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RESPONSE OF SNAP BEAN TO TWO BIOFERTILIZERS AND DIFFERENT LEVELS OF NITROGEN

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ABSTRACT

The present work was carried out during two successive autumn seasons of year 2004 and 2005 in unheated plastic house (40 X 8.5 m) at the Experimental Station, Faculty of Agriculture, Cairo university, Giza, to study the response of two snap bean (*Phaseolus vulgaris,L*.) cultivars, namely Bronco and Pulista, to inoculation with symbiotic bateria Okadine (*Rhizobium leguminosarum biover phaseoli*) and non symbiotic nitrogen fixation bacteria Rhizobacterin (containing Azospirillum + Azotobacter). The experiment included 20 treatments which were a combination of two cultivars, and ten combination treatments between nitrogen fixation bactertia and five levels of nitrogen fertilizers (0, 10, 20, 30 and 40 kg N/feddan). Pulista cv. surpassed cv, Bronco in plant yield, number of branches, pod length, leaves contents of N and K and pods content of K, whereas the reverse was true concerning plant yield, total yield, diameter of pod, leaves content of P and pods content of carbohydrate. Using Okadin + 30 kg N/feddan treatment increased fresh weight of Bronco plants as compared with using nitrogen at level of 40 kg N, and increased yield per plant and feddan as well as N and P content in leaves and pods, respectively in both cultivars. Inoculation bean plants with a mixture of two the biofertilizers, in addition to fertilizing plants with mineral nitrogen at 10, 20 or 30 kg N/feddan promoted plant fresh weight, especially in cv. Pulista, and led to significant increase in early and total yield per plant and feddan. Meanwhile, the treatment of Okadine + Rhizobacterin + 20 kg N/feddan significantly increased in N and P contents in leaves significantly raised pod contents of N ,P and K. and showed markedly higher pods content of carbohydrate than control. There was also a significant increase in fiber content due to using Okadine + Rhizobacterin + 0 kg N/feddan treatment as compared with the control treatment.

INTRODUCTION

Snap bean (*Phaseolus vulgaris,L*.) is one of the most important vegetable crops grown in Egypt for local consumption as well as for exportation. Biological nitrogen fixation (BNF), which enables legumes to depend on atmospheric nitrogen (N), is important in legume based cropping systems when fertilizer- N is limited .BNF contributes N for legume growth and grain production under different environmental and soil may be replenished with N through decomposition of legume residues (Fujita *et al* .,1990)

The literature describing the effectiveness of rhizobium inoculation in increasing vegetative growth, yield and nitrogen content of common bean plants are contradictory, partially because different bean cultivars (Daba and Haile, 2002) environmental and soil conditions (Carvalho *et al*., 1998 and Henandez-Armenta, 1989) and rhizobium strains (Lalande *et al*., 1990 and Sanoria and Yadav ,1993) .For example, inoculation of common bean plants with rhizobium was not effective, when it was conducted in irrigated soil (Carvalho *et al*., 1998) or when the soil temperature was 38^{o} C, or higher, immediately after inoculation (Hernandez – Armenta *et al*., 1989) or when the application of nitrogen was increased (Datt, 2006). On the other hand, inoculation *Phaseolus vulgaris* with Rhizobium increased plant height, pods per plant, fresh weight per plant, seed yield and NPK uptake (Rana, 2006).

Several investigators indicated that the inoculation of beans with *Rhizobium phaseoli* increased nodule, vegetative growth and total nitrogen of above ground parts.

which reflected on yield of bean plants (Ruschel and Ruschel, 1978; Taylor *et al* .,1980 El –Shal *et al*.(1986). Daba and Haile (2002) and Datt *et al* (2006) reported that inoculation of beans with rhizobium increased total nitrogen of above ground parts.

Another factor which may increase the yield of legumes is inoculation with free or associated nitrogen fixation bacteria, which can fix nitrogen by themselves (Chrispeels and Sadava , 1994), improve plant growth, through producing fungistatic substance (Gupta *et al* .,1995) or through improving symbiotic parameter of legume-rhizobium association (Singh and Subba Rao, 1979). In this regard, Shahaby (1981) and Sarig *et al*. (1986) recorded an increase in the yield of cowpeas and peas , respectively .due to inoculation plants with Azospirillium. Similarly, Jauhri et al. (1979), working on *Vigna radieta* and soybean, Shahaby (1981), working on cowpeas and peas, and Choudhapy *et al*.(1984) working on peas, revealed that inoculation with Azotobacter plus Rhizobium was more effective in increasing pod and seed yield as compared with inoculation with Rhizobium alone.

Burdman *et al*. (1997) observed a significant increase in, shoot dry weight accumulation and yield by inoculation with Rhizobium, and a further increase in those variables was observed following combined inoculation with Rhizobium and Azospirillum. Singer *et al*. (2000) showed that inoculation snap bean with Rhizobium and Azospirillum with various rates of NPK significantly increased vegetative growth parameter; i.e, plant height, fresh and dry weight per plant and improved pods quality, such as increased crude protein percentage, increased total carbohydrate content and reduced the fiber percentage. Hamaoui *et al*. (2001) mentioned that results of greenhouse and field experiments carried out in different soils indicated that inoculation with *Azospirillum brasilense* at an optical cell concentration (about 5×10^7 CFU/ plant) consistently improves root and shoot growth of chickpeas and faba beans often resulting in an increase in grain yield

MATERIALS AND METHODS

The present work was carried out during two successive autumn seasons of year 2004 and 2005 in unheated plastic house (40 X 8.5 m) at the Experimental Station, Faculty of Agriculture, Cairo University, Giza, to study the response of two snap bean (*Phaseolus vulgaris,L*.) cultivars, namely Bronco and Pulista, to inoculation with symbiotic bateria okadine (*Rhizobium leguminosarum biover phaseoli*) and non symbiotic nitrogen fixation bacteria Rhizobacterin (containing Azospirillum + Azotobacter). Seeds were sown on 19 th October in the two seasons . Before sowing , seeds were coated with a thin film of Rhizobium and Azospirillum inoculatant using gums Arabic 40% as sticker. The experiment was arranged in split plot design with four replications, where the two cultivars were put in the main plots, and the ten biofertlizers were randomally distributed in the sub main plots. The experiment included 20 treatments which were a combination of two cultivars, and ten combination treatments between nitrogen fixation bactertia and five levels of nitrogen fertilizers. The combination treatments were as follow:

1- Plant received no fertilization with nitrogen and no biofertilizer.
2- Plants received Okadin plus 0 N/feddan
3- Plants received Okadin plus 10 kg N/feddan
4- Plants received Okadin plus 20 kg N/feddan
5- Plants received Okadin plus 30 kg N/feddan
6- Plants received Okadin plus Rhizobacterin plus 0 N/feddan
7- Plants received Okadin plus Rhizobacterin plus 10 kg N/feddan
8- Plants received Okadin plus Rhizobacterin plus 20 kg N/feddan
9- Plants received Okadin plus Rhizobacterin plus 30 kg N/feddan
10- Plants received 40 kg N / feddan

The plot was 8.5 m^2 and consisted of two ridges, each-5m long and 0.85m wide .Seeds were sown on the two sides of ridge in hills at 5 cm apart. Three to five seeds were sown in a hill. Ten days after sowing, plants were thinned to two plants per hill.

Data recorded:

1-Plant growth measurement

Three plants were taken randomly from each experimental plot at the beginning of harvest; i.e , 68 days from seed sowing, as representative sample for recording plant fresh weigh, plant length and number of branches per plant .

2-yield and yield components measurement

2.1-Plant yield: weight of green pods at the beginning of harvest was measured on three plants taken randomly from each plot.

2.2-Early yield : Weight of green pods of the first harvest taken from each plot was recorded and then the average yield of green pods/m^2 was calculated and considered as early yield.

2.3-Total yield: Weight of green pods taken during all harvesting from each plot was recorded ; thereafter the total weight of green pods/m^2 was calculated

2.4-Pods characteristics

Ten pods were taken randomly at the second harvest from each experimental plot for measuring the average pod weight (g). pod length (cm), pod width (mm) and total soluble solids(TSS).

3-Chemical analysis

Hundred gram fresh weight of each of leaves and pods, obtained from the three sample plants taken randomly from each experimental plot at the beginning of harvest , were oven – dried of 70 ^{O} C to a constant weight. The dried samples were taken to measure N, P and K in leaves and pods as well as pod contents of total carbohydrates and crude fibers were determined according the following methods.

2.1- Total nitrogen concentration in leaves and pods were determined according to method of Huphries (1956) by a modified micro -Kjeldahl apparatus.

2.2- Total phosphorus concentration in leaves and pods were determined according to the method Taussky and Shorr (1952) .

2.3- Potassium concentration in leaves and pods were measured using flame photometrically as described by Brown and Lilliland (1964).

2.4-Carbohydrate and fiber concentration in pods were determined as described in A.O.A.C. methods (1980) .

All data were subjected to statically analysis using a combined analysis and means were compared using L.S.D. as described by Senedcor and Corchan (1980). The physical and chemical properties of the soil under study are presented in table (1).

Table 1.Chemical characteristics of plastic house soil at Faculty of Agriculture, Cairo University, Giza.

Microelements (ppm)				Macroelements (ppm)			Soluble anions (meq /L)			Soluble cations (meq /L)				E.C S/m	pH 1:2.5	Calcium Carbonate %
Fe	Zn	Mn	Cu	N	P	K	HCO_3^-	Cl^-	SO_4^{-2}	Ca^{+2}	Mg^{+2}	Na^+	K^+			
4.4	3	16	2.5	90	34	720	1.4	6	29.1	19	6	9.9	1.6	4	7.6	3.6

RESULTS

1- Vegetative growth

The effect of cultivars, biofertilizer treatments, different levels of nitrogen and their interaction are present in Table 2 and 3. As shown in these tables, whereas Bronco cv. plants were significantly higher than those of cv. Pulista, the reverse was true concerning number of branches per plant. Such differences between the two cultivars may be attributed to the genetic variation between them. These results are in agreements with El-Sayed (1990a) who recorded significant among some common bean cultivars regarding to growth and yield components.

Table 2. Effect of Biofertilizer treatments, different levels of N application and snap bean cultivars on vegetative growth and yield of two snap bean cultivars (Combined data of years 2004 and 2005)

Treatments	Vegetative growth			Yield		
Cultivars	**Plant length (cm)**	**Number of branches**	**Fresh weight per plant (g)**	**Plant Yield (g)**	**Early yield (g/m^2)**	**Total yield (g/m^2)**
Bronco	56.2	2.0	86.5	106.3	406.9	663
Pulista	45.7	2.4	85.9	112.1	422.1	554.9
L.S.D at 0.05	3.6	0.4	6.5	4.3	22.1	12.3
Biofertilizer treatments						
0 kg N	46.7	2.6	69.1	90.1	301.3	466 .3
O + 0 kg N	49.9	2.5	82.1	100.3	368.8	553.8
O + 10 kg N	49.5	2.3	75.3	108.9	469.1	586.6
O + 20 kg N	50.9	2.4	78	105.8	423.8	546.6
O+ 30 kg N	51.9	2.3	94.9	114.6	456.3	710.9
O + R + 0 kg N	49.7	2.4	82.3	115.3	403.8	664.1
O +R + 10 kg N	50.4	2.6	103.7	117.6	453.9	686.3
O + R + 20 kg N	50.9	2.4	96.1	121	458.8	702.7
O + R +30 kg N	53.7	2.4	98.6	117.7	450.9	675.8
40N	55.3	2.5	81.9	100.4	358.8	496.3
L.S.D at 0.05	3.2	0.4	10.3	8.6	39.9	35.7

O= Okadin, R= Rhizobaterin

Fertilizing plant with Okadin + Rhizobacterin +10, 20 or 30 kg N or using Okadin alone + 30 kg N/feddan had a positive effect on the plant fresh weight as compared to fertilizing plants with 40 kg N. On the contrary, plants received 40 kg N/feddan were significantly higher than the plants of all treatments, except that treated with a mixture with Okadin + Rhizobacterin + 30 kg N/feddan, which showed a similar effect to that found due to using 40 kg N/feddan. Meanwhile, no treatment had a significant effect on number of branches per plant . These results are in agreement with those of Singer *et al*.(1996) who concluded that applying 50% or 75% of NPK from recommended doses and inoculation with Rhizobium. sp. and non-symbiotic Azosperillum. sp or Rhizobium sp with soil yeast (cand.sp) to snap bean plants resulted in vigorous plant growth. Similar results were observed by Burdman *et al.* (1997) and Singer *et al.* (2000) who recorded positive effects on plant growth of common bean due to treating with a mixture of Rhizobium and Azospirillum

The interaction between biofertilizer treatments and cultivars on all traits of vegetative growth was significant. In cv. Bronco, the treatment Okadine + 30 kg N and Okadin + Rhizobacterin + 10 kg N / feddan had greater fresh weight than the treatment of 40 kg N/feddan, whereas plants got 0 N and no biofertilizer as well as that treated with Okadin + 10 kg N/feddan had less fresh weight than control . In cv. Pulista, biofertilization with Okadin + Rhizobacterin + 10, 20 or 30 kg N/feddan led to a significant increase in plant fresh weight as compared with control (40 kg N) .

Concerning the effect of the interaction on plant height of cv. Bronco, bean plants received no fertilization or treated with Okadin + 0 , 10 or 20 kg N were shorter than those of the control treatment (40 kg N/fed.). In cv. Pulista plants of all treatments were shorter than those of control ; however, there were no significant differences in plant height between the treatments of Okadin + 20 or 30 kg N and the control plants. On the other hand, there were no significant differences in the number of branches per plant between all treatments. The results of Okadin alone are in agreements with Merghany (1999) who found that the highest value of plant fresh weight was obtained by inoculation snap bean cv. Bronco with Rhizobiun under peatmoss inoculation method. Daba and Haile (2002) found that some varieties of common bean were noted to be non- responsive to inoculation with mixed granular rhizobia and application of nitrogen fertilizer. The results concerning effect of the mixture of biofertilizers, i.e., Okadin and Rhizobacetrind, + a medium level of mineral N fertlization are in agreement with those of Singer *et al*.(1996) who concluded that applying 50% or 75% of NPK from recommended doses and inoculation with Rhizobium. sp. and non-symbiotic Azosperillum. sp or Rhizobium sp with soil yeast (cand.sp) to snap bean plants resulted in vigorous plant growth. Similar results were observed by Burdman *et al.* (1997) and Singer *et al.* (2000) who recorded positive effects on plant growth of common bean due to treating with a mixture of Rhizobium and Azospirillum

2. Yield

Data presented in the Table 2 and 3 indicated that pod yield per plant in cv. Pulista was higher than that in Bronco cv., while plants of Bronco produced more total yield than those of Pulista . Meanwhile, the effect of cultivars on early yield was not significant .

Table 3. Effect of the interaction between Biofertilizer treatments, different levels of N application and snap bean cultivars on vegetative growth and yield (Combined data of years 2004 and 2005)

Treatments		Vegetative growth			Yield		
Cultivars	**Biofertilizer treatments**	**Plant height (cm)**	**number of branches**	**Fresh weight per plant (g)**	**Plant Yield (g)**	**Early yield (g/m^2)**	**Total yield (g/m^2)**
Bronco	0 kg N	50.6	2.1	67.3	93.6	275	475.6
	O + 0 kg N	55.7	2.0	83.1	104.6	372.5	630.6
	O + 10 kg N	54.9	2.1	71.3	103.9	438.8	558.8
	O + 20 kg N	55.4	1.9	79.4	105.9	403.1	583.1
	O+ 30 kg N	56.6	1.8	108.4	111.6	436.3	763.8
	O + R + 0 kg N	56.1	2.0	75.4	109.7	445	792.5
	O +R + 10 kg N	56.6	2.1	111.8	112.4	439.6	788.8
	O + R + 20 kg N	56.2	1.9	87.9	112.2	456.3	763.5
	O + R +30 kg N	59.2	2.0	94.3	111.9	446.9	751
	40N	60.2	1.9	86.1	96.7	355.6	521.9
Pulista	0 kg N	42.9	3.1	70.9	86.6	327.5	456.9
	O + 0 kg N	44.2	3.1	81.1	96.1	365	476.9
	O + 10 kg N	44.2	2.5	79.4	113.8	499.4	614.4
	O + 20 kg N	46.5	2.9	76.6	105.6	444.4	510
	O+ 30 kg N	47.3	2.9	81.5	117.7	476.3	658.1
	O + R + 0 kg N	43.4	2.8	89.1	120.9	362.5	535.6
	O +R + 10 kg N	44.2	3.1	95.6	122.9	468.1	583.8
	O + R + 20 kgN	45.5	3.0	104.3	129.7	461.3	641.9
	O + R +30 kg N	48.3	2.8	102.9	123.4	455	600.6
	40N	50.4	3.1	77.8	104	361.9	470.6
L.S.D at 0.05		4.5	0.5	14.6	12.1	56.46	50.41

O= Okadin, R= Rhizobacterin

All treatment of biofertilizer treatments which consisted of Okadin + Rhizobacterin + N fertilization led to a significant increase in early and total yield per feddan as well as plant yield. The present results confirmed those of many previous investigators, such as Shahaby (1981) working on cowpeas and peas, Sarig *et al.* (1986) working on peas, Jauhri *et al*. (1979) working on *Vigna radieta* and soybean, Choudhapy *et al.(*1984) working on peas and Singer *et al.* (2000) working on snap beans. Similarly**,** Burdman *et al*. (1997) observed a significant increase in shoot dry weight accumulation and yield of snap beans by inoculation with Rhizobium, a further increase in those variables was observed following combined inoculation with Rhizobium and Azospirillum Concerning the effect of treating plants with Okadin and mineral nitrogen fertilization, treating plant with Okadin plus mineral N fertilization at 10, 20 or 30 kg N/feddan significantly increased early yield as compared with control, whereas the treatment of Okadin + 30 N kg was the only treatment that increased plant yield as compared with control treatment. All Okadin treatments pulse N fertilization ; i.e , 0, 10, 20 or 30 kg N/feddan, produced significantly a higher total yield. . Similar results were recorded by Merghany (1999), Chandel *et al*. (2002) and Daba and Haile (2002) who found that inoculation of snap bean with Rhizobium increased crop yield and plant yield over the control. In contrast, the present results disagree with the finding of Urzua *et al*.(2003) who found that seeds inoculated with *Rhizobium leguminosarum by phaseoli* did not differ significantly in final yield from those grown with 70 kg /ha nitrogen fertilizer. The contradiction in the results, may partially due to using different bean cultivars (Daba and Haile ,2002) environmental and soil conditions (Carvalho ,1998 and Henandez-Armenta,1989) or to rhizobium strains (Lalande, 1990 and Sanoria and Yadav,1993).

Concerning the effect of the interaction on total yield, in cv. Bronco all treatments, except the plants that did not receive any fertilization and plants received Okadin + 10 kg N, produced a higher yield as compared with the control . Meanwhile, in cv, Pulista all treatments, except plants that did not receive any fertilization and plants received Okadin + 0 or 20 kg N, produced a higher yield as compared with the control.

Concerning early yield, in cv. Bronco, plants received Okadin + 10 or 30 kg N or Okadin + Rhizobacterin + 0, 10, 20 or 30 kg N produced a higher yield as compared with the control . Meanwhile, in cv. Pulista plants got Okadin + 10, 20 or 30 kg N or Okadin + Rhizobacterin + 10, 20 or 30 kg N showed a greater value of early yield as compared with the control .

3. Green pod characters

Data concerning effect of biofertilizer treatments and different levels of nitrogen treatments on some physical and chemical characters of green pod are presented in Tables 4 and 5. Pods of cv. Bronco had significantly higher content of carbohydrate than cv. Pluista pods there were no noticeable differences between the two snap bean cultivars concerning pods content of fiber . These results are in agreements with El- Sayed (1990 b) who found that there were differences among some common bean cultivars regarding to total sugars, crude fiber and protein content .

With respect to effect of biofertilizer treatments on pods content of carbohydrate, plants received Okadin + Rhizobacterin + 10 or 20 kg N/feddan showed markedly higher pods content of carbohydrate than control. The interaction between snap bean cultivars and fertilization treatments on pods content of carbohydrate was significant . It was noticed in this respect that pods content of carbohydrate was increased due to using Okadin + Rhizobacterin + 10 or 30 kg N/feddan in cv. Bronco and Okadin + Rhizobacterin + 20 kg N/feddan in cv. Pulista . On the contrary, pods of cv. Bluista recorded low content of carbohydrate in plants obtained no nitrogen fertilization as compared with these of control plants (using 40 kg N/feddan).

Concerning pods content of fiber, there was a significant increase in fiber content due to using Okadin + 20 kg N or Okadin + Rhizobacterin + 0 kg N/feddan as compared with the control treatment . It was also found that pods content of fiber in cv. Pluista was increased due to using Okadin + 20 kg N/feddan, whereas in cv. Bronco there was no remarkable differences between treatments in cv. Pulista regarding pods fiber content .

Table 4. Effect of Biofertilizer treatments, different levels of N application and snap bean cultivars on physical and chemical pod characters of two snap bean cultivars (Combined data of years 2004 and 2005)

Treatments	Physical characters		Chemical characters	
Cultivars	**pod length (cm)**	**pod width (cm)**	**Carbohydrate (%)**	**Fiber (%)**
Bronco	11.5	7.6	47.89	12.35
Pulista	12.8	6.6	42.34	12.56
L.S.D at 0.05	0.6	0.25	1.936	1.313
Biofertilizer treatments				
0 kg N	12.0	7	41.68	12.97
O + 0 kg N	12.1	7.1	41.38	12.32
O + 10 kg N	12.0	7	41.27	10.45
O + 20 kg N	12.0	7	42.7	14.29
O+ 30 kg N	11.9	7.1	44.7	12.30
O + R + 0 kg N	12.2	7.1	46.83	14.05
O +R + 10 kg N	12.4	7.1	49.92	11.85
O + R + 20 kgN	12.3	7.1	51.29	12.44
O + R +30 kg N	12.2	7.2	46.41	12.36
40N	12.2	7.1	45.01	11.52
L.S.D at 0.05	0.4	0.2	4.76	1.87

O= Okadin, R= Rhizobacterin

Table 5. Effect of the interaction between Biofertilizer treatments, different levels of N application and snap bean cultivars on physical and chemical pod characters (Combined data of years 2004 and 2005)

Treatments		Physical characters		Chemical characters	
Cultivars	**Biofertilizer treatments**	**pod length (cm)**	**pod width (cm)**	**Carbohydrate (%)**	**Fiber (%)**
Bronco	0 kg N	11.4	7.4	48.91	12.59
	O + 0 kg N	11.5	7.5	43.4	11.75
	O + 10 kg N	11.5	7.6	42.63	10.38
	O + 20 kg N	11.6	7.6	47.72	13.91
	O+ 30 kg N	11.2	7.7	48.37	12.01
	O + R + 0 kg N	11.6	7.5	46.08	14.08
	O +R + 10 kg N	11.9	7.8	56.3	12.28
	O + R + 20 kgN	11.8	7.7	46.91	12.79
	O + R +30 kg N	11.8	7.8	52.74	12.24
	40N	11.1	7.2	45.84	11.47
Pulista	0 kg N	12.6	6.5	34.45	13.36
	O + 0 kg N	12.8	6.7	39.35	12.88
	O + 10 kg N	12.6	6.4	39.91	10.52
	O + 20 kg N	12.5	6.4	37.67	14.67
	O+ 30 kg N	12.8	6.5	41.03	12.58
	O + R + 0 kg N	12.7	6.7	47.59	14.03
	O +R + 10 kg N	12.9	6.4	43.53	11.41
	O + R + 20 kgN	12.7	6.4	55.66	12.09
	O + R +30 kg N	12.7	6.6	40.07	12.49
	40N	13.4	6.9	44.17	11.56
L.S.D at 0.05		0.6	0.35	6.73	2.64

O= Okadin, R= Rhizobacterin

Concerning pods length and width, pods of cv. Pluista were significantly longer than those of cv. Bronco pods and the reverse was true concerning pods width.

Table 6. Effect of Biofertilizer treatments, different levels of N application and snap bean cultivars on physical and mineral content of leaves and pods of two snap bean cultivars (Combined data of years 2004 and 2005)

Treatments	Leaves Content (%)			Pods content (%)		
Cultivars	**Nitrogen**	**Phosphorus**	**Potassium**	**Nitrogen**	**Phosphorus**	**Potassium**
Bronco	1.88	0.65	2.04	2.29	0.64	2.83
Pulista	2.26	0.58	2.23	2.21	0.63	3.12
L.S.D at 0.05	0.19	0.03	0.19	0.09	0.02	0.20
Biofertilizer treatments						
0 kg N	1.73	0.54	1.84	1.66	0.53	2.96
O + 0 kg N	1.92	0.52	2.23	2.13	0.53	2.74
O + 10 kg N	2.04	0.58	2.26	2.32	0.63	2.77
O + 20 kg N	2.16	0.57	1.78	2.24	0.60	2.74
O+ 30 kg N	2.32	0.62	2.21	2.48	0.69	2.69
O + R + 0 kg N	1.95	0.66	1.90	2.12	0.61	3.07
O +R + 10 kg N	2.1	0.68	2.35	2.48	0.74	3.36
O + R + 20 kgN	2.41	0.71	2.37	2.65	0.74	3.57
O + R +30 kg N	2.07	0.66	2.37	2.16	0.66	3.16
40N	1.98	0.62	2.09	2.28	0.61	2.76
L.S.D at 0.05	0.25	0.08	0.36	0.26	0.08	0.37

O= Okadin, R= Rhizobacterin

Table 7. Effect of the interaction between Biofertilizer treatments, different levels of N application and snap bean cultivars on physical and mineral content of leaves and pods (Combined data of years 2004 and 2005)

Treatments		Leaves Content (%)			Pods content (%)		
Cultivars	**Biofertilizer treatments**	**Nitrogen**	**Phosphorus**	**Potassium**	**Nitrogen**	**Phosphorus**	**Potassium**
Bronco	0 kg N	1.42	0.61	1.78	1.91	0.54	2.88
	O + 0 kg N	1.70	0.59	2.30	2.23	0.55	2.17
	O + 10 kg N	1.98	0.59	2.04	1.89	0.52	2.69
	O + 20 kg N	1.82	0.57	1.53	2.22	0.54	2.09
	O+ 30 kg N	2.25	0.77	1.86	2.34	0.72	2.44
	O + R + 0 kg N	1.78	0.69	1.89	2.09	0.69	2.96
	O +R + 10 kg N	2.17	0.71	2.31	2.78	0.81	3.88
	O + R + 20 kgN	1.99	0.66	2.54	3.17	0.67	3.97
	O + R +30 kg N	1.92	0.62	2.38	2.10	0.66	2.98
	40 kg N	1.81	0.69	1.81	2.21	0.69	2.27
Pulista	0 kg N	2.03	0.46	1.90	1.41	0.52	3.03
	O + 0 kg N	2.14	0.45	2.15	2.02	0.51	3.32
	O + 10 kg N	2.10	0.57	2.48	2.75	0.74	2.84
	O + 20 kg N	2.51	0.57	2.03	2.26	0.67	3.40
	O+ 30 kg N	2.53	0.48	2.56	2.62	0.67	2.93
	O + R + 0 kg N	2.12	0.64	1.90	2.15	0.52	3.18
	O +R + 10 kg N	2.03	0.65	2.40	2.18	0.67	2.84
	O + R + 20 kgN	2.82	0.76	2.20	2.12	0.81	3.16
	O + R +30 kg N	2.22	0.71	2.36	2.22	0.66	3.34
	40 kg N	2.15	0.56	2.35	2.35	0.53	3.25
L.S.D at 0.05		0.35	0.12	0.51	0.36	0.12	0.53

O= Okadin, R= Rhizobacterin

there were no noticeable differences between the two snap bean cultivars.

Concerning the interaction between snap bean cultivars and fertilization treatments on pods width and length, it was found that pods width in cv. Bronco was increased due to using Okadin + 10, 20 or 30 kg or Okadin + Rhizobacterin +10, 20 or 30 kg N/feddan as compared control, whereas in cv. Pulista plants received no fertilization or Okadin +10, 20 or 30 kg N or Okadin + Rhizobacterin +10 or 20 kg N/feddan had less pods width than the control.

Regarding to the length of pods, in cv. Bronco fertilization with Okadin + Rhizobacterin + 10, 20 or 30 kg N/feddan increased pods length, whereas in cv. Pulista plants received no fertilization or Okadin +10 or 20 kg N or Okadin + Rhizobacterin + 0, 20 or 30 kg N/feddan had shorter pods.

4. Leaves and pods contents of N, P and K

Plants of cv. Pluista were significantly greater than those of cv. Bronco in the leaves contents of K and N and pods content of K. The reverse was true concerning the leaves content of P. On the other hand, there were no remarkable differences between the two snap bean cultivars concerning the pod contents of P and N.

Leaf contents of nitrogen and phosphorus were significantly increased due to using Okadin + 20 kg N/feddan as compared with the control , whereas leaf content of K was not affected by any treatments. The effect of nitrogen fertilization on pod contents of N , P and K was also significant . The treatment Okadin + 20 kg N/ feddan, which increased leaf content of N and P, also significantly raised pod contents of N, P and K. These results are in agreement with theses of Merghany (1999) who found inoculation snap bean with Rhizobiun increased leaves content of nitrogen

High contents of P were also recorded in pods due to fertilizing plants with Okadin + 30 kg N and Okadin + Rhizobacterin +10 kg N/feddan, while increased concentration of pod contents of K was achieved by treating plants with Okadin + Rhizobacterin in presence of nitrogen fertilization at 10 or 30 kg N/feddan . These results confirm previous observation on the positive effects on plant growth, yield and chemical composition of pods caused by azospirillum on legumes, naturally nodulated or co-inoculated with Rhizobium (Butery *et al*.,1987 and Singer *et al.,* 1996 and 2000).

Regarding the effect of the interaction on leaves contents of N, P and K, it was found that leaf content of N in cv. Bronco was increased due to using Okadin + 30 kg N or Okadin + Rhizobacterin +10 kg N .Plants received no fertilization had less leaves content of N than control, whereas it was greater in cv. Pulista as a results of fertilizing plants with Okadin + 20 or 30 kg N or Okadin + Rhizobacterin + 20 kg N.

Concerning leaves content of P, there were no remarkable differences between treatments in cv. Bronco, whereas in cv. Pulista, plants received Okadin + Rhizobacterin + 20 or 30 kg N/feddan had higher leaves content of P than control .

The reverse was true concerning the leaves content of K in both of cultivars. The effect of interaction on pod contents of N, P and K was also significant. In cv. Bronco, bean plants fertilized with Okadin + Rhizobacterin

+10 or 20 kg N/feddan showed significantly simulative effect on the pods content of N, while treating plants of cv. Pulista with Okadin + 10 kg N/feddan led to significant increment in pods content of N. In contract, plants received no fertilization had less pods content of N than control.

With regard to pods content of P, Bronco plants got Okadin + Rhizobacterin + 10 kg N/feddan had a higher pods content of P, whereas plants received no fertilization or Okadin + 0, 10 or 20 kg N/feddan had less pods content of P than control. Meanwhile in cv. Pulista, treating plants with Okadin + 10 , 20 or 30 kg N/feddan or Okadin + Rhizobacterin + 10, 20 or 30 kg N/feddan promoted a higher pods content of P as compared with these received 40 kg N/feddan (control) .

The effect of the interaction on pods content of K was significant, where using no fertilization or Okadin + Rhizobacterin + 0 ,10 , 20 or 30 kg N / feddan led to a remarkable increase in pods content of K in cv. Bronco only.

The positive effects of the inoculation treatment with *Azospirillum brasilense* on plant growth, and consequently on yield and pod characters could be explained by an enhancement of root branching and root growth .These favorable effects on root growth are known to improve the efficiency of mineral and water uptake, and consequently protein production and hormonal activity in inoculated plants (Singer, *et al.*,1996 and Hamaoui *et al*. 2001). So, this may explain the high leaf content of N, and P which was obtained due to treating plants in the present work with a mixture of biofertilizer + N at 20 kg/fed. The positive effect of increased phosphorus absorption by bean plants as a result of inoculation with Okadine + Rhizobacterin on vegetative growth may be due to the beneficial effect of P-element on the activation of photosynthesis and metabolic processes of organic compounds in plants and hence increasing plant growth (Gadener *et al.*, 1985). Also, the enhancing effect of nitrogen absorption on plant growth may be due to the positive effects of N- element on activation photosynthesis and metabolic processes of organic compounds in plants which in turn, encourage the plant vegetative growth , which exert direct effect on the yield (El- Seifi *et al.*, 2004) . Recently, Ogut and Er (2006) mentioned that Azospirillum inoculation combined with P fertilization significantly increased concentration of Mn , Zn and Cu in bean plants. The trace elements play also a great role in the photosynthesis and metabolic processes which cause stimulation in the plant vegetative growth, which in turn exert direct effect on the yield

Hamaoui *et al*. (2001) mentioned that results of greenhouse and field experiments carried out in different soils indicate that inoculation with *Azospirillum brasilense* at an optical cell concentration (about 5 x 10^7 CFU/plant) consistently improved root and shoot growth of chickpeas and faba beans often resulting in an increase in grain yield . Singer, *et al.* (1996) mentioned that a mixture of the three biofertilizers , in general , gave the highest physical properties of snap bean pods even with different levels of NPK applications

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إستجابة الفاصوليا لنوعين من التسميد الحيوى و لمستويات مختلفة من النتروجين

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نفذت هذه التجربة خلال موسمي الخريف في سنتي ٢٠٠٤ و ٢٠٠٥ في صوب بلاستيكية (٤٠× ٨,٥ متر) في محطة التجارب كلية الزراعة جامعة القاهرة , و ذلك لدراسة استجابة صنفين الفاصوليا برنكو و بوليستا للتلقيح بالبكتريا التكافلية العقدين (ريزوبيم) و البكتريا الغير تكافلية ريزوباكترين (ازوسبيريم + ازوتوباكتر) وقد اشتملت هذه التجربة على ٢٠ معاملة تكونت من صنفين و ١٠ معاملة ناتجة من التفاعل بين بكتريا تثبيت النتروجين و ٥ مستويات من التسميد النتروجينى (صفر – ١٠ – ٢٠ – ٣٠ – ٤٠ كجم/فدان) وقد تفوق الصنف بوليستا عن الصنف برنكو فى محصول النبات و عدد الفروع و طول القرون و محتوى الأوراق من النتروجين و البوتاسيوم ومحتوى القرون من و البوتاسيوم , بينما حدث العكس بالنسبة للمحصول الكلى و أنصاف أقطار القرون و محتوى الأوراق من الفوسفور و محتوى القرون من الكربوهيدرات , ولقد أحدثت معاملة العقدين + ٣٠ كجم N / فدان زيادة في الوزن الطازج للصنف برونكو مقارنة بمعاملة النتروجين عند مستوى ٤٠ كجم N / فدان وزاد المحصول لكل نبات و الفدان و كذلك محتوى الأوراق من النتروجين ومحتوى القرون من الفوسفور في كلا الصنفين , وقد أدى تلقيح نباتات الفاصوليا بخليط من كلا السمادين الحيويين بالإضافة إلى تسميد النباتات بالنتروجين عند مستويات ١٠ و ٢٠ و ٣٠ كجم N / فدان إلى تحسين الوزن الطازج لنبات في الصنف بوليستا كما أدت إلى زيادة معنوية فى كلا من المحصول المبكر و الكلى, بينما أدت معاملة العقدين + ريزوباكترين + ٢٠ كجم N / فدان إلى زيادة معنوية فى محتوى الأوراق من النتروجين و الفوسفور و محتو ى القرون من النتروجين و الفوسفور و البوتاسيوم, كما أظهرت زيادة ملحوظة فى محتو ى القرون من الكربوهيدرات مقارنة بالكونترول, و لم تظهر أي زيادة معنوية في محتو ى القرون من الألياف عند استعمال المعاملة عقدين + ريزوباكترين + صفر كجم N /فدان مقارنة بالمعاملة الكونترول.