00	65.67	48.33
MN3	17.2	13.1	15.2	105.3	104.7	105.0	5.417	5.718	5.567	6.45	6.40	6.35	32.00	68.67	50.33
N4	14.6	13.8	14.2	101.3	103.0	102.2	5.220	5.127	5.174	6.30	6.40	6.42	35.33	78.67	57.17
Mean	13.9	11.6		96.7	101.3		4.980	4.370		6.08	6.08		30.80	64.00	
LSD 0.05															
O. V.		1.5			3.8			0.323			ns			5.03	
Fer. treat		1.0			3.9			0.271			0.44			2.12	
O.V.X Fer		1.4			ns			ns			ns			3.00	

M= bio-fertilizer Microbein ns=not significant

N 0, 1, 2, 3, 4 = Nitrogen fertilizer at 0, 10, 20, 30, 40 Kg /fed, respectively

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تأثير إضافة السماد الحيوى مع السماد الأزوتى على الباميا

سامح عبد المنعم محمد عبد الله – سامى محمد على منصور – روحية محمد وهبه

معهد بحوث البساتين – مركز البحوث الزراعية – مصر

أجريت تجربتان حقليتان فى المزرعة البحثية لمحطة بحوث البساتين بالصبحية خلال موسمى الزراعة ٢٠٠٢ و ٢٠٠٣ ؛ لدراسة تأثير معاملة بذور صنفين من الباميا (صبحية ١ ، وصبحية ٢) بالمخصب الحيوى التجارى " الميكروبين " مع إضافة مستويات مختلفة من السماد النيتروجينى وهى: صفر ، و ١٠ ، و ٢٠ ، و ٣٠ كجم نيتروجين/ فدان (صفر% ، و٢٥% ، و٥٠% ، و ٧٥% من الجرعة الموصى بها) ، بالاضافة إلى معاملة الكنترول وهى ٤٠ كجم نيتروجين للفدان (١٠٠% من الجرعة الموصى بها) بدون استخدام " الميكروبين " .

وكانت أهم النتائج المتحصل عليها كالآتى :

١. أدت زيادة مستوى السماد النتيروجينى الى زيادة قيم معظم الصفات تحت الدراسة ، وقد وجد أن معاملة بذور الباميا بالميكروبين مع إضافة السماد بمستوى ٣٠ كجم ن / فدان قد تساوت مع – وفى بعض الصفات تفوقت على – إضافة السماد النيتروجينى فقط بمستوى ٤٠ كجم ن/فدان (الكنترول).
٢. أعطى الصنف صبحية ١ قيما أعلى معنويا عن السلالة الثانية فى صفات محصول القرون فى كلا الموسمين ، بينما أعطى الصنف صبحية ٢ قيما أعلى معنويا عن السلالة الأولى فى صفات ارتفاع النبات ، نسبة انبات البذور فى كلا الموسمين .
٣. اختلفت استجابة صنفى الباميا لمعاملات التسميد لعدد من الصفات فى كلا الموسمين .