RESULTS AND DISCUSSION

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I. Soybean.

A. Number of nodules/plant and growth characters.

1. Effect of cropping system on :

I. Number of nodules/plant

Results in Table (1) and Fig. (1) indicate that cropping system had significant effects on the number of nodules/plant. These observations were valid on the active, unactive and total number of nodules in root of soybean plant in both seasons. It is evident that active, unactive and total number of nodules/plant of soybean intercropped with maize were significantly lower than those calculated in the root of pure stand soybean. The results were fairly true in both seasons. The excesses of number of the active and total bacteria in plant rhizosphere of pure stand soybean over those of intercropped soybean were estimated to 6.53, 7.30% and 6.44, 7.11% in 1999 and 2000 seasons, respectively.

II. Growth characters after 75 days from planting.

Pronounced effects of intercropping were prominent on growth characters of soybean plants in Table (1). Statistical analysis revealed significant effects on plant height and number of leaves/plant. On other hand, results revealed that the average number of branches/plant was still beyond significancy when soybean plants were compared under intercropping or grown in pure stand.

Results indicated that soybean height when plants were intercropped with maize exceeded those grown in pure stand.

Table (1): Effect of cropping system on number of nodules/plant and growth characters of soybean in 1999 and 2000 seasons.

Characters / Treatments	Number of nodules/plant			Plant height (cm)	No. of branches/plant	No. of leaves/plant
	Active	Unactive	Total			
	First season 1999					
Intercropping	8.57	0.33	8.90	74.69	1.80	25.50
Pure stand	9.13	0.42	9.55	72.16	1.84	23.80
L.S.D. at 0.05	0.32	0.02	0.32	0.31	N.S	0.21
	Second season 2000					
Intercropping	7.45	0.29	7.74	62.34	1.68	23.82
Pure stand	7.93	0.36	8.29	60.90	1.72	22.23
L.S.D. at 0.05	0.26	0.02	0.26	0.25	N.S	0.11

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Interpretation of this superiority could be attributed to the relatively higher plant to plant competition for light interccepted by foliage, which in turn resulted in the elongation of stem internodes. These results were in agreement with those obtained by Kamel *et al* (1990), and Sahar Sherif (1993).

The effect of intercropping on the average number of leaves/plant was significant. The number of leaves in intercropped plants surpassed that of pure stand by 1.70 and 1.59 leaf in 1999 and 2000 seasons respectively. On the other hand, the average number of branches/plant was not influenced by intercropping, although, a tendency to branch more was associated with soybean grown in pure stand. However Beaty *et al* (1982), reported that intercropping are among the dominant factors controlling the branching of soybean. It is also worthy to mention that the treatment effect on the three growth traits were true in both seasons.

2. Effect of nitrogen fertilizer levels on :

I. Number of nodules/plant.

The effect of increasing nitrogen fertilization level on active, unactive and total nodules/plant followed a distinctive pattern, Table (2) and Fig. (2). The results indicate that number of nodules in the rhizosphere of soybean root increased with the level of nitrogen fertilizer only up to 60 Kg N/fed. in case of the active and total number of nodules. Thereafter, a slow down was observed up to the heaviest level. The results hold true in both seasons. The excesses in the average number of nodules/plant in cases of active and total number due to addition of first level of nitrogen (60 Kg N/fed.) were estimated to 21.00, 17.81% and

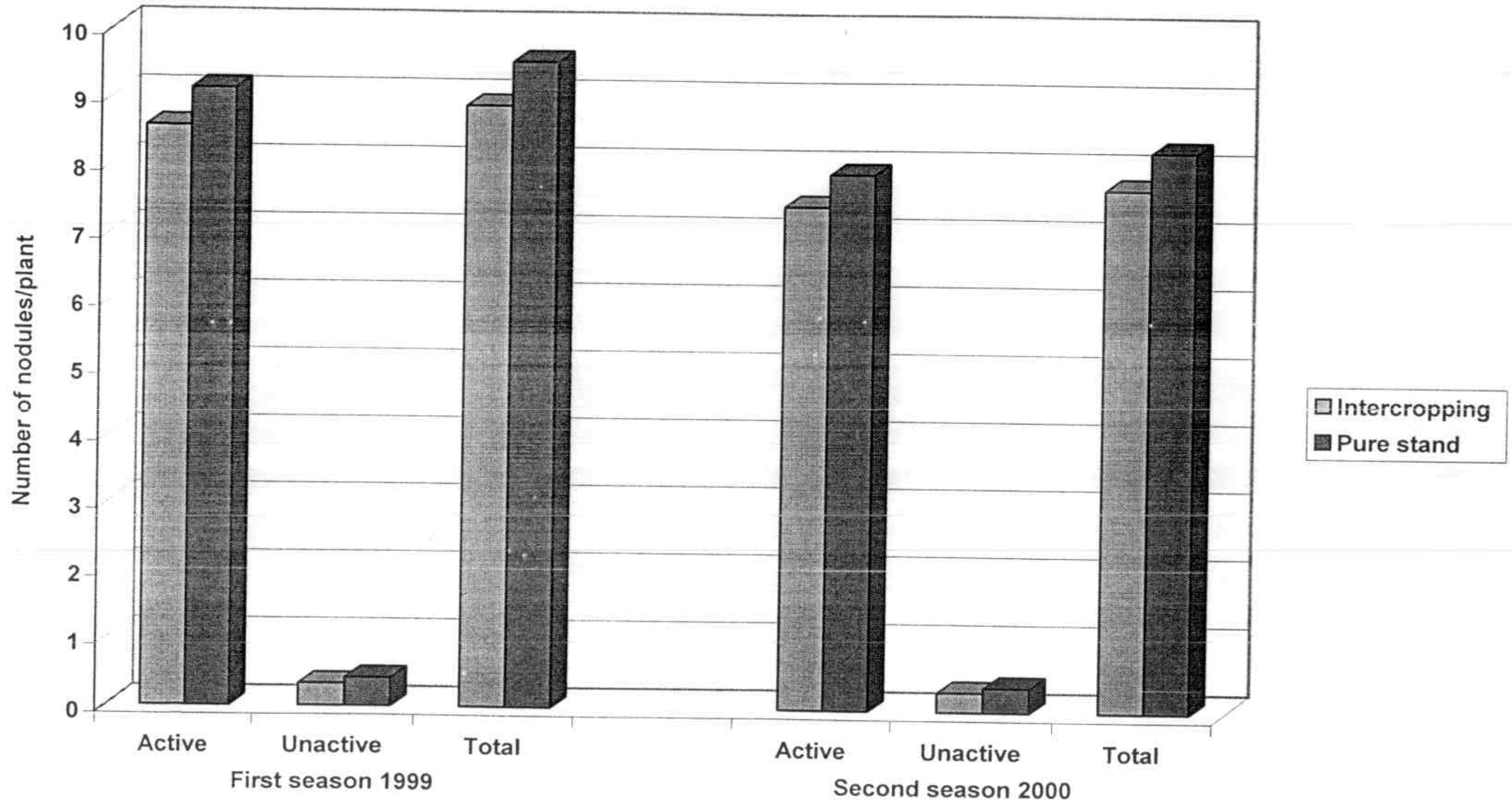

Fig. (1): Effect of cropping system on number of nodules/plant of soybean in 1999 and 2000 seasons.

Table (2): Effect of N levels on number of nodules/plant and growth characters of soybean in 1999 and 2000 seasons.

Characters / Treatments	Number of nodules/plant			Plant height (cm)	No. of branches/plant	No. of leaves/plant
	Active	Unactive	Total			
N levels (Kg/fed.)	First season 1999					
0	9.38	0.50	9.88	68.93	1.71	14.70
60	11.35	0.29	11.64	74.10	1.85	22.35
90	8.06	0.17	8.23	74.12	1.79	26.20
120	6.62	0.56	7.18	76.55	1.94	35.35
L.S.D. at 0.05	0.45	0.02	0.45	0.44	0.17	0.30
	Second season 2000					
0	8.15	0.43	8.58	57.93	1.59	13.73
60	9.86	0.25	10.11	62.70	1.73	20.88
90	7.00	0.15	7.15	62.35	1.67	24.47
120	5.74	0.48	6.22	63.50	1.81	33.02
L.S.D. at 0.05	0.36	0.03	0.37	0.35	0.12	0.16

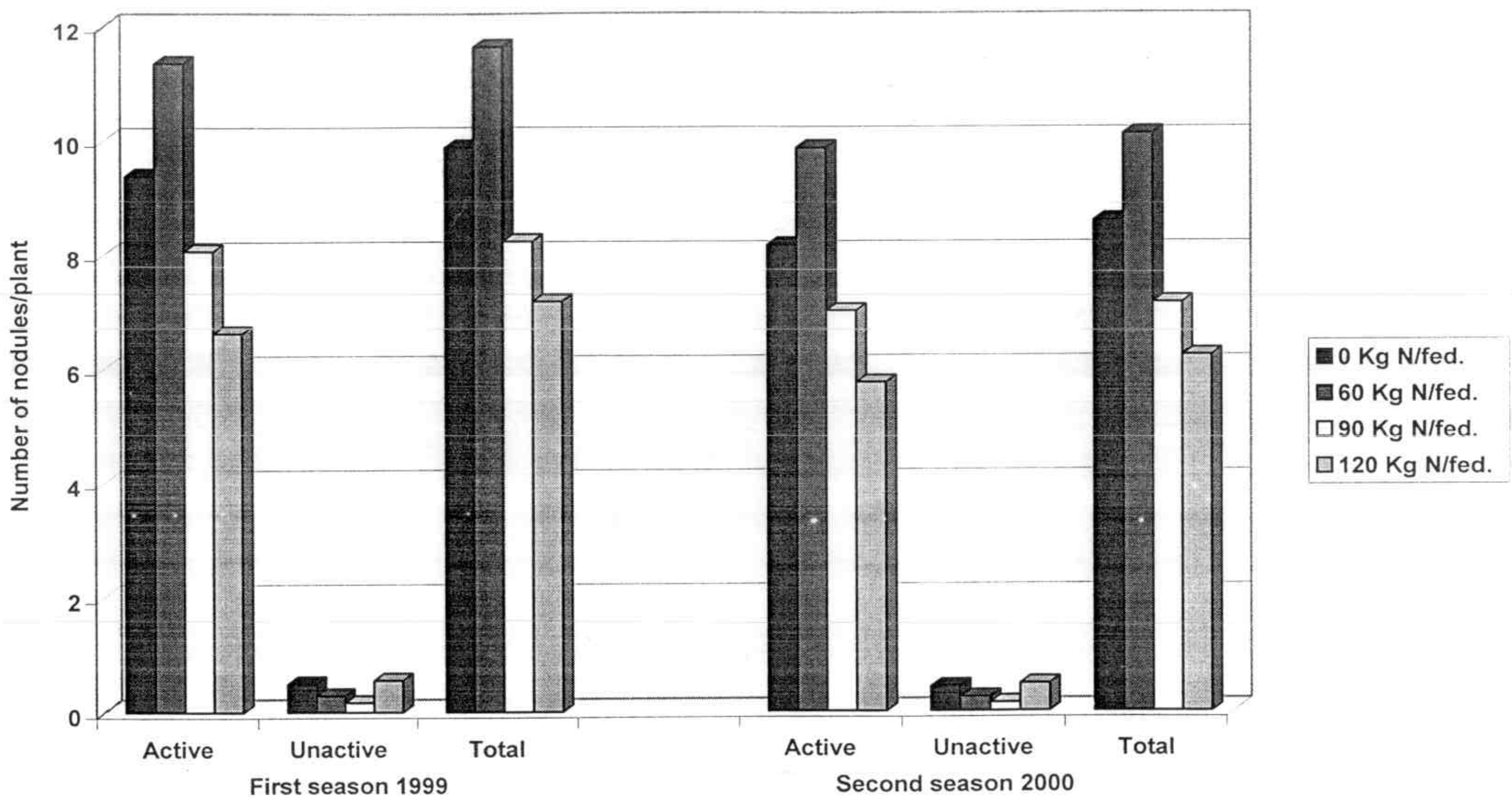

Fig. (2): Effect of N levels on number of nodules/plant of soybean in 1999 and 2000 seasons.

20.98, 17.83% in 1999 and 2000 seasons, respectively as compared with control. The percent decrease with increasing the level of nitrogen dose up to the heaviest were estimated to 29.42, 27.33% and 29.57, 27.51% in the same respective seasons.

II. Growth characters after 75 days from planting.

Results in Table (2) indicate clearly that there were gradient and consistent increases in plant height of soybean plant with increasing the level of nitrogen fertilizer up to 120 Kg N/fed.. The results revealed significant differences among the treatments imposed in both seasons. Furthermore, the treatment effect in both seasons followed the same course of significance. There were significant differences in plant height among fertilization treatments, except, between 60 and 90 Kg N/fed. treatments where differences were not great enough to reach the 5% level of significance. The increase in plant height due to increasing nitrogen up to 120 Kg N/fed. was 7.62 and 5.57 cm for the two seasons respectively as compared with control.

Increasing the level of nitrogen fertilizer up to the heaviest level had a similar effect on the average number of branches/plant and the average number of leaves/plant. These results hold true in both seasons. While the course of significance was similar in both seasons in case of the average number of leaves/plant being significant among all treatments imposed, it differed in case of the average number of branches/plant where differences between 60 and 90 Kg N/fed. treatments were beyond significancy. Increasing nitrogen application up to 120 Kg N/fed. increased number of branches/plant by 0.23 and 0.22 respectively for the two successive seasons whereas the increase in number of leaves/plant was 20.65 and 19.29 leaf. The importance of nitrogen in stimulating meristematic activity and plant growth was demonstrated by several investigators. However, although, there were decreases in utilization nitrogen fertilizer with increasing the level of application yet nitrogen application was still indicating benificial effect. These results were in harmony with those obtained by Singh, *et al*, (1986) who stated that addition of nitrogen up to 80 Kg N/ha. to soybean plants resulted in significant increases in soybean plant growth. It seemed that failure of nodulation in the root system (30<) of soybean plants was the main cause for the plants to remain responsive to increases in N application up to the highest level, i.e., 120 Kg N/fed. and hence, the need to increase N fixation by developing efficient rhizobium strains and inoculation method is necessary.

3. Effect of bacterial inoculation on :

I. Number of nodules/plant.

Results in Table (3) and Fig. (3) indicate that inoculating soybean plants with rhizobium inocula significantly increased the average number of nodules/plant. These results were true in case of active, unactive and total nodules/plant in both seasons. The increases in number of active and total nodules in plant root rhizosphere when inoculated with the rhizobia over uninoculated plants were estimated to 17.32, 17.95 and 15.04, 15.59 nodules in 1999 and 2000 season, respectively. Several investigators reached same result such as Abo-Taleb (1991).

Table (3): Effect of bacterial inoculation on number of nodules/plant and growth characters of soybean in 1999 and 2000 seasons.

Characters / Treatments	Number of nodules/plant			Plant height (cm)	No. of branches/plant	No. of leaves/plant
	Active	Unactive	Total			
Bacterial inoculation	First season 1999					
Uninoculated	0.19	0.06	0.25	67.46	1.76	22.73
Inoculated	17.51	0.69	18.20	79.38	1.89	26.58
L.S.D. at 0.05	0.32	0.02	0.32	0.31	0.12	0.214
	Second season 2000					
Uninoculated	0.17	0.05	0.22	57.46	1.64	21.23
Inoculated	15.21	0.60	15.81	65.78	1.76	24.82
L.S.D. at 0.05	0.26	0.02	0.26	0.25	0.83	0.11

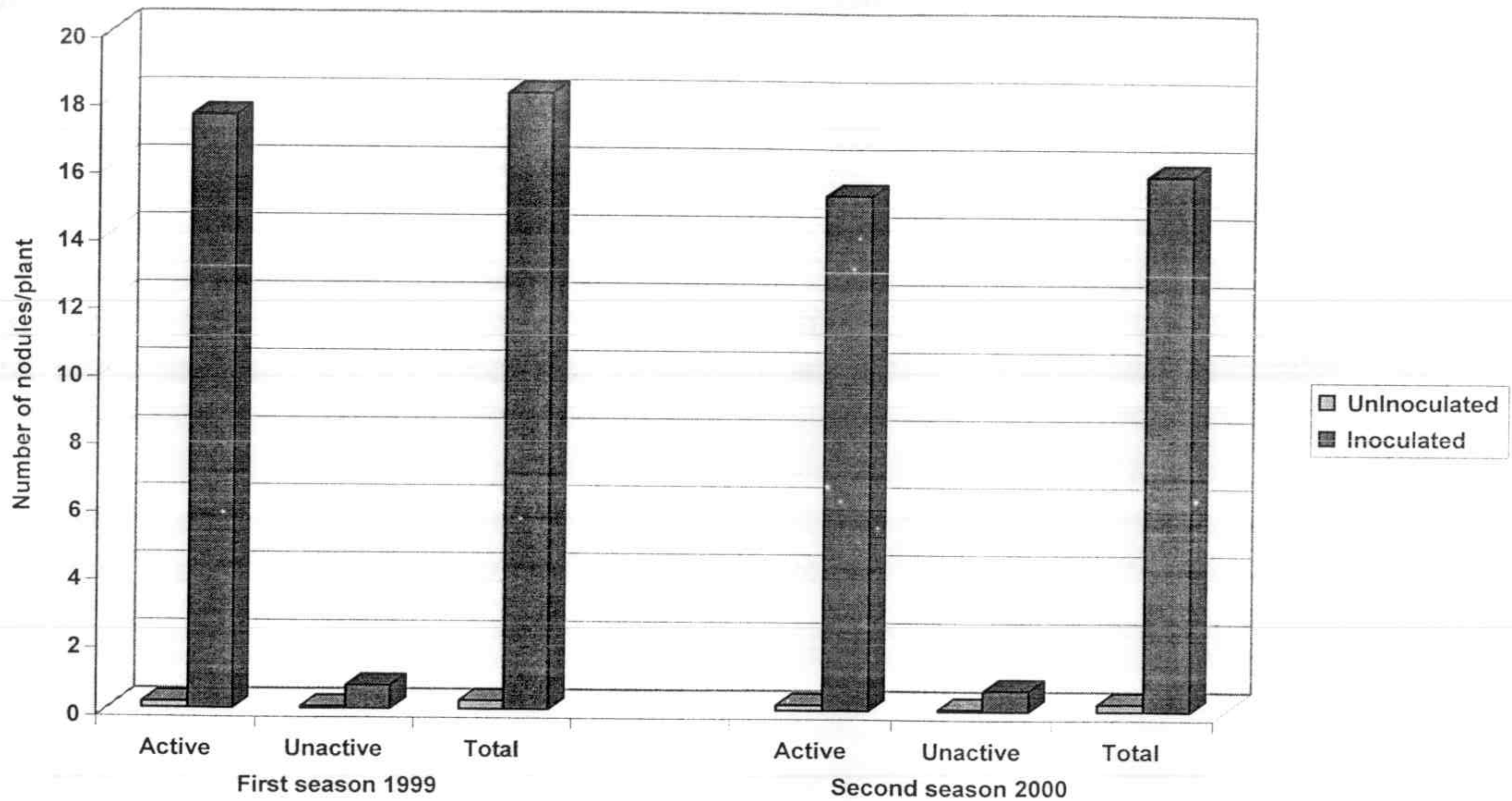

Fig. (3): Effect of bacteria inoculation on number of nodules/plant and of soybean in 1999 and 2000 seasons.

II. Growth characters after 75 days from planting.

Inoculating soybean with rhizobium had favourable and significant effects on growth traits Table (3); plant height, the average numbers of branches and leaves/plant. The results revealed that all values of these traits were significantly higher than those left without bacterial inoculation. Furthermore these trends were valid in both seasons. However these results are cogent and plausible, since N_2 fixer bacteria has the cabablity to fix 18 mg nitrogen per 1 gm of sugar, and further as the media lives and has lower nitrogen salt (nitrate level and ammonia nitrogen) fixation becomes more and more which led to more growth and developing (Subba Rao 1984).

4. Interaction of cropping system and nitrogen fertilizer levels on :

I. Number of nodules/plant.

The interaction effect of both nitrogen fertilizer level and the cropping system on the average number of nodules/plant followed the general tendency of the main variables effect as a whole. The results in Table (4) revealed that active and total number of nodules/plant significantly increased with increasing the level of nitrogen up to 60 Kg N/fed., thereafter a gradual slow down was observed up to the heaviest dose, i.e., 120 Kg N/fed.. This tendency was true under both cropping systems in both seasons. The highest number of active and total nodules/plant was recorded in inoculated plants fertilized with 60 Kg N/fed..

Table (4): Effect of interaction between cropping system and N levels on number of nodules/plant and growth characters of soybean in 1999 and 2000 seasons.

Treatments	Characters	Number of nodules/plant			Plant height (cm)	No. of branches/plant	No. of leaves/plant
	N levels (Kg/fed.)	Active	Unactive	Total			
		First season 1999					
Intercropping	0	9.24	0.44	9.68	71.25	1.70	16.00
	60	10.53	0.25	10.78	75.10	1.83	23.00
	90	7.97	0.15	8.12	75.60	1.78	26.40
	120	6.56	0.49	7.05	76.80	1.92	36.60
Pure stand	0	9.52	0.56	10.08	66.60	1.73	13.40
	60	12.18	0.32	12.50	73.10	1.87	21.70
	90	8.15	0.19	8.34	72.63	1.81	26.00
	120	6.67	0.62	7.29	76.30	1.96	34.10
L.S.D. at 0.05		0.63	0.03	0.63	0.63	N.S	0.43
		Second season 2000					
Intercropping	0	8.04	0.38	8.42	58.95	1.58	14.95
	60	9.14	0.22	9.36	63.90	1.71	21.49
	90	6.92	0.13	7.05	62.60	1.66	24.66
	120	5.70	0.43	6.13	63.90	1.79	34.19
Pure stand	0	8.27	0.48	8.75	56.90	1.61	12.52
	60	10.57	0.28	10.85	61.50	1.74	20.27
	90	7.08	0.17	7.25	62.10	1.69	24.29
	120	5.79	0.53	6.32	63.10	1.83	31.85
L.S.D. at 0.05		0.51	0.05	0.52	0.50	1.17	0.22

Abo-Taleb (1991) studied the effect of nitrogen level as interacted with rhizobia inoculation in the intercrop of soybean with maize. He evidenced significant differences on nodulation parameters which were attributed to level of nitrogen fertilization of neighbouring maize and to a smaller extent to intercropping. Nitrogen fertilization of maize did influence nodulation of neighbouring soybean plants. Such effect was significantly positive (increase of 14 and 60%) in presence of a rational dose of 45 Kg N/fed. but negative (decrease of 62 and 11%) in the presence of a high dose of 135 K N/fed.. supporting our results. This interpretation also indicates the direct interaction among the rhizospere zone of maize and soybean plants.

The results also revealed that nodulation was little higher within the pure stand cropping of soybean as compared with nodulation of soybean within the intercrop in both seasons.

II. Growth characters after 75 days from planting.

Distinctive pattern of change of soybean height was observed when intercropping interacted with nitrogen fertilizer level. Results in Table (4) revealed that the interaction effect in most cases was governed by the trend of change of the main variables i.e., cropping system and N fertilization level. The results indicated increases in height with increasing the level of nitrogen fertilizer level up to the highest in most cases. These results hold true in both cropping systems, i.e., intercropped soybean or pure stand soybean. Furthermore, the results revealed significant differences in both seasons. Maximum value (76.30 cm) of plant height was associated with the intercropped plant and received the heaviest level of nitrogenous fertilization (120

Kg N/fed.). This observation hold true in both seasons. On other hand, minimum value (66.60 cm) was associated with lowest nitrogen fertilizer level when soybean was grown in pure stand. This result was also true in both seasons.

The average number of branches/plant was not responsive in the first season, whereas, significant interaction effect was indicated in the second season. However, the results revealed in both seasons, an increasing tendency in branching with increasing the level of fertilization level whether in the intercropped or pure stand soybean systems.

The highest number of branches/plant (1.83) was obtained in pure stand planting given 120 Kg N/fed.. The interaction effect on the average number of leaves/plant was more regular and was totally governed by nitrogen fertilization level and the cropping system applied in the first season. There were gradual and significant increases with increasing the level of nitrogen fertilization within both cropping system with values being higher in case of the monoculture system as compared with intercropping system. Consequently highest values (36.60) were obtained when soybean received heaviest level of N fertilization and grown in sole cropping system whereas in the second season, same trend of nitrogen fertilization effect was observed but with higher values when soybean plants were grown in the intercrop, and consequeutly maximum value (34.19) was associated with soybean plants intercropped with maize and received heaviest dose of nitrogen fertilizer.

5. Interaction effect of cropping system and bacterial inoculation on :

I. Number of nodules/plant.

The interaction effect of inoculation with rhizobia and intercropping was much more appreciable. Results in Table (5) indicate clearly that inoculating soybean plants with rhizobia increased the number of active and total number of nodules/plant whether plants were grown in pure stand or intercropping. The highest number of active and total nodules was obtained in pure stand when soybean plants were inoculated with Rhizobia. It seemed that the increase in nodulation when plant were grown in pure stands as compared with the intercropped soybean in both seasons, under same respective level of inoculation might be attributed much to the greater vigor of the pure stand soybean plant and the direct interaction among the rhizosphere zone of maize and soybean plants. (Abo-Taleb 1991). The positive responses of soybean whether was grown solely or intercropped to inoculation with rhizobia were supported by various reports. Several investigators indicated that Egyptian soils are void of *Brady rhizobium japonicum* (Hamdi *et al.*, 1968, 1974; Abdel Gaffar, 1976; Mahmoud *et al.*, 1978; Hamdi, 1982; El-Haddad *et al* 1984; Abdel-Daiem and Hamdi, 1986 and Saleh, 1986). In general, significant increases in soybean growth traits were attributed to inoculation (Raitshewa, 1967; Wu *et al.*, 1968; Subba Rao and Balasundaram, 1971 and El-Essawi *et al* 1988).

II. Growth characters after 75 days from planting.

Results in Table (5) indicate that soybean plant height was also influenced by the main variables (i.e., intercropping and

Table (5): Effect of interaction between cropping system and bacterial inoculation on number of nodules/plant and growth characters of soybean in 1999 and 2000 seasons.

Treatments	Characters	Number of nodules/plant			Plant height (cm)	No. of branches/plant	No. of leaves/plant
	Bacterial inoculation	Active	Unactive	Total			
		First season 1999					
Intercropping	Uninoculated	0.18	0.05	0.23	69.30	1.74	23.10
	Inoculated	16.97	0.61	17.58	80.08	1.87	27.90
Pure stand	Uninoculated	0.21	0.07	0.28	65.63	1.78	22.35
	Inoculated	18.06	0.77	18.83	78.69	1.90	25.25
L.S.D. at 0.05		0.45	0.02	0.45	0.44	N.S	0.30
		Second season 2000					
Intercropping	Uninoculated	0.15	9.05	0.20	58.23	1.62	21.58
	Inoculated	14.74	0.53	15.27	66.45	1.75	26.06
Pure stand	Uninoculated	0.18	0.06	0.24	56.70	1.66	20.88
	Inoculated	15.68	0.67	16.35	65.10	1.78	23.58
L.S.D. at 0.05		0.36	0.03	0.37	0.35	0.12	0.16

bacterial inoculation) when subjected to the interaction effect. Uninoculated plants grown in pure stand were always shorter than those inoculated and grown in the intercrop. The tallest soybean plants were obtained from inoculated seeds grown intercropped with maize .

On other hand soybean branching followed a reversal trend. The results indicate that average number of branching when plants were grown in pure stand exceeded that of the intercropped plants whether inoculated on left uninoculated with rhizobia. Inoculated plants grown in pure standing gave the highest number of branches/plant.

The average number of leaves/plant followed the general trend of plant height as influenced by the interaction effect. Pure stand plants were always associated with lower values of leaves number whether inoculated or left without inoculation with rhizobia. These observation were also true in both seasons. The highest number of leaves/plant was produced by inoculated intercropped plants. It seemed that the average number of leaves was tenaciously bound by plant height and number of internodes. The concern with more branching associated with plants inoculated with bacteria could be attributed much to more nitrogen fixation according to more nodulation when soybean was inoculated with the bacteria.

6. Interaction effect of N levels and bacterial inoculation on :

I. Number of nodules/plant.

Nodulation was severly affected by bacterial inoculation with rhizobia at different levels of nitrogen fertilization, Table

(6). Inoculated plants fertilized with 60 K N/fed. had the highest number of active and total nodules/plant. These results coincided with several investigators reports such as Abdel-Nasser *et al* (1990). They reported that application of 100 Kg N/ha. to the inoculated plants significantly reduced nodulation and resulted in lower N-fixed than application of 20 Kg N/ha. Safwat *et al* (1990) also reported that higher numbers as well as weight of nodules were obtained only in treatments received 20 Kg N/ha. as compared with treatment received 100 Kg N/ha. Kage (1995) explained the effect of nitrogen on nodulation. He reported that when soil was inoculated with *Rhizobium leguminosum* or uninoculated and grown in nutrient solution with different nitrogen concentrations, the limitation of nitrate uptake due to N-fixation was relatively variable. Nitrate concentrations of approximately 1 mol m^{-3} and 5 mol m^{-3} decreased N fixation to value of 16% and 1% of the control plants which received no nitrate level. Reduction in N fixation was mainly due to a decreased of specific N fixation per unit nodule weight and to a lesser extent due to a reduction of nodule growth. Ismail *et al* (1997) also found that inoculation with microbial strains significantly increased both number and dry weight of nodules, nitrogen content of plants was also increased by inoculation. Inoculation and fertilization with active 0.6 g N pot^{-1} also significantly increased the amount of nitrogen fixed compared to the uninoculated or those supplied with 1.6 g N /pot. Badr El-Din *et al* (1998) also mentioned that the percent plant N derived from the atmosphere of each crop was affected by the high level of available soil nitrogen. N_2 fixation is inhibited by supply of

Table (6): Effect of interaction between N levels and bacterial inoculation on number of nodules/plant and growth characters of soybean in 1999 and 2000 seasons.

Treatments / Characters		Number of nodules/plant			Plant height (cm)	No. of branches/plant	No. of leaves/plant
N levels (Kg/fed.)	Bacterial inoculation	Active	Unactive	Total			
		First season 1999					
0	Uninoculated	0.17	0.08	0.25	60.45	1.63	11.90
	Inoculated	18.59	0.91	19.50	77.40	1.80	17.50
60	Uninoculated	0.26	0.05	0.31	66.10	1.67	21.50
	Inoculated	22.45	0.53	22.98	82.10	2.03	23.20
90	Uninoculated	0.21	0.03	0.24	70.00	1.75	25.70
	Inoculated	15.91	0.31	16.22	78.23	1.84	26.70
120	Uninoculated	0.12	0.09	0.21	73.30	1.99	31.80
	Inoculated	13.11	1.02	14.13	79.80	1.89	38.90
L.S.D. at 0.05		0.63	0.03	0.63	0.63	0.24	0.43
		Second season 2000					
0	Uninoculated	0.15	0.07	0.22	52.35	1.51	11.12
	Inoculated	16.16	0.80	16.96	63.50	1.67	16.35
60	Uninoculated	0.23	0.04	0.27	56.60	1.56	20.09
	Inoculated	19.49	0.46	19.95	68.80	1.90	21.67
90	Uninoculated	0.18	0.03	0.21	59.80	1.63	24.01
	Inoculated	13.81	0.27	14.08	64.90	1.71	24.94
120	Uninoculated	0.10	0.08	0.18	61.10	1.85	29.71
	Inoculated	11.38	0.88	12.26	65.90	1.77	36.34
L.S.D. at 0.05		0.51	0.05	0.52	0.50	0.17	0.22

nitrate level in the root zone (0-90cm) coupled with a low demand for nitrogen during plant growth.

II. Growth characters after 75 days from planting.

Positive interaction effect of nitrogen fertilization level and bacterial inoculation on growth characters were also indicated in both seasons. The results in Table (6) revealed significant differences among the treatment imposed in both seasons. Consistent and gradient increases in soybean height was observed with increasing nitrogen fertilizer level up to the heaviest. These results were fairly true whether soybean plants were inoculated with rhizobia or left without inoculation. Inoculated plants fertilized with 60 Kg N/fed. were the tallest plants.

The interaction effect on soybean branching and the average number of leaves/plant followed the same general trend. The results revealed increases in their values with increasing the level of nitrogen fertilizer up to the heaviest level, i.e., 120 Kg N /fed. and inoculated plants had higher values of these traits in comparison with plants left uninoculated with rhizobia under the same respective level of nitrogen fertilization. However, it is interesting to note that inoculated soybean plants and received 60 Kg N/fed. had maximum values of both plant height and branching traits, but, the average number of leaves/plant was proportionally responsive to nitrogen dose up to the heaviest in both seasons. These results coincided with those obtained by Abo-Taleb (1991) who reported that highest growth of soybean plants was recorded for those rhizobia inoculated and neighboring maize plants fertilized with a rational dose of 45 Kg

N/fed. an effect which is attributed not to direct use of N fertilizer only but to the previously indicated positive effect on nodulation of soybean plants. This because such positive effect of maize N-fertilization did not elevate parallel to the increase of applied dose of N-fertilizer. Several investigators studied the interaction effect of inoculation with rhizobia and nitrogen fertilization level on growth characters of soybean plants. Abdel-Nasser *et al* (1990), reported that uninoculated plants failed to for any nodules, and recorded the lowest amount of dry matter. The inoculation and application of 20 Kg N/ha produced the highest amount of those parameters and increased nodule formation. Application of 100 Kg N/ha. to the inoculated plants significantly reduced nodulation and resulted in lower N fixed than application of 20 Kg N/ha.

Muller and Pereira (1995), studied the effect of mineral nitrogen application at different growth stages on N_2-fixation, nodulation and shoot dry weight of two cultivars of common bean. Mineral N application at sowing did not affect final shoot dry weight. They also added that application at sowing was less detrimental to the quantity of symbiotically fixed nitrogen of both cultivars than the effect of 25 mg N/Kg soil during vegetative growth.

7. Interaction effects of cropping system, nitrogen fertilizer level and bacterial inoculation on :

I. Number of nodules/plant.

Results on the combined effect of the three main variables were also the sum of dual effects of these variables, i.e., the general three dimension effects were quite evident. Table (7).

Table (7): Effect of interaction among cropping system, N levels and bacterial inoculation on number of nodules/plant and growth characters of soybean in 1999 and 2000 seasons.

Treatments		Characters	Number of nodules/plant			Plant height (cm)	No. of branches/plant	No. of leaves/plant
	N levels (Kg/fed.)	Bacterial inoculation	Active	Unactive	Total			
			First season 1999					
Intercropping	0	Uninoculated	0.16	0.07	0.23	65.00	1.61	12.40
		Inoculated	18.31	0.80	19.11	77.50	1.78	19.60
	60	Uninoculated	0.24	0.04	0.28	66.20	1.65	22.00
		Inoculated	20.82	0.46	21.28	84.00	2.01	24.00
	90	Uninoculated	0.19	0.02	0.21	72.60	1.73	25.80
		Inoculated	15.75	0.27	16.02	78.60	1.82	27.00
	120	Uninoculated	0.11	0.08	0.19	73.40	1.97	32.20
		Inoculated	13.01	0.90	13.91	80.20	1.87	41.00
Pure stand	0	Uninoculated	0.18	0.09	0.27	55.90	1.64	11.40
		Inoculated	18.86	1.02	19.88	77.30	1.81	15.40
	60	Uninoculated	0.28	0.05	0.33	66.00	1.69	21.00
		Inoculated	24.08	0.59	24.67	80.20	2.04	22.40
	90	Uninoculated	0.23	0.03	0.26	67.40	1.77	25.60
		Inoculated	16.07	0.34	16.41	77.86	1.85	26.40
	120	Uninoculated	0.13	0.10	0.23	73.20	2.00	31.40
		Inoculated	13.22	1.14	14.36	79.40	1.91	36.80
L.S.D. at 0.05			0.89	0.05	0.89	0.89	0.33	0.61

Table (7): Cont.

Treatments		Characters	Number of nodules/plant			Plant height (cm)	No. of branches/plant	No. of leaves/plant
			Active	Unactive	Total			
	N levels (Kg/fed.)	Bacterial inoculation	Second season 2000					
Intercropping	0	Uninoculated	0.14	0.06	0.20	53.90	1.50	11.58
		Inoculated	15.95	0.70	16.65	64.00	1.66	18.31
	60	Uninoculated	0.21	0.03	0.24	57.40	1.54	20.55
		Inoculated	18.07	0.40	18.47	70.40	1.88	22.42
	90	Uninoculated	0.17	0.02	0.19	60.00	1.62	24.10
		Inoculated	13.67	0.24	13.91	65.20	1.70	25.22
	120	Uninoculated	0.10	0.07	0.17	61.60	1.84	30.08
		Inoculated	11.30	0.78	12.08	66.20	1.75	38.30
Pure stand	0	Uninoculated	0.16	0.07	0.23	50.80	1.53	10.65
		Inoculated	16.38	0.89	17.27	63.00	1.69	14.38
	60	Uninoculated	0.24	0.04	0.28	55.80	1.58	19.62
		Inoculated	20.91	0.51	21.42	67.20	1.91	20.92
	90	Uninoculated	0.20	0.03	0.23	59.60	1.65	23.91
		Inoculated	13.96	0.30	14.26	64.60	1.73	24.66
	120	Uninoculated	0.11	0.08	0.19	60.60	1.87	29.33
		Inoculated	11.47	0.98	12.45	65.60	1.78	34.37
L.S.D. at 0.05			0.73	0.06	0.73	0.70	0.23	0.31

Results evidenced that maximum nodulation (24.67) occurred when soybean was grown soley, received 60 Kg N/fed. and inoculated with the bacteria, whereas, minimum value (0.19) was obtained when intercropped plants were left without inoculation and received the heaviest dose of fertilization.

II. Growth character after 75 days from planting.

The three dimension effect in Table (7) governed and peridominated the interaction effects of the three main variables on growth characters of soybean plants (Intercropping, N-fertilization levels and inoculation with N-fixer bacteria). The intercropped plants inoculated with Rhizobium and given 60 Kg N/fed. were the tallest whereas those grown in pure stand uninoculated and given no fertilizer were the shortest in both seasons. The results on the average number of branches followed the same pattern of change as plant height did when exposed to the same respective treatments in most cases. It seemed that this trait responded parallel to change in plant height. The highest number of branches/plant was obtained from inoculated plants grown in pure stand and fertilized with 60 Kg N/fed.. Number of leaves/plant was significantly affected by the interaction among the three main variables. The highest number of leaves/plant was obtained from intercropped plants inoculated with Rhizobium and fertilized with 120 Kg N/fed. whereas the lowest number was recorded in plants grown in pure stand, uninoculated and without nitrogen application.

B. Yield and yield components.

1. Effect of cropping system on yield and yield components of soybean plants.

Results in Table (8) and Fig. (4) indicate that yield of soybean as well as yield components were significantly influenced by the cropping system. The effect was regular in both seasons. The values of the average number of pods and seeds/plant and weight of 100-seeds of soybean grown in pure stand were significantly higher than those of intercropped soybean. These observations hold true in both seasons. The inferiority of values obtained when soybean was intercropped was reported by several investigators such as Galal and Metwally (1982), Kamel *et al* (1990) and El-Douby (1992). They all attributed these reductions to the inter competition between the tall overstory component (maize) and the shorter understory component (soybean) as well as the intra competition soybean plants when grown at dense population in the intercrop for light intercepted by foliage.

Seed, straw and biological yield of soybean plants were significantly influenced by cropping system in both seasons. The results evidenced that seed, straw and biological yield of intercropped soybean were significantly less than those obtained by pure stand soybean. Reductions were estimated to 53.62, 53.59 and 53.61% in 1999 season and 63.33, 63.06 and 63.18% in 2000 season respectively. Reduction in yield of the intercropped soybean was also supported by several investigators such as Galal and Metwally (1982), Kamel *et al* (1990), El-Douby (1992), Sahar-Sherif (1993) and Zohry (1994).

Table (8): Effect of cropping system on yield and yield components of soybean in 1999 and 2000 seasons.

Characters / Treatments	No. of pods/plant	Weight of pods/plant (g)	No. of seeds/plant	Weight of 100-seed (g)	Seed yield/plant (g)	Seed yield (ton/fed.)	Straw yield (ton/fed.)	Biological yield (ton/fed.)	Oil (%)	Crude protein (%)
	First season 1999									
Intercropping	31.42	17.22	75.07	13.45	10.14	0.64	0.84	1.48	19.99	34.06
Pure stand	48.00	27.86	114.66	14.43	16.63	1.38	1.81	3.19	21.93	35.86
L.S.D. at 0.05	0.08	2.76	0.18	0.18	1.64	0.02	0.03	0.05	0.36	0.35
	Second season 2000									
Intercropping	23.61	11.90	56.40	12.47	7.06	0.44	0.58	1.02	17.39	32.24
Pure stand	42.57	24.55	101.68	14.13	14.46	1.20	1.57	2.77	19.06	33.95
L.S.D. at 0.05	0.08	2.28	9.18	0.18	1.35	0.02	0.02	0.04	0.33	0.34

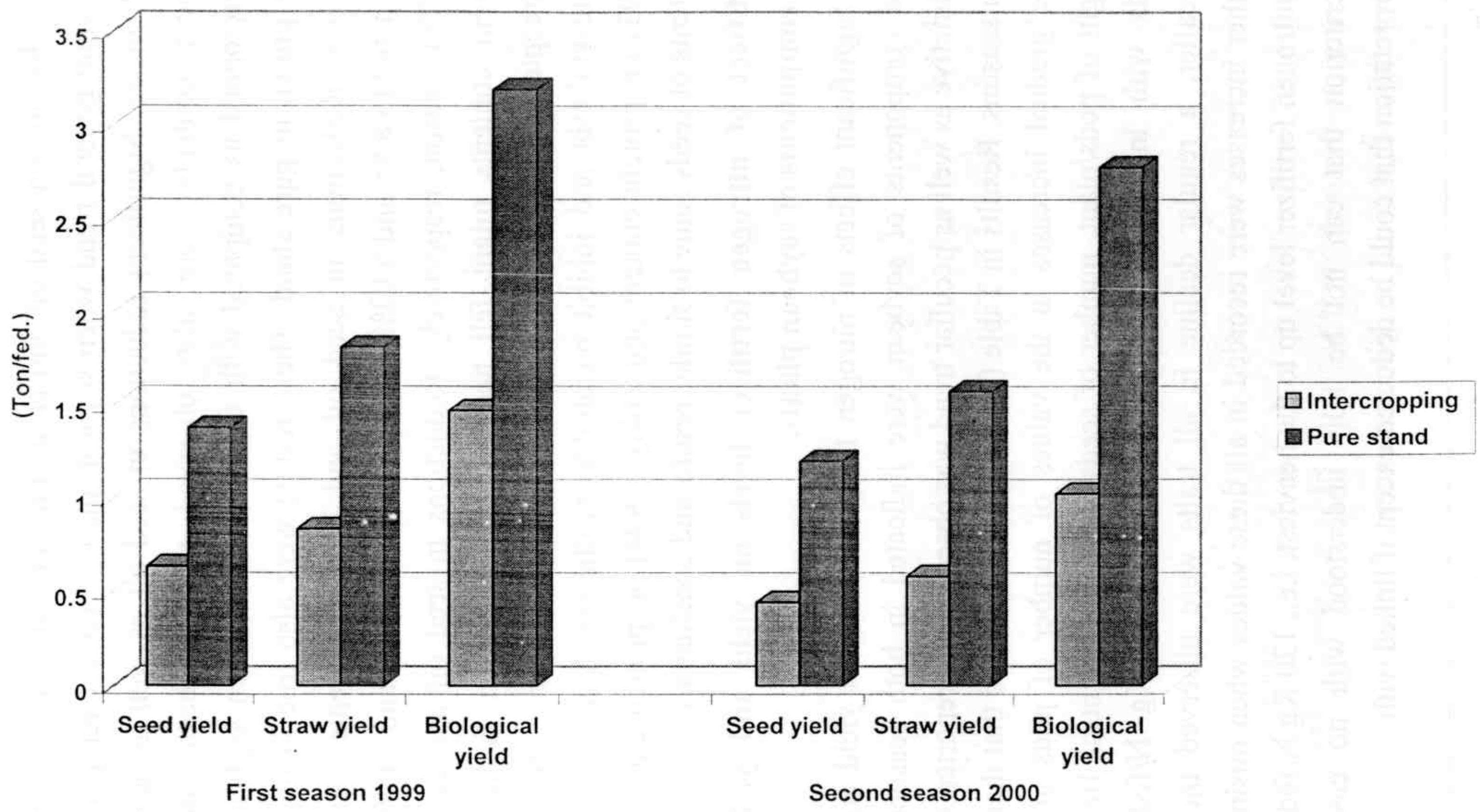

Fig. (4): Effect of cropping system on yield of soybean in 1999 and 2000 seasons.

Results on seed oil and crude protein contents followed the same general trend when soybean plants were intercropped with maize. Significant reductions in seed oil as well as seed protein contents were also observed when soybean was intercropped as compared with values obtained when soybean was grown in pure stand. These results were also true in both seasons. Reductions in seed oil and protein contents were estimated to 8.85 and 5.02% in 1999 season and 8.76 and 5.04% in 2000 season, respectively. Reductions in seed oil and seed protein contents might fell heavily upon, reduction in light intercepted by soybean foliage which inturn inhibit photosynthesis and inhibit metabolite synthetase. Sahar-Sherif (1993) on protein content and Zohry (1994) on protein and oil contents of seeds came to similar results and conclusions.

2. Effect of nitrogen fertilizer levels on yield and yield components of soybean plants.

Significant effects of nitrogen fertilizer levels on yield and yield components of soybean were indicated in both seasons. Distinctive as well as peculiar trend was observed and reported in both seasons. Results in Table (9) and Fig. (5) revealed that there were gradual increases in the values of number of pods and weight of pods/plant, number of seeds/plant and weight of 100-seeds with increasing nitrogen level up to 60 Kg N/fed., thereafter, a regular decline in all traits were observed then another increases were recorded in all these values when raising the nitrogen fertilizer level up to the heaviest, i.e., 120 Kg N/fed.. A criterion that can not be fully understood with no easy interpretation that could be deducted except if linked with

Table (9): Effect of N levels on yield and yield components of soybean in 1999 and 2000 seasons.

Characters / Treatments	No. of pods/plant	Weight of pods/plant (g)	No. of seeds/plant	Weight of 100-seed (g)	Seed yield/plant (g)	Seed yield (ton/fed.)	Straw yield (ton/fed.)	Biological yield (ton/fed.)	Oil (%)	Crude protein (%)
N levels (Kg/fed.)	First season 1999									
0	31.55	17.29	75.36	13.50	10.27	0.77	1.01	1.78	20.58	33.97
60	40.32	22.83	96.31	13.96	13.56	1.04	1.36	2.40	21.28	35.45
90	37.28	20.95	89.06	13.88	12.44	0.89	1.17	2.06	20.85	35.17
120	49.70	29.09	118.73	14.42	17.28	1.33	1.75	3.08	21.13	35.25
L.S.D. at 0.05	0.11	3.90	0.26	0.26	2.32	0.03	0.07	0.50	0.50	0.50
	Second season 2000									
0	26.32	13.99	62.88	12.88	8.26	0.63	0.83	1.46	17.90	32.16
60	33.66	18.49	80.41	13.32	10.92	0.85	1.11	1.96	18.50	33.55
90	30.98	16.88	74.02	13.23	9.97	0.73	0.95	1.68	18.15	33.29
120	41.38	23.54	98.85	13.76	13.90	1.08	1.42	2.50	18.35	33.38
L.S.D. at 0.05	5.44	3.23	12.99	0.25	1.90	0.02	0.03	0.05	0.47	0.48

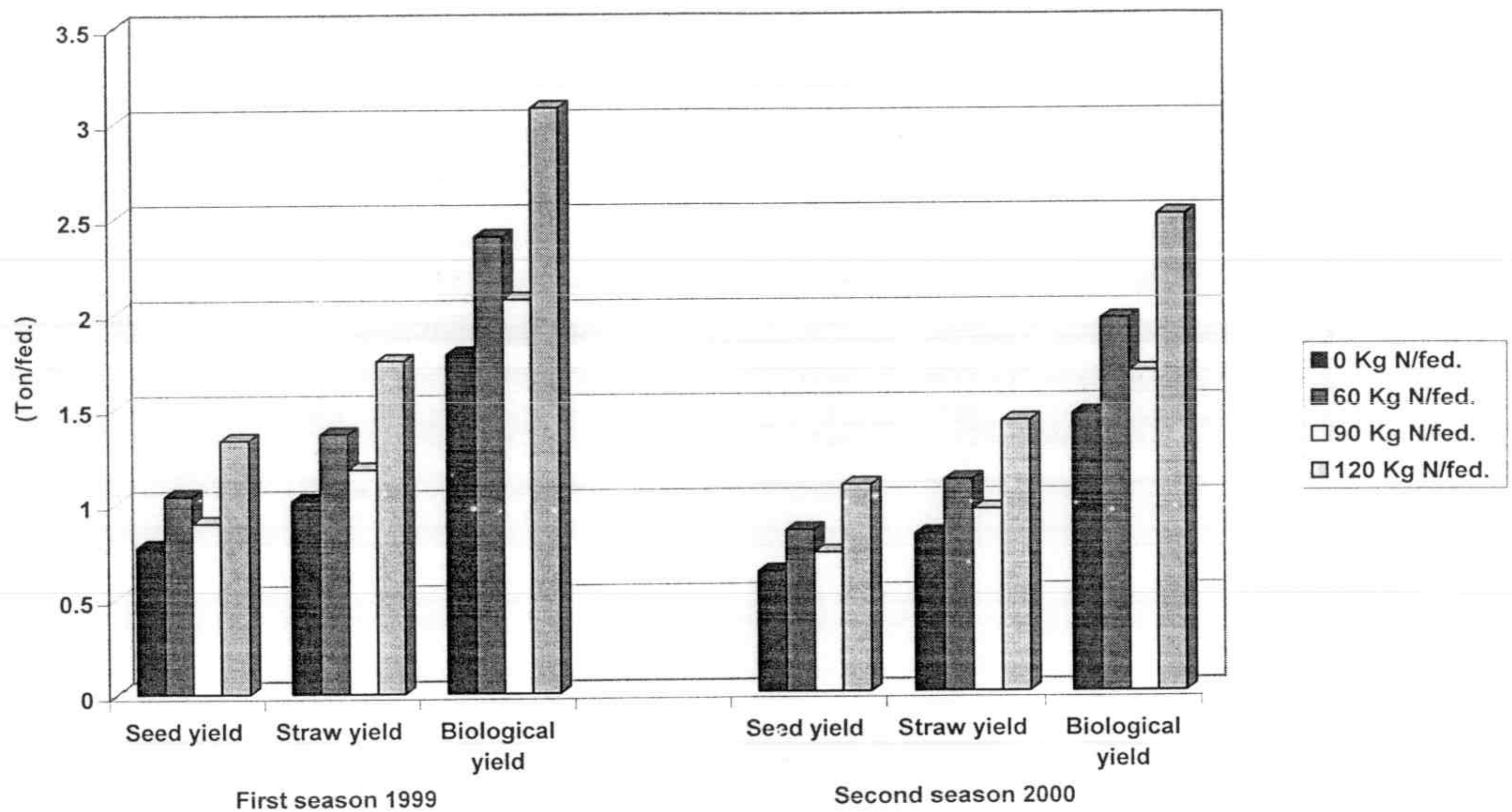

Fig. (5): Effect of N levels on yield of soybean in 1999 and 2000 seasons.

nodulation that at 90 Kg N/fed. nodulation was severely affected and the plant become nitrogen big user, continued at full dependency on N mineral fertilization. However, increases in values of these traits which were associated with increases in nitrogen fertilizer level might owe much to important role of nitrogen in neueleic acid and protein synthesis that led to increases in values of these traits. These results were also supported by Mehasen (1994).

Increasing nitrogen fertilizer level led to increases in the values of seed, straw yields and biological yield/fed.. Nevertheless, same decline was observed at 90 Kg N/fed. Treatment, thereafter another increases were recorded. This trend was observed in both seasons. The excesses in seed, straw and biological yield of soybean plants received highest level of nitrogen over soybean plants received lowest level (nil) were estimated to 72.73, 73.27 and 73.03% in 1999 season and 71.43, 71.08 and 71.23% in 2000 season respectively.

However, these results were in accordance with those obtained by Mehasen (1994) who reported that nitrogen enhanced meristematic activities and increased photosynthetic capacity which resulted in more yielding.

Nitrogen fertilization level had the same effect on seed oil content and seed crude protien content percent. Moreover, differences were also significant in both seasons. However, differences among the treatment imposed were more appreciable between plots which received no fertilization and other treatments. The highest value of oil and protein was obtained by adding 60 Kg N/fed. . These values were 21.28 and 35.45 in

1999 and 18.50 and 33.55 in 2000 season, respectively. Further N application caused a decline in both oil and protein percent. This observation hold true in case of seed oil content and more in seed crude protein content.

3. Effect of bacterial inoculation on yield and yield components of soybean plants.

Results in Table (10) and Fig. (6) indicated that inoculating with rhizobia had significant effects on the average number of pods/plant, the weight of pods/plant, number of pods and seeds/plant and the weight of 100 seeds. These observations hold true in both seasons, except in the second season, differences in case of number of seeds/plant and number of pods/plant did not reach the 5% level of significance. The benificial effect of inoculation with rhizobia has been previously demonstrated. Nodulation and that bacteriods are considered the seats for nitrogen fixation. Nitrogenase is the enzyme which mediate the reduction of N_2. The nitrogenase catalyzed reaction requires a source of ATP and reductant. Products of photosynesis are translocated from leaves to nodule which provide the necessary ATP and reductant for nitrogen fixation. Most measurements, been done previously indicate a requirement of 12 molecules of ATP per molecule of N_2 fixed. However, the amount of photosynthate available to the nodule, the amount of leghaemoglobin and the extent of bacteriod tissue in nodule have direct bearing on the amount of nitrogin fixed by the legume (Hardy and Havelka 1976).

Results on seed yield/plant, seed, straw and the biological yield followed the same tendency, since, these parameters are

Table (10): Effect of bacterial inoculation on yield and yield components of soybean in 1999 and 2000 seasons.

Characters / Treatments	No. of pods/plant	Weight of pods/plant (g)	No. of seeds/plant	Weight of 100-seed (g)	Seed yield/plant (g)	Seed yield (ton/fed.)	Straw yield (ton/fed.)	Biological yield (ton/fed.)	Oil (%)	Crude protein (%)
Bacterial inoculation	First season 1999									
Uninoculated	38.62	21.01	92.25	13.39	12.48	0.92	1.21	2.13	20.39	34.25
Inoculated	40.81	24.07	97.48	14.49	14.30	1.10	1.44	2.54	21.53	35.68
L.S.D. at 0.05	0.08	2.76	0.18	0.18	1.64	0.02	0.03	0.05	0.36	0.35
	Second season 2000									
Uninoculated	32.19	16.99	76.89	12.77	10.03	0.75	0.99	1.74	17.73	32.42
Inoculated	33.99	19.47	81.19	13.83	11.49	0.89	1.17	2.06	18.73	33.77
L.S.D. at 0.05	N.S	2.28	N.S	0.18	1.35	0.02	0.02	0.04	0.33	0.34

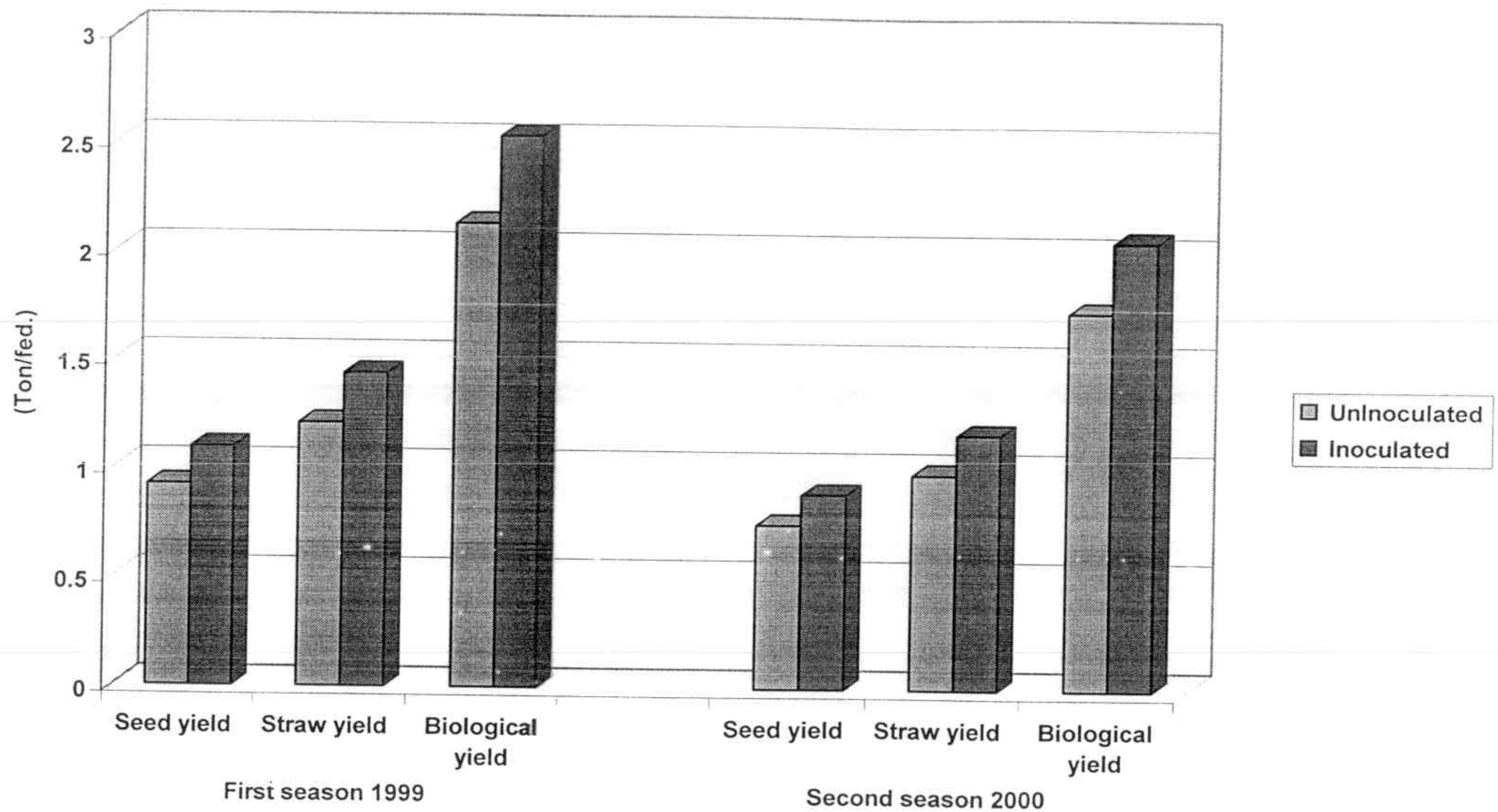

Fig. (6): Effect of bacteria inoculation on yield of soybean in 1999 and 2000 seasons.

reliable index of the yield components. The results indicate that seed yield/plant, seed, straw and the biological yield/fed.. of inoculated soybean were superior to those calculated on uninoculated soybean. The excesses were estimated to 14.58, 19.57, 19.01 and 19.25% in 1999 season and 14.56,18.67,18.18 and 18.39 % in 2000 season respectively . The results also evidenced that differences were significant in both seasons.

Inoculating soybean with rhizobia also had a stimulating effect on seed oil and seed crude protein content. The favorable effect was also significant in both seasons. These results were in harmony with those obtained by Kamel *et al* (1983)and Sharaf and Salwau (1992) on oil content, Hammam (1986) and Sharaf and Salwau (1992) on protein content.

4. Interaction effect of cropping system and nitrogen fertilizer level on yield and yield components of soybean plants.

The combined effect of cropping system and nitrogen fertilizer level on yield and its components behaved conventionally as the sum of both variables (cropping system and fertilizer level). This tendency has been observed in all the traits and in both seasons Table (11). The highest values of yield components, namely; No. of pods and seeds/plant, weight of 100 seeds, weight of pods and seed yield/plant were obtained from pure standing and 120 Kg N/fed. application. Same trend was observed in straw and biological yield of soybean where application of 120 Kg N/fed. the pure stand planting produced the highest straw and biological yield.

Table (11): Effect of interaction between cropping system and N levels on yield and yield components of soybean in 1999 and 2000 seasons.

Treatments	Characters / N levels (Kg/fed.)	No. of pods/plant	Weight of pods/plant (g)	No. of seeds/plant	Weight of 100-seed (g)	Seed yield/plant (g)	Seed yield (ton/fed.)	Straw yield (ton/fed.)	Biological yield (ton/fed.)	Oil (%)	Crude protein (%)
		First season 1999									
Intercropping	0	25.00	13.21	59.72	13.01	7.78	0.47	0.62	1.09	19.65	33.15
	60	32.00	17.44	76.45	13.43	10.27	0.66	0.86	1.52	20.35	34.55
	90	29.31	16.01	70.03	13.46	9.43	0.57	0.74	1.31	19.80	34.25
	120	39.38	22.23	94.07	13.90	13.09	0.85	1.12	1.97	20.15	34.30
Pure stand	0	38.09	21.37	90.99	13.99	12.76	1.07	1.4!	2.48	21.50	34.80
	60	48.63	28.22	116.18	14.49	16.85	1.42	1.86	3.28	22.20	36.35
	90	45.25	25.89	108.09	14.29	15.46	1.22	1.61	2.83	21.90	36.10
	120	60.03	35.96	143.39	14.95	21.47	1.81	2.37	4.18	22.10	36.20
L.S.D. at 0.05		0.15	5.52	0.37	0.36	3.28	0.05	0.06	0.10	0.71	0.70
		Second season 2000									
Intercropping	0	18.85	9.17	45.03	12.06	5.44	0.33	0.43	0.76	17.10	31.39
	60	24.22	12.11	57.85	12.45	7.18	0.46	0.60	1.06	17.70	32.69
	90	21.77	10.96	51.99	12.48	6.50	0.39	0.51	0.90	17.25	32.43
	120	29.60	15.37	70.71	12.88	9.11	0.59	0.78	1.37	17.50	32.48
Pure stand	0	33.79	18.81	80.72	13.70	11.08	0.93	1.22	2.15	18.70	32.94
	60	43.11	24.88	102.98	14.19	14.65	1.23	1.62	2.85	19.30	34.41
	90	40.20	22.81	96.04	13.99	13.43	1.06	1.39	2.45	19.05	34.16
	120	53.16	31.72	126.98	14.63	18.68	1.57	2.06	3.63	19.20	34.28
L.S.D. at 0.05		7.69	4.56	18.37	0.35	2.69	0.03	0.05	0.07	0.67	0.68

The analysis of data also revealed that highest seed yield/fed. (1.81 and 1.57 ton/fed.) was obtained when soybean was grown in pure stand and received the heaviest dose of N (120 Kg) in both seasons, whereas, minimum yield of seeds/fed. (0.47 and 0.62 ton/fed.) was from intercropped soybean plant which received no nitrogen. Reductions were estimated to 74.03% in 1999 and 79.14% in 2000.

Results of seed oil content and seed crude protein content had the same trend. This observation hold true in both seasons. Soybean plants grown in pure stand and received highest nitrogen level had highest values of both traits, whereas, minimum values were obtained when soybean was intercropped and received no nitrogen. Moreover, the statistical analysis revealed significant differences among all these traits in both seasons.

5. Interaction effect of cropping system and bacterial inoculation on yield and yield components of soybean plants.

The interaction of cropping system and bacterial inoculation with rhizobia had also two dimension effect which predominated the treatment effect, i.e., the interaction was governed by both variables; cropping system and inoculation with rhizobia (Table 12). Inoculated soybean grown in pure stand had the highest yield component. Same trend was also observed in cases of seed yield/plant, seed, straw and the biological yield/fed., where the two conventional effects were evident and predominated the interaction treatments in both seasons. In addition, differences were always significant in all

Table (12): Effect of interaction between cropping system and bacterial inoculation on yield and yield components of soybean in 1999 and 2000 seasons.

Treatments	Characters	No. of pods/plant	Weight of pods/plant (g)	No. of seeds/plant	Weight of 100-seed (g)	Seed yield/plant (g)	Seed yield (ton/fed.)	Straw yield (ton/fed.)	Biological yield (ton/fed.)	Oil (%)	Crude protein (%)
	Bacterial inoculation	First season 1999									
Intercropping	Uninoculated	30.56	16.06	73.00	12.91	9.46	0.58	0.76	1.34	19.45	33.38
	Inoculated	32.29	18.39	77.13	13.98	10.83	0.70	0.91	1.61	20.53	34.75
Pure stand	Uninoculated	46.68	25.97	111.50	13.86	15.50	1.27	1.66	2.93	21.33	35.13
	Inoculated	49.32	29.75	117.83	15.00	17.76	1.49	1.96	3.45	22.53	36.60
L.S.D. at 0.05		0.11	3.90	0.26	0.26	2.32	0.03	0.04	0.07	0.50	0.50
		Second season 2000									
Intercropping	Uninoculated	22.99	11.09	54.91	11.97	6.58	0.40	0.53	0.93	16.90	31.59
	Inoculated	24.23	12.71	57.88	12.96	7.54	0.49	0.64	1.13	17.88	32.89
Pure stand	Uninoculated	41.39	22.89	98.87	13.57	13.48	1.10	1.44	2.54	18.55	33.25
	Inoculated	43.74	26.22	104.49	14.69	15.44	1.30	1.70	3.00	19.58	34.64
L.S.D. at 0.05		5.44	3.23	12.99	0.25	1.90	0.02	0.03	0.05	0.47	0.48

traits and in both seasons. The analysis of data revealed that the excesses in seed yield/fed. of the pure stand soybean and inoculated with bacteria over the intercropped plants and left without inoculation were estimated by 159.38% in 1999 season and 223.94% in 2000 season.

Results obtained in Table (12) indicate clearly the both seed oil and seed crude protein contents followed the same trends. Moreover, differences were also significant in both seasons. The excesses in seed oil percent of inoculated pure stand soybean over that of intercropped soybean and left without inoculation were 15.84% in 1999 and 15.86% in 2000. The excesses in seed crude protein were 9.65% in 1999 and 9.66% in 2000.

6. Interaction of nitrogen fertilizer levels and bacterial inoculation.

The interaction of nitrogen fertilizer levels and bacterial inoculation was also governed by the trends of the main variables (Table 13). Yield components values were significantly influenced by the interaction of nitrogen levels and bacterial inoculation.the highest values of yield components were obtained from inoculated plants fertilized with 120 Kg N/fed.. A controversy and opposing opinions on the effect of nitrogen fertilization to achieve successful inoculation and nodulation of Rhizobia were offered by several investigators. Odongo *et al* (1990) found that inoculation soybean seeds with *Brady rhizobium japonicum* increased seed yield only when N was not applied, whereas, application of N up to 250 Kg N/ha did not affect significantly the yield of maize or soybean, due to high

Table (13): Effect of interaction between N levels and bacterial inoculation on yield and yield components of soybean in 1999 and 2000 seasons.

Treatments	Characters	No. of pods/plant	Weight of pods/plant (g)	No. of seeds/plant	Weight of 100-seed (g)	Seed yield/plant (g)	Seed yield (ton/fed.)	Straw yield (ton/fed.)	Biological yield (ton/fed.)	Oil (%)	Crude protein (%)
N levels (Kg/fed.)	Bacterial inoculation	First season 1999									
0	Uninoculated	29.89	15.74	71.41	13.00	9.35	0.70	0.92	1.62	20.00	32.90
	Inoculated	33.20	18.84	79.31	14.00	11.19	0.84	1.11	1.95	21.15	35.05
60	Uninoculated	39.88	21.74	95.27	13.44	12.91	0.98	1.29	2.27	20.70	34.85
	Inoculated	40.76	23.92	97.36	14.48	14.21	1.09	1.43	2.52	21.85	36.05
90	Uninoculated	36.75	19.89	87.78	13.37	11.81	0.79	1.03	1.82	20.30	34.60
	Inoculated	37.82	22.01	90.34	14.38	13.07	1.00	1.32	2.32	21.40	35.75
120	Uninoculated	47.95	26.68	114.55	13.74	15.85	1.22	1.59	2.81	20.55	34.65
	Inoculated	51.45	31.51	122.91	15.11	18.71	1.45	1.90	3.35	21.70	35.85
L.S.D. at 0.05		0.15	5.52	0.37	0.36	3.28	0.05	0.06	0.10	0.71	0.70
		Second season 2000									
0	Uninoculated	24.97	12.74	59.64	12.40	7.52	0.57	0.75	1.32	17.40	31.15
	Inoculated	27.68	15.24	66.12	13.36	9.00	0.69	0.90	1.59	18.40	33.18
60	Uninoculated	33.34	17.59	79.65	12.83	10.38	0.80	1.05	1.85	18.00	32.99
	Inoculated	33.98	19.39	81.18	13.82	11.45	0.89	1.17	2.06	19.00	34.11
90	Uninoculated	30.53	16.03	72.92	12.75	9.46	0.64	0.84	1.48	17.65	32.75
	Inoculated	31.44	17.74	75.11	13.72	10.47	0.81	1.07	1.88	18.65	33.84
120	Uninoculated	39.92	21.59	95.35	13.10	12.75	0.99	1.30	2.29	17.85	32.80
	Inoculated	42.84	25.49	102.34	14.41	15.05	1.18	1.54	2.72	18.85	33.95
L.S.D. at 0.05		7.69	4.56	18.37	0.35	2.69	0.03	0.05	0.07	0.67	0.68

availability of N in the soil. Martin *et al* (1995) also found that lower level of N and inoculating soybean with *Brady rhizobium sp.* maximized nodulation biomass and N yields in nodulating soybean. Abo Taleb (1991) found significant differences on growth, yield and yield component parameters as influenced by levels of nitrogen fertilization of neighboring maize. N fertilization did influence nodulation of neighboring soybean plants. Such effect was significantly positive (increase of 14 and 60%) in presence of a rational dose of 45 Kg N/fed., but negative (decrease of 62 and 11%) in the presence of high dose of 135 Kg N/fed.. He concluded that successful nodulation resulted in healthy soybean plants with total weight of 8-11 g/plant compared to non-inoculated ones (4-8 g/plant). The highest dry weight (11-12.8 g/plant) of soybean plants was recorded for those Rhizobia inoculated and neighboring maize plants fertilized with a rational dose of 45 Kg N/fed..

Safwat *et al* (1990) obtained congrunt results with the same doses (20 Kg N/ha. as a low dose and 100 Kg N/ha. as high dose). On other hand Koreish *et al* (1998), found significant increases in yield when 178.5 Kg N/ha. or more were added. Berge *et al* (1990) found the response extended to 240 Kg N/ha. However, Pineda *et al* (1994) concluded that Rhizobium selection coupled with N fertilization regime, although laborious and need further studies on nature and inherent fertility of soil micro environmental condition, host sensitivity to nodulation could be effective and can be recommend for use as inoculants by farmers.

Results on seed yield/plant, seed yield/fed., straw yield/fed. and biological yield/fed. followed the same general trend of both main variable.

However, it is interesting to note that highest values of yield parameters was obtained when soybean was inoculated with rhizobia and received highest level of N-fertilizer. Those received same dose of N-fertilizer and left without inoculation ranked the second but, on other hand those received no N-fertilizer and left without inoculation had least values. These results hold true in both seasons. The results also revealed that differences between maximum value of seed yield/fed. and minimum value were 0.746 and 0.604 ton/fed. in 1999 and 2000 seasons, respectively. The excesses were going around more one fold. Furthermore, the results revealed significant differences among the interacted treatments. Similar trends of both main variables effect predominated seed oil content and seed crude protein contents. Nevertheless, highest seed crude protein content was not directly correlated with heaviest dose of nitrogen fertilizer, but, was parallel with the activator dose, i.e., 60 Kg N/fed.. This observation hold true in both seasons. It is also evident that seed crude protein was at its peak when highest seed nodulation was occurred, Table (13). This trend was also observed in case of seed oil content in both seasons. These results were also coincided with those obtained by Abo Taleb (1991).

7. Interaction effect of cropping system, nitrogen fertilizer levels and bacterial inoculation with rhizobia.

Results on the combined interaction effect of the three main variables on yield components in Table (14), revealed that these traits were influenced by the general tendencies of the treatment effect. The three dimension effects were quite obvious. All values obtained from inoculated plants were always higher than those obtained from the uninoculated plants within each nitrogen fertilizer level whether soybean was intercropped or left in pure stand. The treatment effects on these traits were also significant in both seasons. Inoculated pure stand fertilized with 120 Kg N/fed. gave the highest values of yield component of soybean

Results on yield parameters indicate that maximum seed, straw and the biological yield/fed. were obtained when soybean plants were inoculated with rhizobia, grown in pure stand and received highest dose of N-fertilizer (120 Kg N/fed).

Table (14): Effect of interaction among cropping system, N levels and bacterial inoculation on yield and yield components of soybean in 1999 and 2000 seasons.

Treatments		Characters	No. of pods/plant	Weight of pods/plant (g)	No. of seeds/plant	Weight of 100-seed (g)	Seed yield/plant (g)	Seed yield (ton/fed.)	Straw yield (ton/fed.)	Biological yield (ton/fed.)	Oil (%)	Crude protein (%)
	N levels (Kg/fed.)	Bacterial inoculation	First season 1999									
Inter cropping	0	Uninoculated	23.65	12.03	56.50	12.54	7.09	0.42	0.55	0.97	19.10	32.10
		Inoculated	26.35	14.39	62.94	13.47	8.48	0.52	0.68	1.20	20.20	34.20
	60	Uninoculated	31.71	16.61	75.74	12.91	9.78	0.62	0.81	1.43	19.80	34.00
		Inoculated	32.30	18.28	77.16	13.95	10.77	0.70	0.92	1.62	20.90	35.10
	90	Uninoculated	28.97	15.20	69.21	12.94	8.95	0.49	0.64	1.13	19.30	33.70
		Inoculated	29.65	16.81	70.84	13.98	9.91	0.64	0.84	1.48	20.30	34.80
	120	Uninoculated	37.90	20.39	90.53	13.26	12.01	0.77	1.02	1.79	19.60	33.70
		Inoculated	40.86	24.07	97.60	14.53	14.18	0.93	1.23	2.16	20.70	34.90
Pure stand	0	Uninoculated	36.13	19.45	86.31	13.37	11.62	0.98	1.28	2.26	20.90	33.70
		Inoculated	40.05	23.28	95.68	14.43	13.90	1.17	1.53	2.70	22.10	35.90
	60	Uninoculated	48.05	26.87	114.79	13.97	16.04	1.35	1.77	3.12	21.60	35.70
		Inoculated	49.21	29.56	117.56	15.01	17.65	1.49	1.95	3.44	22.80	37.00
	90	Uninoculated	44.52	24.58	106.34	13.80	14.67	1.08	1.42	2.50	21.30	35.50
		Inoculated	45.98	27.20	109.85	14.78	16.24	1.37	1.79	3.16	22.50	36.70
	120	Uninoculated	58.01	32.97	138.56	14.11	19.69	1.66	2.17	3.83	21.50	35.60
		Inoculated	62.05	38.94	148.22	15.58	23.25	1.96	2.57	4.53	22.70	36.80
L.S.D. at 0.05			0.22	7.80	0.52	0.51	4.64	0.06	0.08	0.14	1.01	0.99

RESULTS AND DISCUSSION

Table (14): Cont.

Treatments		Characters	No. of pods/plant	Weight of pods/plant (g)	No. of seeds/plant	Weight of 100-seed (g)	Seed yield/plant (g)	Seed yield (ton/fed.)	Straw yield (ton/fed.)	Biological yield (ton/fed.)	Oil (%)	Crude protein (%)
	N levels (Kg/fed.)	Bacterial inoculation	Second season 2000									
Inter cropping	0	Uninoculated	17.86	8.36	42.67	11.62	4.96	0.30	0.39	0.69	16.60	30.40
		Inoculated	19.84	9.99	47.40	12.49	5.92	0.36	0.47	0.83	17.60	32.38
	60	Uninoculated	24.08	11.52	47.53	11.97	6.83	0.43	0.57	1.00	17.20	32.18
		Inoculated	24.35	12.70	58.18	12.93	7.53	0.49	0.64	1.13	18.20	33.20
	90	Uninoculated	21.51	10.39	51.39	11.99	6.16	0.34	0.44	0.78	16.80	31.90
		Inoculated	22.02	11.52	52.59	12.96	6.83	0.44	0.58	1.02	17.70	32.95
	120	Uninoculated	28.49	14.10	68.06	12.29	8.36	0.54	0.71	1.25	17.00	31.90
		Inoculated	30.71	16.63	73.36	13.47	9.86	0.65	0.85	1.50	18.00	33.05
Pure stand	0	Uninoculated	32.07	17.13	76.61	13.18	10.09	0.85	1.11	1.96	18.20	31.90
		Inoculated	35.51	20.50	84.83	14.22	12.07	1.02	1.33	2.35	19.20	33.98
	60	Uninoculated	42.60	23.66	101.76	13.68	13.94	1.17	1.54	2.71	18.80	33.80
		Inoculated	43.62	26.09	104.19	14.70	15.37	1.29	1.70	2.99	19.80	35.03
	90	Uninoculated	39.54	21.66	94.45	13.51	12.76	0.94	1.23	2.17	18.50	33.60
		Inoculated	40.87	23.95	97.63	14.47	14.11	1.19	1.56	2.75	19.60	34.73
	120	Uninoculated	51.34	29.09	122.64	13.91	17.13	1.44	1.89	3.33	18.70	33.70
		Inoculated	54.97	34.34	131.32	15.36	20.23	1.70	2.23	3.93	19.70	34.85
L.S.D. at 0.05			10.87	6.45	25.97	0.50	3.81	0.05	0.06	0.10	0.94	0.96

The adjusted seed yield of soybean is one fold the actual yield, since the intercrop pattern was in equal ratio (2:2). This pattern is valid under all the interacted treatments. The data in Table (15) showed that in all the interacted treatments, the adjusted seed yield of the intercropped soybean were lower than that of their respective actual seed yield when soybean was grown in pure stand. These results were valid in both seasons. Moreover, the results showed significant differences. The decreases in the adjusted seed yield of the intercropped soybean compared with those recorded of the actual values of the intercropping treatments might be due to the higher interspecific competition within the intercropping treatments rather than the intra specific competition among solid planting under the same respective interacted treatment. The results were also true in both seasons. It seemed that less shading effect of soybean plants resulted in the increases in seed yield of pure stand soybean. Inferiority of the adjusted seed yield/unit area of the intercropped soybean plants compared with the yield of sole cropped soyben under same treatment was demonstrated by Khalil (1994).

From another angle of data the adjusted seed yield of sooybean followed the same course of change as influenced by the treatment effect. There were gradual and consistent increases (in both seasons) with increasing nitrogen fertilizer level up to 60 Kg N/fed., then a slow down was observed. Then rather increases were also observed up to the heaviest dose, i.e, 120 Kg N/fed.. This pattern was coupled with higher values of the inoculated treatments as compared with the uninoculated treatment under any interacted treatment.

Table (15): Effect of interaction among cropping systems, N levels and bacterial inoculation on yield of soybean in 1999 and 2000 seasons.

Treatments		Characters	Actual Seed yield (ton/fed.)	Adjusted * Seed yield (ton/fed.)	Actual Seed yield (ton/fed.)	Adjusted * Seed yield (ton/fed.)
	N levels (Kg/fed.)	Bacterial inoculation	First season 1999		Second season 2000	
Inter cropping	0	Uninoculated	0.42	0.84	0.30	0.60
		Inoculated	0.52	1.04	0.36	0.72
	60	Uninoculated	0.62	1.24	0.43	0.86
		Inoculated	0.70	1.40	0.49	0.98
	90	Uninoculated	0.49	0.98	0.34	0.68
		Inoculated	0.64	1.28	0.44	0.88
	120	Uninoculated	0.77	1.54	0.54	1.08
		Inoculated	0.93	1.86	0.65	1.30
Pure stand	0	Uninoculated	0.98	0.98	0.85	0.85
		Inoculated	1.17	1.17	1.02	1.02
	60	Uninoculated	1.35	1.35	1.17	1.17
		Inoculated	1.49	1.49	1.29	1.29
	90	Uninoculated	1.08	1.08	0.94	0.94
		Inoculated	1.37	1.37	1.19	1.19
	120	Uninoculated	1.66	1.66	1.44	1.44
		Inoculated	1.96	1.96	1.70	1.70
L.S.D. at 0.05			0.06	0.78	0.05	0.05

*** Adjusted yield: Seed yield was adjusted according to unit area basis.**

Maize.

A. **Azospirilla count in maize root rhizosphere and growth characters of maize.**

1. **Effect of cropping system on :**

   I. **Number of active bacteria in maize root rhizosphere .**

Results in Table (16) and Fig. (7) indicate clearly that cropping system had a significant effect on the number of non-symbiotic fixer bacteria in the soil. This observation hold true in both seasons. It is evident that the number of active bacteria in the rhizosphere of maize root when plants were grown in pure stand was significantly higher than in the rhizosphere of maize intercropped with soybean. Pure standing surpassed by 0.16×10^7 and 0.22×10^7 in 1999 and 2000 seasons respectively . The results were coincided with those obtained by El-Kholy (1993). Superiority in number of active bacteria within pure stand maize rhizosphere over those of intercropped plants could be explained through the facts that N-fixation through nitrogenase needs more energy and this energy is certainly created more with plants have higher photosynthetic capacity as well as merstimatic activity (Brawn, 1976) and to root system vigor (adsorption and absorption root surface).

II. Growth characters after 75 days from planting.

Growth characters of maize as influenced by cropping system are presented in Table (16). The results revealed that intercropping had a depressive effect on the values of these traits. Reductions were significant and were evident in both

Table (16): Effect of cropping system on number of active bacteria in soil (rhizosphere zone), number of days to 50% tasseling, silking and growth characters of maize in 1999 and 2000 seasons.

Characters / Treatments	No. of active bacteria in soil	No. of days to 50%		Plant height (cm)	Topmost ear height (cm)	Stem diameter (cm)	Leaf area of topmost ear (cm^2)	Plants with double ears (%)
		Tasseling	Silking					
	First season 1999							
Intercropping	0.59×10^7	56.56	59.00	223.26	110.89	1.82	524.97	19.37
Pure stand	0.75×10^7	57.34	59.78	231.27	115.79	1.87	541.06	20.85
L.S.D. at 0.05	1.02	0.56	0.63	4.81	3.04	0.04	N.S	N.S
	Second season 2000							
Intercropping	0.78×10^7	56.72	59.09	262.78	145.61	1.78	715.27	22.10
Pure stand	1.00×10^7	57.59	59.91	272.21	152.04	1.82	737.20	23.84
L.S.D. at 0.05	1.05	0.61	0.63	5.67	3.99	0.04	N.S	N.S

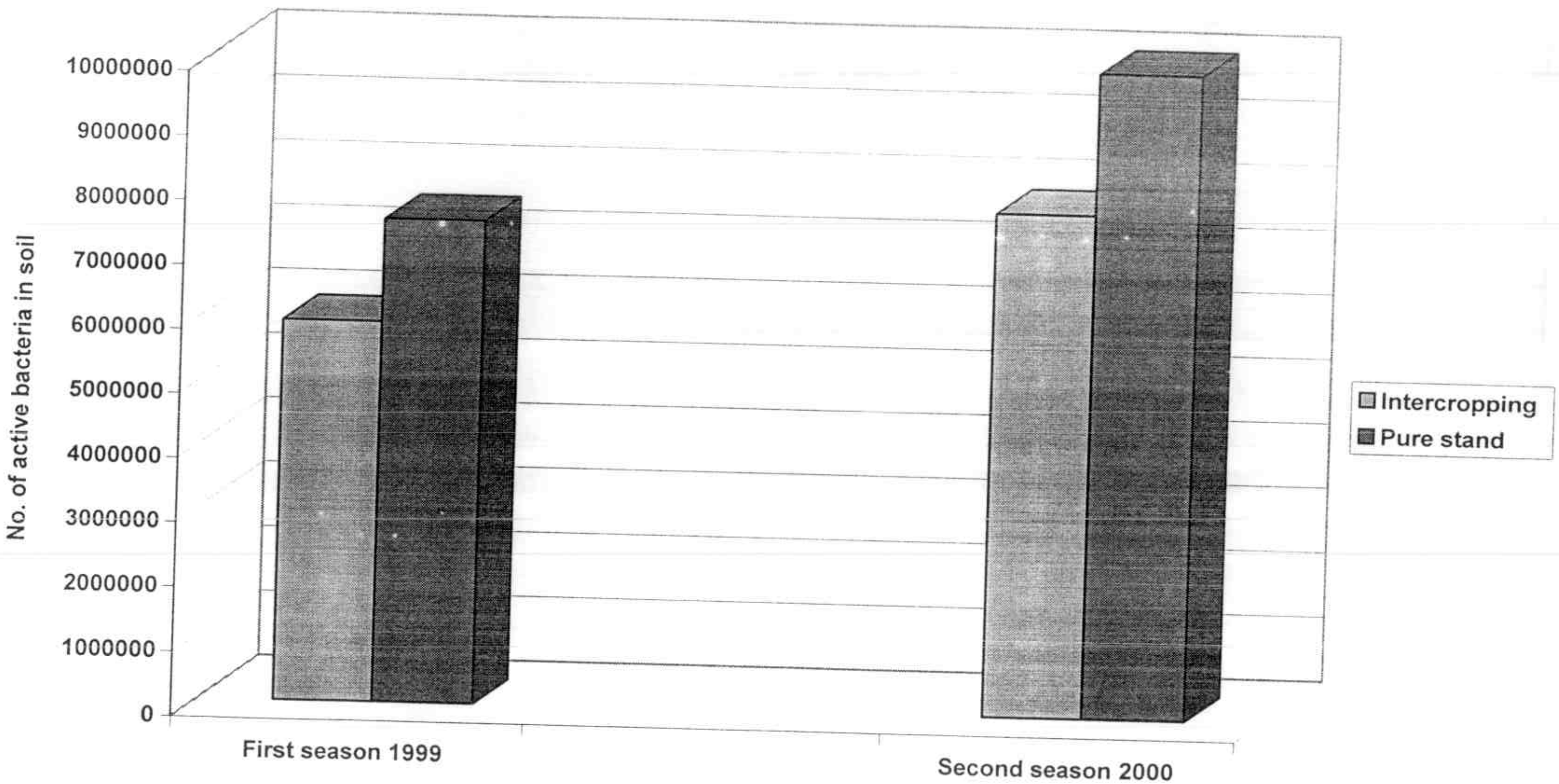

Fig. (7): Effect of cropping system on number of active bacteria in soil (rhizosphere zone) of maize in 1999 and 2000 seasons.

seasons. Heights of the intercropped plants were lower than those grown in pure stand in both seasons. These results were supported by several investigators such as Galal and Metwally (1982), Khedr (1982). They interpreted reduction in height of intercropped maize plants as due to less intra competition for light, water and mineral and as related to more plant population density per unit area of land.

Intercropping had also a diminishing effect on topmost ear height in both seasons where the pure stand plants surpassed the intercropped ones by 4.9 and 6.43 cm in both seasons respectively. These results were also supported by Sahar-Sherif (1993). It seemed that this trait was tenaciously bound with plant height and the trend of change was governed by the length of internodes.

Intercropping maize with soybean significantly reduced stem diameter in both seasons. Interpretation for these observations is plausible. Reduction in stem diameter of the intercropped plants is related to the general tendency to diminution of the intercropped maize growth. The low below and above ground competition among the pure stand maize plants were the cause and effect to increase meristematic activity as well as metabolite synthesized by the pure stand plants. These results are in agreement with those obtained by several investigators such as El-Douby *et al* (1996).

The treatment effect on leaf area of topmost ear and percent of plant with double ears followed also the general tendency of the treatment effect on maize as a whole. Nevertheless, differences between both cropping systems were insignificant in both seasons for the traits either. The relative excesses in both traits when plants were grown in pure stand are also attributed much to lesser intra competition between plants rather than the intercropped plants. These results were also concordant with those obtained by Galal and Metwally (1982), Khedr (1982), Ahmed (1983) and El-Douby *et al* (1996). Interpretation for the favourable effect of growing in pure stand on traits has been previously reported.

The effect of cropping systems on number of days to 50% tasseling and silking was infavour of growing maize in pure stand. Number of days to 50% tasseling and silking was significantly lower when maize was intercropped with soybean. These observation hold true in both seasons.

It seemed that intercropped maize plants terminated their life cycle earlier than those grown in pure stand due to more plant to plant competition for light, water and minerals as a results of more plant population density per unit of land.

2. Effect of nitrogen fertilizer levels on :

I. Number of active bacteria in maize root rhizosphere.

The effect of nitrogen fertilizer level on the average number of active bacteria in maize root rhizosphere was also significant in both seasons. However, the trend of change was distinctive. Results in Table (17) and Fig. (8), revealed that addition of 60 Kg N/fed. increased number of active bacteria, there after, gradual decreases were observed up to the heaviest level, i.e., 120 Kg N/fed.. These results hold true in both seasons. Several investigators came to similar result. Fayez *et al* (1985)

Table (17): Effect of N levels on number of active bacteria in soil (rhizosphere zone), number of days to 50% tasseling, silking and growth characters of maize in 1999 and 2000 seasons.

Characters / Treatments	No. of active bacteria in soil	No. of days to 50%		Plant height (cm)	Topmost ear height (cm)	Stem diameter (cm)	Leaf area of topmost ear (cm^2)	Plants with double ears (%)
		Tasseling	Silking					
N levels (Kg/fed.)	First season 1999							
0	0.31×10^7	58.81	62.13	196.61	95.44	1.57	472.52	8.75
60	1.03×10^7	56.69	58.88	239.13	118.80	1.85	574.61	14.56
90	0.78×10^7	56.00	58.56	231.55	113.89	2.03	531.40	24.95
120	0.56×10^7	56.31	57.81	241.76	125.25	1.93	553.53	32.16
L.S.D. at 0.05	1.09	0.79	0.89	6.81	4.30	0.06	28.66	3.19
	Second season 2000							
0	0.42×10^7	59.31	62.31	231.41	125.32	1.53	643.82	9.99
60	1.37×10^7	56.75	59.06	281.46	155.99	1.80	782.91	16.64
90	1.04×10^7	56.13	58.69	272.54	149.54	1.98	724.04	28.50
120	0.73×10^7	56.44	57.94	284.55	164.46	1.88	754.18	36.73
L.S.D. at 0.05	1.06	0.87	0.89	8.01	5.65	0.06	39.05	3.56

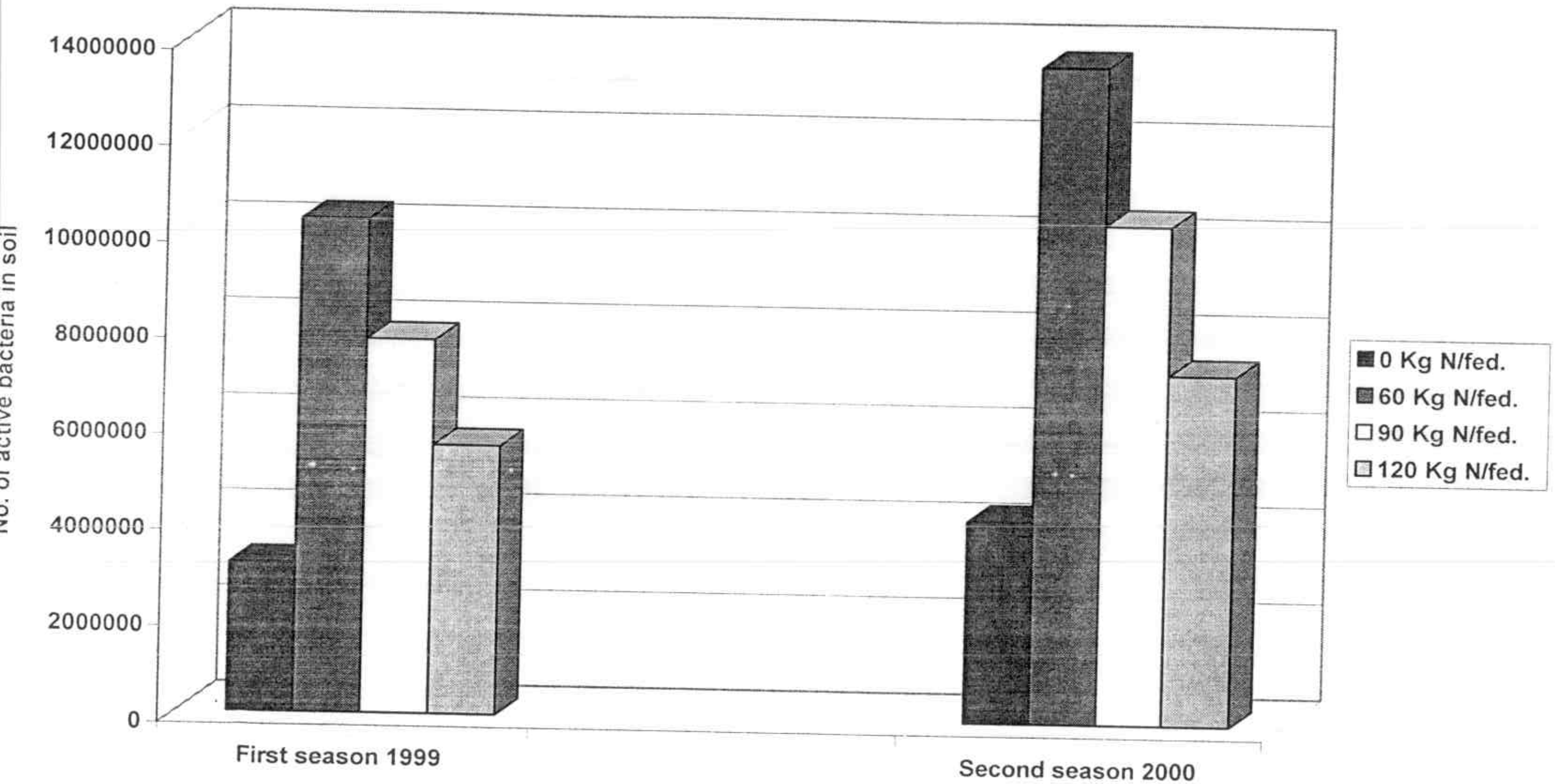

Fig. (8): Effect of N levels on number of active bacteria in soil (rhizosphere zone) of maize in 1999 and 2000 seasons.

stated that N-fertilizer was required to enhance the response to inoculation with Azospirilla. Application of rather high of N-fertilizers (105 Kg N/fed.) limited positive response (Abo-Taleb, 1991). El-Kholy (1993), reported that, at all growth stages, the stimulative nitrogen dose tended to increase the number of *Azospirillum lipoferum* and *Azotobacter sp.* bacteria.

II. Growth characters after 75 days from planting.

Results in Table (17) indicate clearly that growth characters of maize plants were significantly responsive to increasing nitrogen fertilizer up to the heaviest level. Nevertheless, deviation in this trend was observed in case of plant height, topmost ear height and leaf area of topmost ear where, values of these traits when maize was fertilized with 90 Kg N/fed. was relatively lower than when plants received 60 Kg N/fed.. Plant height increased with increasing nitrogen fertilization up to 120 Kg N/fed. in both seasons. The increases were 21.63, 17.77 and 22.96% in the first season for 60, 90 and 120 Kg N/fed. respectively without significant differences among the three mentioned treatments. In the second season, increasing nitrogen level from 0 to 60, 90 and 120 Kg N/fed. caused an increases of 21.63, 17.77 and 22.96% without significant differences between 60 and 120 Kg N/fed..

Topmost ear height increases were 24.48, 19.33 and 31.23% due to 60, 90 and 120 Kg N/fed. levels respectively in the first season and 24.47, 19.33 and 31.33% respectively in the second season. The differences among 60, 90 and 120Kg N/fed. were significant increase with the increase in nitrogen application up to 120 Kg N/fed.

Concerning stem diameter, there was a consistent increase with the increase in nitrogen application up to 120 Kg N/fed.. The increases were 17.83, 29.30 and 22.93% in the first season and 17.65, 29.41 and 22.88% in the second season respectively due to 60, 90 and 120 Kg N/fed.

LA of topmost ear increased with the increase in nitrogen application up to 120 Kg N/fed. but the highest value was recorded on plant fertilized with 60 Kg N/fed. in both seasons further increase in nitrogen application caused a reduction in LA of topmost ear.

Plants with double ears increased consistently with increasing nitrogen fertilizer level up to the heaviest in both seasons. There increases were 5.81, 16.20 and 23.41 in the first season and 6.65, 18.51 and 26.74 in the second season from 0 to 60, 90 and 120 Kg N/fed., respectively.

However, it is interesting to note that increasing nitrogen fertilizer level up to the heaviest level (120 Kg/fed.) increased percent of plant with double ear about four fold in both seasons. This stimulative effect of nitrogen on growth traits of maize was supported by Sahar-Sherif (1993).

The beneficial effect of nitrogen is attributed to the stimulative effect of nitrogen to stimulate meristimatic activites due to its important role in nucleic acid and protein synthesis which in turn result in increased dry matter and cell formation.

Results of days to 50% tasseling and silking revealed that increasing nitrogen fertilizer level decreased number of days to both tasseling and silking. These results were observed in both seasons. It seemed that nitrogen fertilizer effect extended to the reproductive phase and that with increasing nitrogen fertilizer level maize plants transferred to the reproductive phase more earlier than those unfertilized. Early tasseling was recorded in plants fertilized with 90 Kg N/fed. whereas early silking was in those given 120 Kg N/fed..

3. Effect of Azospirilla inoculation on :

I. Number of active bacteria in maize root rhizosphere.

Results in Table (18) and Fig. (9) revealed that the average number of Azospirilla in maize root rhizosphere increased with artificial inoculation with Azospirilla inocula. The increases over the untreated treatment were estimated to as much as 2033 and 2025% in 1999 and 2000 seasons, respectively. These results are in accordance with those obtained by Abo-Taleb (1991), El-Kholy (1993) and Zaghloul et al (1996).

II. Growth characters after 75 days from planting.

Plant height, topmost ear height, stem diameter, leaf area of topmost ear and plants with double ears were significantly affected by inoculating with the associative N_2-fixer bacteria in both seasons (Table 18). Inoculation with Azospirilla had a favourable effects on these traits. The percent increases in these traits due to inoculating with Azospirilla were estimated to 7.21, 7.49, 5,4.21 and 18.41% in 1999 season and 7.21, 7.49, 4.55, 4.21 and 18.40% in 2000 season for the same respective traits. These results were reported by several investigators such as El-Hosieny and Rabie (1979), Hegazi *et al* (1982), Saleh *et al* (1986), Abo-Taleb (1991), Rohitashav *et al* (1993) El-Kholy

Table (18): Effect of bacterial inoculation on number of active bacteria in soil (rhizosphere zone), number of days to 50% tasseling, silking and growth characters of maize in 1999 and 2000 seasons.

Characters / Treatments	No. of active bacteria in soil	No. of days to 50%		Plant height (cm)	Topmost ear height (cm)	Stem diameter (cm)	Leaf area of topmost ear (cm^2)	Plants with double ears (%)
		Tasseling	Silking					
Bacterial inoculation	First season 1999							
Uninoculated	0.06×10^7	57.16	59.88	219.36	109.25	1.80	522.02	18.41
Inoculated	1.28×10^7	56.75	58.91	235.17	117.43	1.89	544.01	21.80
L.S.D. at 0.05	1.06	N.S	0.63	4.81	3.04	0.04	20.27	2.25
	Second season 2000							
Uninoculated	0.08×10^7	57.38	60.00	258.19	143.45	1.76	711.26	21.03
Inoculated	1.70×10^7	56.94	59.00	276.80	154.20	1.84	741.22	24.90
L.S.D. at 0.05	1.05	N.S	0.63	5.67	3.99	0.04	27.61	2.52

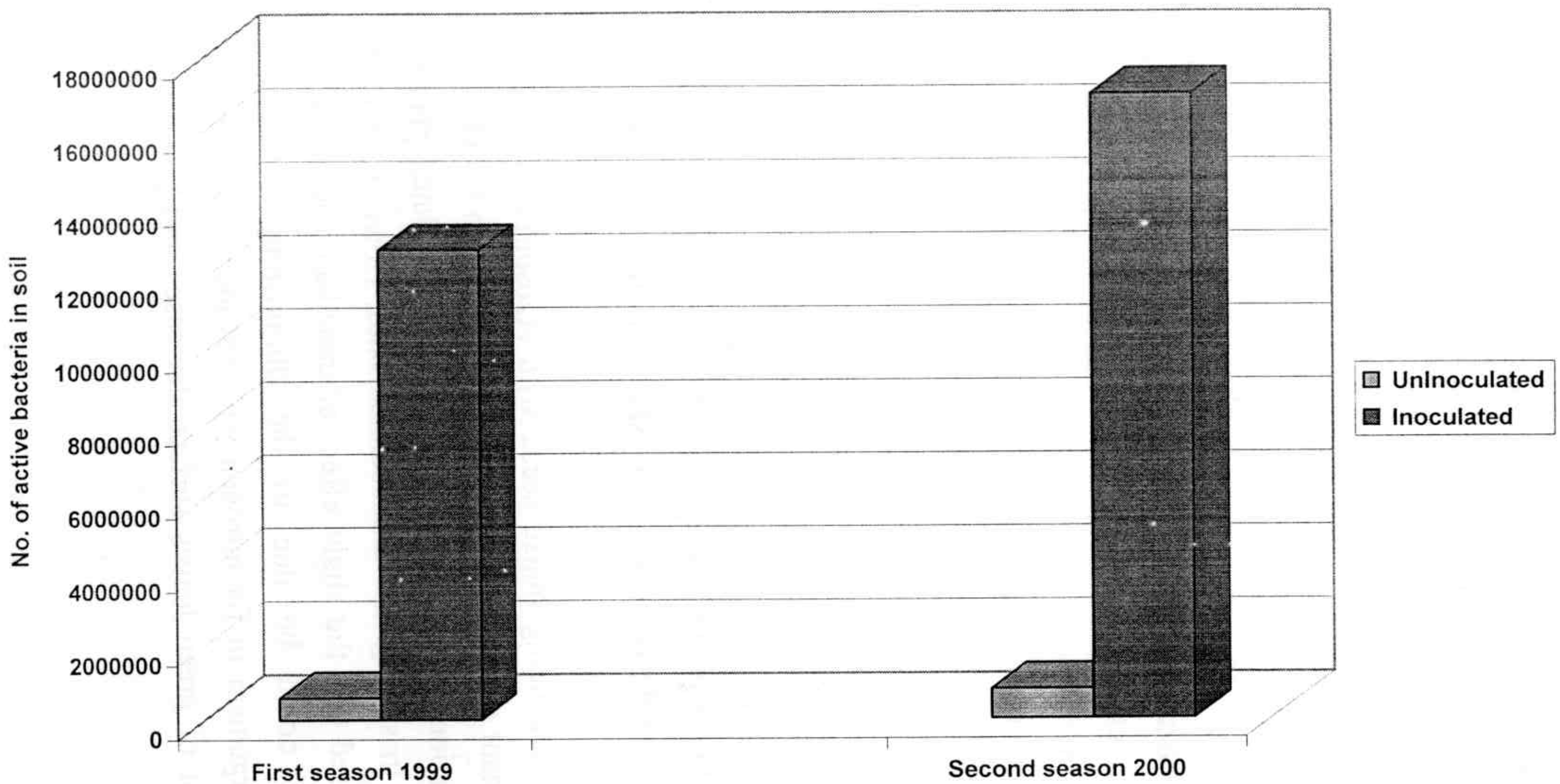

Fig. (9): Effect of bacteria inoculation on number of active bacteria in soil (rhizosphere zone) of maize in 1999 and 2000 seasons.

(1993), Fulchieri and Frioni (1994), Abdel-Gawad *et al* (1995-a). However El-Kholy (1993), stated that inoculation with *Azospirilla sp.* seemed to be coupled with beneficial effect for most vegetative growth criteria. Many investigators studied the physiology and function of Azospirilla to fix nitrogen. Primarily, the function of Azospirilla might owe much to fixation of molecular nitrogen. The ability of the microorganism to synthesize auxins, vitamins, growth substances and antifungal antibiotics confer it with additional advantages. The over all reaction in the enzymic reduction of atmospheric nitrogen to ammonia could be stated as follows:

$$\underset{\text{(Dinitrogen)}}{N_2} \xrightarrow[2e]{2H^+} \underset{\text{(Diamide)}}{HN{=}NH} \xrightarrow[2e]{2H^+} \underset{\text{(Hydrazine)}}{H_2N\text{-}NH_2} \xrightarrow[2e]{2H^+} \underset{\text{(Ammonia)}}{2NH_3}$$

Electrons are needed to reduce N_2 to NH_3 and it has been calculated that 12 molecules of ATP are needed for reducing one molecule of N_2 to 2 molecules of ammonia. The electrons pass through nitrogenase and N_2 to NH_3 (Fortell, 1968, Postage 1971, 1974).

Inoculating maize seeds with Azospirillum inocula had significant effect on silking but insignificant on tasseling. These observations hold true in both seasons. Inoculated plants were earlier in silking that uninoculated ones. However, it could be concluded that the slight effect of inoculating with Azospirilla inocula could be due to the diminishing effect of the microorganism to fix nitrogen with advancing plant age where the area of green leaves surface decreases and photosynthesis decline and N-fixation through nitrogenase needs was also diminished.

4. Effect of interaction of nitrogen fertilizer level and cropping system on :

I. Azospirilla count in maize root rhizosphere.

The interaction effect on Azospirilla count in maize root rhizosphere was governed by both main factors of the interaction (Table 19). Nitrogen application of 60 Kg N/fed. resulted in activation of Azospirilla count, thereafter, a slow down in number of Azospirilla was observed due to the increase in nitrogen up to 90 and 120 Kg N/fed.. These results hold true in both seasons, and were congruent when maize was grown in pure stand or intercropped with soybean. From another angle of results values of maize grown in pure stand were ever higher than those recorded for the intercropped plants under same respective level of nitrogen fertilizer. However, number of active azospirilla reached maximals (1.14×10^7 and 1.52×10^7) when maize was grown in pure stand and received 60 Kg N/fed.. Intercropped maize received the same level of nitrogen fertilizer ranked the second. Whereas Azospirilla count reached minimal (0.29×10^7 and 0.39×10^7) when maize was grown soley and received no nitrogen. Intercropped maize with the same level of nitrogen fertilizer (nil) ranked above the minimum.

II. Growth characters after 75 days from planting.

Results in Table (19), revealed that values of growth traits, i.e., plant height, topmost ear height, stem diameter, leaf area of topmost ear and plants with double ears of pure stand

Table (19): Effect of interaction between cropping system and N levels on number of active bacteria in soil (rhizosphere zone), number of days to 50% tasseling, silking and growth characters of maize in 1999 and 2000 seasons.

Treatments	Characters	No. of active bacteria in soil	No. of days to 50%		Plant height (cm)	Topmost ear height (cm)	Stem diameter (cm)	Leaf area of topmost ear (cm^2)	Plants with double ears (%)
			Tasseling	Silking					
	N levels (Kg/fed.)	First season 1999							
Intercropping	0	0.29×10^7	57.75	61.38	193.12	92.25	1.54	454.93	8.14
	60	0.92×10^7	56.50	58.75	233.12	115.67	1.81	567.93	13.92
	90	0.67×10^7	55.88	58.38	229.39	112.41	2.02	526.80	23.88
	120	0.48×10^7	56.13	57.50	237.39	123.24	1.92	550.21	31.53
Pure stand	0	0.33×10^7	59.88	63.25	200.10	98.63	1.60	490.12	9.37
	60	1.14×10^7	56.88	59.00	245.14	121.93	1.89	581.28	15.20
	90	0.89×10^7	56.13	58.75	233.71	115.36	2.05	536.00	26.03
	120	0.64×10^7	56.50	58.13	246.12	127.26	1.94	556.85	32.78
L.S.D. at 0.05		1.13	1.11	1.26	9.63	6.08	0.08	40.53	4.51
		Second season 2000							
Intercropping	0	0.39×10^7	58.13	61.38	227.31	121.14	1.51	619.84	9.29
	60	1.23×10^7	56.63	59.00	274.39	151.88	1.77	773.82	15.89
	90	0.89×10^7	55.88	58.38	270.00	147.60	1.97	717.78	27.24
	120	0.62×10^7	56.25	57.63	279.41	161.82	1.87	749.66	35.97
Pure stand	0	0.45×10^7	60.50	63.25	235.52	129.50	1.56	667.80	10.71
	60	1.52×10^7	56.88	59.13	288.54	160.10	1.84	792.00	17.38
	90	1.19×10^7	56.38	59.00	275.08	151.48	2.00	730.30	29.77
	120	0.84×10^7	56.63	58.25	289.69	167.10	1.90	758.71	37.49
L.S.D. at 0.05		N.S	1.22	1.25	11.33	7.99	0.08	55.22	5.04

maize were relatively higher than those recorded for the intercropped plants under any nitrogen level. These values increased with increasing nitrogen level with exception when maize received 90 Kg N/fed. where values slightly reduced as compared with the maize received only 60 Kg N/fed. In case of plant height, topmost ear height and leaf area of topmost ear and when maize received 120 Kg N/fed.. Sahar-Sherif (1993) obtained similar results on growth characters of maize when maize was intercropped with soybean under different levels of N fertilizer. The interaction effect of nitrogen level with cropping system had also significant effect on number of days to 50% tasseling and silking. Interplanted plants fertilized by 90 Kg N/fed. were the earliest in tasseling. On other hand, number of days to 50% silking decreased consistently with increasing nitrogen fertilizer level up to the heaviest (120 Kg N/fed.) in both seasons whether plants were grown in pure stand on intercropped with soybean. The earliest silking plants were those intercropped and given 120 kg N/fed.. Values obtained from pure stand maize were relatively higher than those recorded for intercropped plants under same respective levels of nitrogen fertilizer. Reduction in the values of both traits with increasing nitrogen fertilizer level is plausible, since, the role of nitrogen in enhancing growth stages is not arguable and has been reported by mumerous investigators.

5. **Effect of interaction of cropping system and inoculating maize with azospirilla on :**

I. **Number of active Azospirilla.**

Results in Table (20) revealed that inoculating maize grains with Azospirilla had an activating effect on Azospirilla count in maize root rhizosphere under the two cropping system. On other hand, pure stand maize had also more number of active Azospirilla rather than maize grown in the intercrop. It is worthy mentioning that inoculating maize grain with Azospirilla increased the number of active bacteria by 853 and 1810% over the untreated maize plants grown in pure stand and by 2181 and 2043% over the untreated maize plants grown in association with soybean plants in 1999 and 2000 seasons respectively.

II. **Growth characters after 75 days from planting.**

The interaction effect of cropping system with inoculating maize with Azospirilla on growth characters of maize was also governed by the trends of both variables when behaved individually. Values of plant height, topmost ear height, stem diameter, leaf area of topmost ear and percent of plants with double ears of maize grown in pure stand were relatively higher than those grown in association with soybean at any level of inoculation. These observations hold fairly true in both seasons Table (20). Maize plants grown alone and inoculated with Azospirilla gave the highest values of plant height, topmost ear height, stem diameter, leaf area of topmost ear and plants with double ears percentage.

Table (20): Effect of interaction between cropping system and bacterial inoculation on number of active bacteria in soil (rhizosphere zone), number of days to 50% tasseling, silking and growth characters of maize in 1999 and 2000 seasons.

Treatments	Characters	No. of active bacteria in soil	No. of days to 50%		Plant height (cm)	Topmost ear height (cm)	Stem diameter (cm)	Leaf area of topmost ear (cm^2)	Plants with double ears (%)
			Tasseling	Silking					
	Bacterial inoculation	First season 1999							
Intercropping	Uninoculated	0.05×10^7	56.81	59.63	214.56	106.84	1.77	514.63	17.60
	Inoculated	1.14×10^7	56.31	58.38	231.95	114.94	1.87	535.31	21.14
Pure stand	Uninoculated	0.15×10^7	57.50	60.13	224.15	111.66	1.84	529.41	19.22
	Inoculated	1.43×10^7	57.19	59.44	238.39	119.93	1.90	552.71	22.47
L.S.D. at 0.05		N.S	0.79	0.89	6.81	4.30	0.06	28.66	3.19
		Second season 2000							
Intercropping	Uninoculated	0.07×10^7	57.00	59.69	252.55	140.29	1.73	701.18	20.08
	Inoculated	1.50×10^7	56.44	58.50	273.01	150.93	1.83	729.36	24.11
Pure stand	Uninoculated	0.10×10^7	57.75	60.31	263.83	146.62	1.79	721.33	21.98
	Inoculated	1.91×10^7	57.44	59.50	280.59	157.47	1.86	753.07	25.70
L.S.D. at 0.05		1.06	0.87	0.89	8.01	5.65	0.06	39.05	3.56

These results seemed cogent and easy to explain, since, intercropping creates more competitive pressure whether inter or intra on maize plants which resulted in these reductions. These results were supported by Khalil (1995) and El-Douby *et al* (1996). From another angle of results growth traits of inoculated maize grain with Azospirilla were superior to those recorded on the untreated maize. The results were also supported by several investigators such Salmeron *et al* (1990), Fulchieri *et al* (1993) and Lippmann *et al* (1995).

The beneficial effect of inoculating maize with Azospirilla has been interpreted by several investigators. Salmeron *et al* (1990) studied the effect of symbiotic N-fixing bacteria. They revealed that these micro-organisms, produce auxin, gebberellins and cytokinnins. The studies of Yadav *et al* (1992), also revealed that inoculating maize genotypes with *A. lipoferum* resulted in enhancing nitrogenase activity. Lippmann *et al* (1995), studied the influence of auxin producing rhizobacteria on root morphology and nutrient accumulation of crops and the changes in root morphology. They revealed that inoculation with effective strains resulted in increased concentrations of P, Fe and Zn in the roots. The action of the bacteria was comparable to that of treatment with IAA which stimulated the lateral root production of the primary root and of the mesocotyle root and resulted in higher root concentrations of P and Fe in comparison with control plants. The effect of inoculation with bacteria on root growth were reflected in the shoot growth of maize plants. The concentration of the nutrients Ca, K, Mg, P, Fe and Zn in roots of treated plants exceeded those of the untreated plants. Fulchieri *et al* (1993), also indicated that inoculation with *Azospirillum lipoferum* affects growth and gibberellin status of maize roots. Anita- Pandey *et al* (1998) revealed stimulation of some of the natives beneficial groups of micro-organisms during the middle of growing period of maize. They concluded that this observed effect of seed inoculation on plant growth may in part be due to the stimulation of already existing plant growth promoting rhizobacteria in and around roots.

The results also revealed that the number of days to 50% tasseling and silking were statistically influenced by the interaction effect. Tasseling as well as silking when maize plants were inoculated with Azospirilla were enhanced and appeared earlier as compared with plants left without inoculation. These observations hold true in both pure stand and intercropped maize in both seasons. This observation seemed cogen and could be attributed to the beneficial effect of inoculating maize on growth and plant development. The results of Garcia-de–Salomone and Dobereiner (1996) are coincided with these observations. They found significant inoculation effects on leaf nitrate reductase activity at the flowering stage, observed in the range of 55% to 176% according to Azospirilla strain. Values of the pure stand maize were relativey higher than those grown in association with soybean under the same respective status of inoculation. Intercropped inoculated plants were the earliest in tasselling and silking in both seasons. The result is also plausible and could be explained as maize plants in association transferred to the reproductive phase more rapid than the pure stand plants.

6. The interaction effect of nitrogen fertilizer levels and inoculation with Azospirilla on :

I. Number of active bacteria in the soil.

The number of active bacteria as influenced by the interaction effect of nitrogen level and inoculating maize seeds with Azospirilla inoculum followed a distinctive pattern of change Table (21). Number of active bacteria in the soil increased up to 60 Kg N/fed., whether plants inoculated or uninoculated thereafter a slow down was observed. On other hand, all values of inoculated maize treatments exceeded the untreated maize treatments under any level of nitrogen. These results hold true in both seasons. The trend of nitrogen level component in the interaction seemed to be like switch mechanism where optimum level to reach azospirilla count at maximal was 60 Kg N/fed. in inoculated plants, thereafter a decline was observed. Several investigators reached the same results such as Abo-Taleb (1991), Stancheva and Dinev (1992), Yadav *et al* (1992) and El-Kholy (1993). They all emphasized that the associative N_2 fixer bacteria activity reached maximal with low level of nitrogen fertilizer level (starter with small dose of N). On other hand, the sharp increase in Azospirilla count due to artificial inoculation with the bacteria reflects the scarcity of soil by these microorganisms.

II. Growth characters after 75 days from planting.

Results in Table (21) indicated that plant height, topmost ear height and leaf area of the topmost ear followed the general trend of both components of the interaction when behaved individually, i.e., values of these traits gradually increased up to

Table (21): Effect of interaction between N levels and bacterial inoculation on number of active bacteria in soil (rhizosphere zone), number of days to 50% tasseling, silking and growth characters of maize in 1999 and 2000 seasons.

Treatments: N levels (Kg/fed.)	Bacterial inoculation	No. of active bacteria in soil	No. of days to 50%: Tasseling	No. of days to 50%: Silking	Plant height (cm)	Topmost ear height (cm)	Stem diameter (cm)	Leaf area of topmost ear (cm^2)	Plants with double ears (%)
		First season 1999							
0	Uninoculated	0.01×10^7	59.13	63.25	178.70	85.64	1.46	449.98	6.54
	Inoculated	0.62×10^7	58.50	61.38	214.51	105.24	1.69	495.07	10.96
60	Uninoculated	0.16×10^7	56.88	59.25	234.45	117.78	1.82	567.88	13.30
	Inoculated	1.90×10^7	56.50	58.50	243.82	119.82	1.88	581.34	15.83
90	Uninoculated	0.06×10^7	56.13	59.00	227.15	111.10	2.02	529.64	23.78
	Inoculated	1.50×10^7	55.88	58.13	235.95	116.68	2.05	533.16	26.12
120	Uninoculated	0.02×10^7	56.50	58.00	237.13	122.49	1.92	540.58	30.01
	Inoculated	1.12×10^7	56.13	57.63	246.39	128.01	1.94	566.47	34.30
L.S.D. at 0.05		1.13	1.11	1.26	9.63	6.08	0.08	40.53	4.51
		Second season 2000							
0	Uninoculated	0.01×10^7	59.75	63.25	210.34	112.45	1.42	613.11	7.48
	Inoculated	0.83×10^7	58.88	61.38	252.49	138.19	1.65	674.53	12.52
60	Uninoculated	0.21×10^7	56.88	59.50	275.95	154.65	1.78	773.74	15.20
	Inoculated	2.53×10^7	56.63	58.63	286.98	157.33	1.83	792.08	18.08
90	Uninoculated	0.08×10^7	56.25	59.13	267.36	145.88	1.97	721.64	27.17
	Inoculated	2.00×10^7	56.00	58.25	277.72	153.20	2.00	726.44	29.84
120	Uninoculated	0.02×10^7	56.63	58.13	279.10	160.84	1.87	736.54	34.28
	Inoculated	1.44×10^7	56.25	57.75	290.00	168.08	1.90	771.83	39.18
L.S.D. at 0.05		1.09	1.23	1.25	11.33	7.99	0.08	55.22	5.04

60 Kg N/fed. in inoculated and uninoculated plants, then a slow down was observed. These observations hold true in both seasons. The highest values of these traits were recorded in inoculated maize plants fertilized with 120 kg N/fed. except leaf area which gave the highest value with 60 Kg N/fed. in inoculated plants. However the effect of nitrogen fertilizer level and inoculation with the associative N_2-fixer Azospirilla was studied by several investigators which were coincided with these results. (Bashan *et al* 1990, Abo-Taleb 1991, El-Kholy 1993, El-Demerdash 1994, Lippmann *et al* 1995). Abo-Taleb (1991) stated that in the absence of N-fertilizer, inoculation with rhizospheric micro-organisms (R.M.O) introduced as associative N_2-fixers or rhizobia did increase the growth. N-fertilization with moderate level dose, i.e., 60 Kg N/fed. supported better establishment and beneficial effect of associative N_2 fixers such increases of 43%. High dose of N (200 Kg N/fed.) did limit the beneficial effect of introduced microorganisms to growth increases of 10-14%. Fayez *et al* (1985) showed that higher level of nitrogen depressed the response to inoculation with Azospirilla. El-Borollosy *et al* (1986) also found that growth of maize plants expressed as plant height, number of leaves per plant and dry weight significantly increased by inoculation with a mixture of *Azospirillum lipoferum* . They attributed this increase to the available nitrogen supplemented by the inoculated organism due to its high N_2-fixation activity. Saleh *et al* (1986) also revealed that Azospirilla stimulated maize grown by increasing nitrogenase activity in soil rhizosphere of maize. Reiad *et al* (1987), also showed that the dry weight of blades was

higher when maize plants were inoculated with a mixture of Azotobacter and Azospirillum and fertilized with 90 Kg N/fed.. El-Kholy (1993), also demonstrated that the small amount of N fertilizer increased significantly plant height and blade area.

On other hand, the results revealed that the trend of change was more regular in case of stem diameter and the percent of plants with double ears in both season. Values of both traits gradually increased with increasing nitrogen fertilizer level up to the heaviest in case of the percent of plants with double ears and only to 90 Kg N/fed. in case of stem diameter whether maize was inoculated with Azospirillum or left without inoculation. The highest values of both traits were the highest when maize was inoculated with the inoculum and given 90 kg N/fed. in stem diameter and 60 Kg N/fed. in plants with double eares percent.

Results obtained on number of days to 50% tasseling and silking revealed that there were gradual decreases to its lower value in number of days to 50% tasseling or silking with increasing nitrogen fertilizer level up to the heaviest (120 Kg N/fed.) but only to 90 Kg N/fed. in case of tasseling. Tassel or silk emerged earlier when plants were inoculated with azospirilla and given 90 and 120 Kg N/fed. respectively.

7. **The interaction effect of cropping system, nitrogen fertilizer level and inoculation with Azospirilla on :**

I. Number of active bacteria.

Number of active bacteria was significantly affected by the interaction among the three factors (Table 22). Inoculation

Table (22): Effect of interaction among cropping system, N levels and bacterial inoculation on number of active bacteria in soil (rhizosphere zone), number of days to 50% tasseling, silking and growth characters of maize in 1999 and 2000 seasons.

Treatments		Characters	No. of active bacteria in soil	No. of days to 50%		Plant height (cm)	Topmost ear height (cm)	Stem diameter (cm)	Leaf area of topmost ear (cm^2)	Plants with double ears (%)
	Nlevels (Kg/fed.)	Bacterial inoculation		Tasseling	Silking					
			First season 1999							
Inter cropping	0	Uninoculated	0.01×10^7	58.25	62.75	173.91	83.71	1.43	430.98	5.57
		Inoculated	0.57×10^7	57.25	60.00	212.33	100.80	1.66	478.88	10.70
	60	Uninoculated	0.12×10^7	56.75	59.25	227.43	114.48	1.76	561.46	12.03
		Inoculated	1.72×10^7	56.25	58.25	238.82	116.87	1.86	574.41	15.82
	90	Uninoculated	0.05×10^7	56.00	58.75	225.22	110.36	2.00	525.79	23.09
		Inoculated	1.30×10^7	55.75	58.00	233.57	114.46	2.04	527.82	24.67
	120	Uninoculated	0.01×10^7	56.25	57.75	231.70	118.83	1.89	540.29	29.72
		Inoculated	0.95×10^7	56.00	57.25	243.08	127.65	1.94	560.13	33.34
Pure stand	0	Uninoculated	0.01×10^7	60.00	63.75	183.50	87.57	1.49	468.99	7.51
		Inoculated	0.66×10^7	59.75	62.75	216.69	109.68	1.71	511.26	11.22
	60	Uninoculated	0.20×10^7	57.00	59.25	241.48	121.09	1.88	574.30	14.58
		Inoculated	2.08×10^7	56.75	58.75	248.82	122.77	1.90	588.26	15.83
	90	Uninoculated	0.08×10^7	56.25	59.25	229.08	111.83	2.04	533.49	24.48
		Inoculated	1.70×10^7	56.00	58.25	238.34	118.89	2.05	538.51	27.57
	120	Uninoculated	0.02×10^7	56.75	58.25	242.56	126.16	1.94	540.87	30.31
		Inoculated	1.26×10^7	56.25	58.00	249.69	128.36	1.95	572.82	35.26
L.S.D. at 0.05			1.19	1.57	1.78	13.62	8.60	0.11	57.32	6.37

Table (22): Cont.

Treatments		Characters	No. of active bacteria in soil	No. of days to 50% Tasseling	No. of days to 50% Silking	Plant height (cm)	Topmost ear height (cm)	Stem diameter (cm)	Leaf area of topmost ear (cm^2)	Plants with double ears (%)
	Nlevels (Kg/fed.)	Bacterial inoculation	Second season 2000							
Inter cropping	0	Uninoculated	0.01×10^7	58.75	62.75	204.69	109.92	1.39	587.21	6.36
		Inoculated	0.77×10^7	57.50	60.00	249.92	132.35	1.62	652.47	12.21
	60	Uninoculated	0.17×10^7	56.75	59.50	267.69	150.31	1.72	764.99	13.72
		Inoculated	2.28×10^7	56.50	58.50	281.09	153.45	1.81	782.64	18.06
	90	Uninoculated	0.07×10^7	56.00	58.75	265.09	144.91	1.95	716.39	26.34
		Inoculated	1.71×10^7	55.75	58.00	274.91	150.29	1.99	719.16	28.15
	120	Uninoculated	0.02×10^7	56.50	57.75	272.71	156.03	1.84	736.14	33.90
		Inoculated	1.22×10^7	56.00	57.50	286.11	167.61	1.89	763.18	38.03
Pure stand	0	Uninoculated	0.01×10^7	60.75	63.75	215.98	114.98	1.45	639.00	8.59
		Inoculated	0.89×10^7	60.25	62.75	255.05	144.02	1.67	696.59	12.83
	60	Uninoculated	0.25×10^7	57.00	59.50	284.20	158.99	1.83	782.49	16.67
		Inoculated	2.78×10^7	56.75	58.75	292.87	161.20	1.85	801.51	18.09
	90	Uninoculated	0.10×10^7	56.50	59.50	269.63	146.84	1.99	726.88	28.00
		Inoculated	2.29×10^7	56.25	58.50	280.53	156.11	2.00	733.72	31.53
	120	Uninoculated	0.02×10^7	56.75	58.50	285.49	165.65	1.89	736.94	34.66
		Inoculated	1.66×10^7	56.50	58.00	293.89	168.54	1.90	780.47	40.32
L.S.D. at 0.05			N.S	1.73	1.77	16.03	11.29	0.11	78.10	7.13

with Azospirilla raised the number of active bacteria under any level of nitrogen fertilizer whether maize was grown in pure stand or in association with soybean. The increases were estimated to 0.56×10^7, 1.60×10^7, 1.25×10^7 and 0.94×10^7 and 0.76×10^7, 2.11×10^7, 1.64×10^7 and 1.20×10^7 over the untreated maize when plants were grown in association with soybean in 1999 and 2000 seasons respectively and estimated to 0.65×10^7, 1.88×10^7, 1.62×10^7 and 1.24×10^7 and 0.88×10^7, 2.53×10^7, 2.19×10^7 and 1.64×10^7 when maize plants were grown in pure stand in 1999 and 2000 seasons, respectively.

The results also indicated that Azospirillum number increased with increasing the level of nitrogen fertilizer up to 60 Kg N/fed. then a slow down was observed till 120 Kg N/fed. was applied. This trend was observed whether maize was grown in pure stand or in association with soybean and in the inoculated maize and uninoculated maize either.

Maximum record was associated with maize grown in pure stand and received 60 Kg N/fed. and inoculated with Azospirilla, whereas, the minimum was associated with maize grown in the intercrop and received no nitrogen and was left untreated with the inocula. Difference between both treatments was estimated to 2.07×10^7 and 2.77×10^7 in 1999 and 2000 seasons respectively.

II. Growth character of maize after 75 days from planting.

The effect of the interaction among the three main variables, i.e., cropping system, inoculation with Azospirilla and nitrogen fertilization level followed the general tendency of the three main variables when behaved individually. Results on maize height, topmost ear height and leaf area of topmost ear revealed that the values of these traits increased with adding the first 60 Kg N/fed., thereafter, a slowdown was observed then, a rather increase was observed when the heaviest level was applied. These results hold true in both seasons under pure stand system or in association with soybean and whether maize seeds were artificially inoculated with Azospirilla or left untreated without inoculation. Moreover, the results revealed significant differences among the treatment imposed. The interpretation of this distinctive pattern of change probably lies in the fact that while nitrate reductase activity increased with N application, it was increased by Azospirillum at low levels. Both opposing trends, probably inhibit parallism. The tallest plants, and highest topmost ear highest were produced by inoculated pure stand plants fertilized with 120 Kg N/fed.. The highest leaf area of topmost ear was recorded in inoculated pure stand plants given 60 kg N/fed..

On other hand, values of stem diameter increased with increasing nitrogen level up to 90 Kg N/fed., then a slow down was observed whether plants were grown alone or associated with soybean under the two inoculation treatments.

In concern with percent of plants with double ear, parallel increase in the values of this trait was associated with increasing nitrogen fertilizer level up to the heaviest dose, i.e., 120 Kg N/fed.. These results were observed under any treatment of inoculation or cropping system. Inoculated maize plants grown in pure stand and fertilized with 120 kg N/fed. produced the highest percentage of plants with double ears. This result has been previously explained by Fulchieri *et al* (1993), who indicated that *Azospirillum sp* affects growth through altering the level of gibberellin status.

The interaction effect on the number of days to 50% tasseling or silking was also significant. Inoculated maize plants intercropped with soybean were the earliest in tasseling and silking when plants were fertilized with 90 and 120 Kg N/fed. respectively. Probably the higher competitive pressure exerted due to intercropping was the cause and effect to reduce growth period and stimulate maize plant to the reproductive phase more earlier.

B. Yield and yield components of maize.

1. Effect of cropping system.

Results in Table (23) and Fig. (10) revealed that ear length, ear diameter, number of rows/ear, 100-kernel weight and shelling percent were insignificantly influenced by the cropping system. These observation hold true in both seasons. Nevertheless, values of these traits of pure stand maize were relatively higher than those recorded in case of intercropped maize. Number of kernels/row, ear weight and kernels weight/ear followed the same trend but with significant differences in favour of pure stand maize in 1999 season and with insignificant differences in 2000 season. In 1999, these traits of pure standing surpassed that of intercropped by 12.42, 14.02 and 14.24% respectively. The deleterious effect of intercropping on yield component of maize when intercropped with soybean have been reported by several investigators Galal

Table (23): Effect of cropping system on yield and yield components of maize in 1999 and 2000 seasons.

Characters / Treatments	Ear length (cm)	Ear diameter (cm)	No. of rows /ear	No. of kernels /row	Ear weight (g)	Kernels weight /ear (g)	100-kernel weight (g)	Shelling (%)	Grain yield (ton/fed.)	Straw yield (ton/fed.)	Biological yield (ton/fed.)	Oil (%)	Crude protein (%)
	First season 1999												
Intercropping	19.64	4.31	12.00	33.83	167.14	144.20	35.15	86.24	2.60	3.26	5.86	3.99	7.96
Pure stand	19.87	4.34	12.14	38.03	190.57	164.74	35.64	86.43	4.00	4.57	8.57	4.38	8.38
L.S.D. at 0.05	N.S	N.S	N.S	1.14	8.90	7.59	N.S	N.S	0.17	0.20	0.37	0.07	0.08
	Second season 2000												
Intercropping	20.31	4.80	12.72	38.64	203.29	175.52	35.68	86.30	3.24	3.66	6.90	4.18	8.34
Pure stand	20.55	4.83	12.87	38.70	208.34	180.23	36.18	86.50	4.49	5.10	9.59	4.59	8.78
L.S.D. at 0.05	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	0.20	0.22	0.42	0.08	0.09

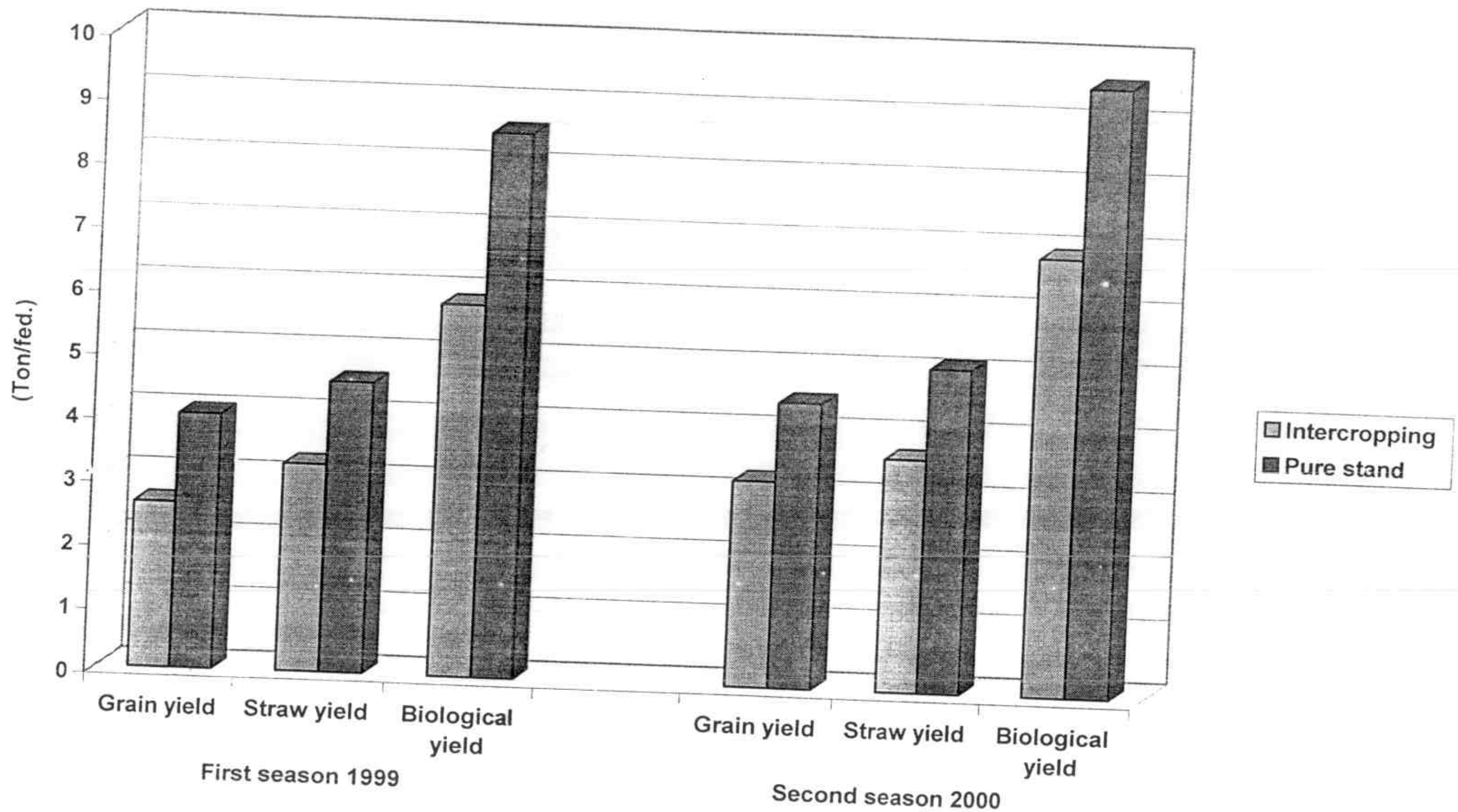

Fig. (10): Effect of cropping system on yield of maize in 1999 and 2000 seasons.

and Metwally (1982) revealed detrimenal effect on yield components of maize. Khedr (1982), found that intercropping significantly decreased shelling percent, ear diameter, number of kernels/row, kernels weight/ear and weight of 100-kernels. El-Douby (1992) and Sahar-Sherif (1993) Came to similar results.

Results on yield of maize followed the general trend of yield components, i.e., intercropping had significant diminshing effects on grain, straw and biological yields/fed.. These results hold true in both seasons. Reductions in yield parameters of maize intercropped with soybean estimated to 35.00, 28.67 and 31.62% in 1999 and 27.84, 28.24 and 28.05% in 2000 season. These results were explained as due to the higher competitive pressure due to more dense population per unit of land. Several investigators came to similar result and conclusion such as Gunanseva *et al* (1979), El-Douby (1992) and Sahar-Sherif (1993).

The effect of cropping system on crude protein and oil percents followed the same trend. Both traits significantly decreased with intercropping in both seasons. Crude protein and oil percent of intercropped maize was lower than that of pure standing by 5.01 and 6.90% in 1999 and 5.01 and 8.93% in 2000 seasons respectively. Reduction might be due to inhibition of metabolites synthesized by the intercropped maize plant as compared with the pure stand plants.

2. Effect of nitrogen fertilizer level.

Results in Table (24) and Fig. (11) indicate that most yield components of maize plants significantly increased with increasing nitrogen fertilizer level up to the heaviest (120 Kg

Table (24): Effect of N levels on yield and yield components of maize in 1999 and 2000 seasons.

Characters / Treatments: N levels (Kg/fed.)	Ear length (cm)	Ear diameter (cm)	No. of rows /ear	No. of kernels /row	Ear weight (g)	Kernels weight /ear (g)	100-kernel weight (g)	Shelling (%)	Grain yield (ton/fed.)	Straw yield (ton/fed.)	Biological yield (ton/fed.)	Oil (%)	Crude protein (%)
First season 1999													
0	18.38	4.20	12.15	33.25	158.60	135.50	33.43	85.44	2.61	3.27	5.88	4.11	7.94
60	19.63	4.31	11.65	35.69	180.54	155.52	37.36	86.19	3.15	3.83	6.98	4.16	8.22
90	20.29	4.36	11.86	37.16	183.08	159.42	36.14	87.06	3.53	3.99	7.52	4.22	8.24
120	20.72	4.44	12.61	37.63	193.18	167.44	34.65	86.67	3.92	4.57	8.49	4.25	8.28
L.S.D. at 0.05	0.65	0.11	0.31	1.61	12.59	10.73	1.66	0.53	0.24	0.28	0.52	0.10	0.12
Second season 2000													
0	19.01	4.68	12.88	35.49	181.56	155.20	33.94	85.50	3.00	3.61	6.61	4.31	8.32
60	20.30	4.79	12.35	38.15	207.39	178.77	37.93	86.25	3.66	4.24	7.90	4.37	8.61
90	20.98	4.84	12.58	39.71	210.29	183.23	36.69	87.12	4.14	4.46	8.60	4.41	8.83
120	21.43	4.93	13.37	41.32	224.01	194.30	35.17	86.73	4.66	5.20	9.86	4.45	8.68
L.S.D. at 0.05	0.67	0.12	0.32	1.77	14.56	12.43	1.69	0.53	0.28	0.32	0.59	0.11	0.12

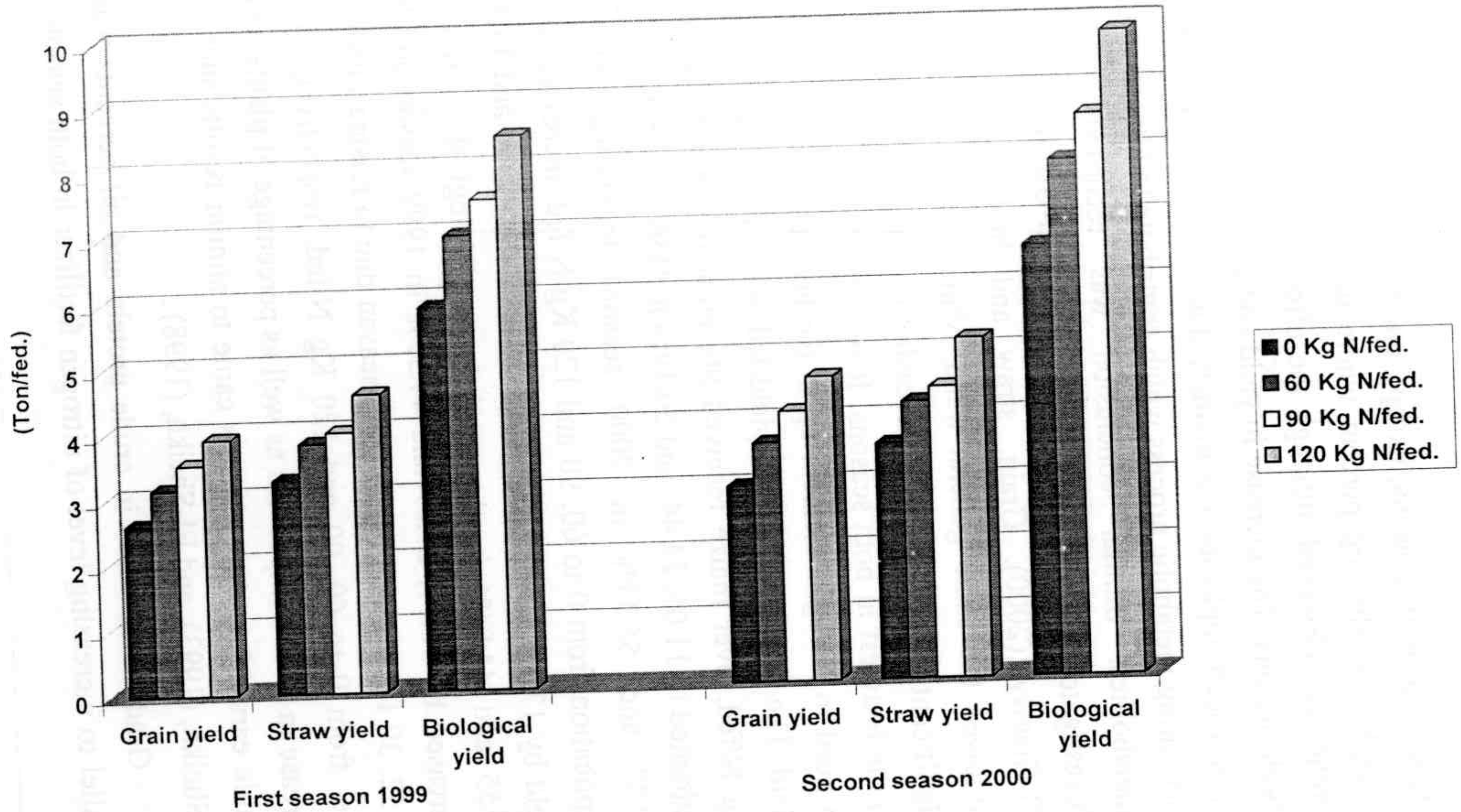

Fig. (11): Effect of N levels on yield of maize in 1999 and 2000 seasons.

N/fed.) in both seasons, except, number of rows/ear 100-kernel weight and shelling percent where deviation from the general trend was observed although the effect was still significant in both seasons. The increase in yield components with the increase in nitrogen application is mainely due to the role of nitrogen in activating metabolic process which contribute to high amounts of metabolites. Similar conclusion was recorded by many investigators such as Sahar-Sherif (1993), El-Gizawy (1996) and El-Gizawy (2000). Grain, straw and biological yields/fed. followed the same general trend. Values of yield parameters significantly increased with increasing nitrogen fertilizer level up to the heaviest in both seasons. It seemed that maize plants still in need to nitrogen element up to the heaviest level to improve yield. The increases in grain yield/fed. when maize received 120 Kg N/fed. over maize received 90, 60 and 0 Kg N/fed. were estimated to 11.05, 24.44 and 50.19% in 1999 season and 12.56, 27.32 and 55.33% in 2000 season. Increasing nitrogen application from 0 to 60, 90 and 120 Kg N/fed. increased straw yield by 17.13, 22.02 and 39.76% in the first season and 17.45, 23.55 and 44.04% in the second one. Biological yield also increased by 18.71, 27.89 and 44.39% in 1999 season and by 19.52, 30.11 and 49.17% in 2000 season due to raising nitrogen level from 0 to 60, 90 and 120 Kg N/fed. respectively. The increase in yield components as well as percentage of plants with double ears. Many investigators came to similar results such as El-Sheikh, (1993) and El-Sheikh, (1998) .

Gradual increases in crude protein and oil percents was parallel to increasing level of nitrogen fertilizer in both seasons.

Interpretation for these observation has been previously mentioned.

3. Effect of bacterial inoculation.

Results in Table (25) and Fig. (12) revealed that inoculating maize seeds with associative N_2 fixer bacteria *Azospirillum spp* had favourable effects on maize yield and yield components whether these effects were significant or did not reach the 5% level of significance in both seasons. Significant differences were recorded in cases of ear length, ear weight, kernel weight/ear. Inoculated plants surpassed uninoculated ones, concerning ear length, ear weight and kernel weight/ear by 2.72, 6.38 and 6.70% in 1999 and 2.78, 6.26 and 6.59% in 2000 seasons respectively. Same pattern of change was also observed in case of yield parameter i.e., grain yield/fed., straw yield/fed. and the biological yield/fed. and as well as crude protein and oil percent in maize grains with significant differences in all these traits in both seasons. Inoculated plants were superior to the uninoculated ones in grain, straw and biological yield by 9.52, 8.80 and 9.13% in the first season and 10.05, 8.57 and 9.26% in the second one respectively. These results seemed cogent and plausible and were supported by a variety of investigators. Some of them reported that non-symbiotic fixer bacteria, such as azospirillum were considered as a nitrogen fertilizer for improving maize yield. Fedrov (1940), Hegazi *et al* (1982) also reported that inoculation maize with *Azospirillum lipoferum* gave similar effects as mineral fertilization. Abo-Taleb (1991), Yadav *et al* (1992), El-Ganbeehy (1994) and Mehasen (1994) came to the similar results. Several researcher studied the phisiological

Table (25): Effect of bacterial inoculation on yield and yield components of maize in 1999 and 2000 seasons.

Characters / Treatments	Ear length (cm)	Ear diameter (cm)	No. of rows /ear	No. of kernels /row	Ear weight (g)	Kernels weight /ear (g)	100-kernel weight (g)	Shelling (%)	Grain yield (ton/fed.)	Straw yield (ton/fed.)	Biological yield (ton/fed.)	Oil (%)	Crude protein (%)
Bacteria inoculation						First season 1999							
Uninoculated	19.49	4.30	11.97	35.51	173.32	149.46	35.09	86.20	3.15	3.75	6.90	4.07	8.00
Inoculated	20.02	4.35	12.17	36.35	184.38	159.48	35.70	86.48	3.45	4.08	7.53	4.30	8.34
L.S.D. at 0.05	0.46	N.S	N.S	N.S	8.90	7.59	N.S	N.S	0.17	0.20	0.37	0.07	0.08
						Second season 2000							
Uninoculated	20.15	4.78	12.69	38.09	199.57	172.20	35.62	86.26	3.68	4.20	7.88	4.26	8.39
Inoculated	20.71	4.84	12.90	39.25	212.06	183.54	36.24	86.54	4.05	4.56	8.61	4.50	8.73
L.S.D. at 0.05	0.47	N.S	N.S	N.S	10.29	8.79	N.S	N.S	0.20	0.22	0.42	0.08	0.09

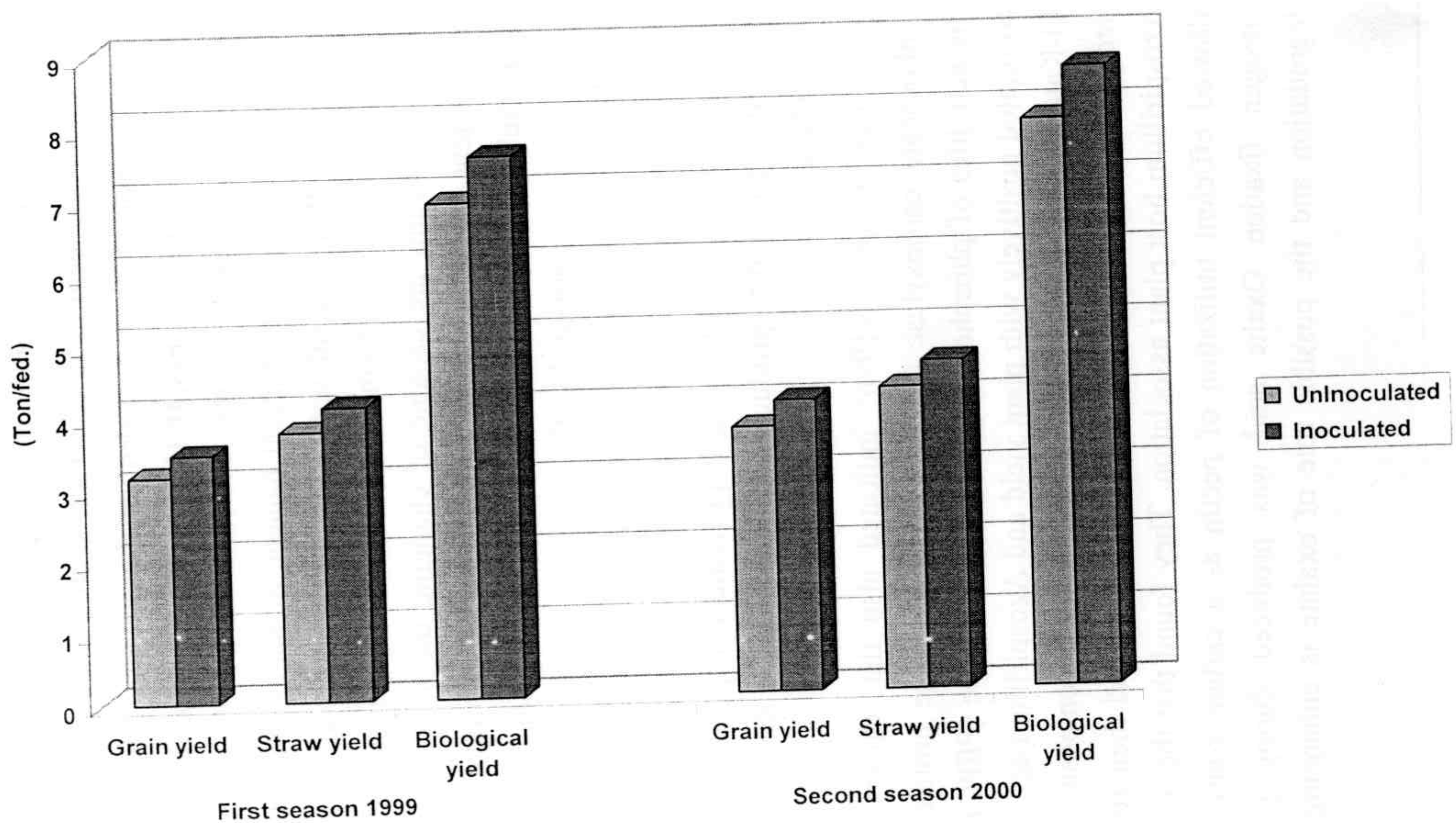

Fig. (12): Effect of bacteria inoculation on yield of maize in 1999 and 2000 seasons.

aspects and mode of action of N-fixer bacteria *Azospirillum spp* to explain the benificial effect on crop plants. Bashan *et al* (1990), reported that *Azospirillum barasilense* enhances the accumulation of K^+, P, Fe_2, B, Cu_2^+ and Zn_2^+ in inoculated wheat and soybean plants. They indicated that all inoculation treatments changed the mineral balance of plants. Nevertheless they found that mineral uptake by plants also varied greatly among Azospirillum strains. They concluded that although *A. brasilense* strains are capable of changing the mineral balance and content of plants in favour their growth and productivity, it is unlikely that this ability is a general mechanism responsible for plant improvement by the associative N_2-fixer bacteria. Another interpretation of the benificial effect of the associative N_2-fixer bacteria has been offered by Nieto and Frankenbeger (1991). They revealed that the improvement in plant yield was primarily attributed to production of cytokinins in the plant root rhizosphere.

Purcino *et al* (1996) indicated also that ribulose 1-5 biphosphate carboxylase (RUBISCO) and soluble protein and the activities of phosphoenol pyruvate carboxylase (PEPC) was correlated positively with plant yield and Azospirillum activities. El-Katatny *et al* (1997), also studied pectin decomposition by *Azospirillum sp* and *Penicillium corylophillum* and their role in Azospirillum host plant association. They found that the inocula allowed efficient utilization of pectin as a carbon source for nitrogen fixation Oxalic acid was produced during pectin degradation and the possible role of oxalate is enhancing PG activity (Poly galacturouase and feredoxin-glutamate synthase (Fd-GOGAT) and affecting nitrogen fixation by *A. brasilense*.

4. Effect of interaction of cropping system and nitrogen fertilization level on yield and yield components of maize.

The results in Table (26) revealed that ear length and diameter, number of kernel/row, ear weight and kernels weight/ear increased consistently with increasing nitrogen fertilizer level up to 120 Kg N/fed. under both cropping system. Whereas, the positive response on kernel weight and shelling percent disappeared when maize plants received 90 Kg N/fed. or 120 Kg N/fed.. On other hand, the interaction effect on number of rows/ear followed an irrigular pattern, although differences were significant in both seasons. However, it could be concluded that most traits of yield components improved with increasing nitrogen fertilizer level up to the heaviest level whether plants were grown alone or intercropped with soybean. The highest values of yield components were recorded in pure standed plants fertilized with 120 Kg N/fed.. These results hold true in both seasons. Sahar-Sherif (1993) came to similar results.

Results on the grain yield/fed., straw yield/fed. and the biological yield/fed. followed more regular trend in both seasons. Results revealed significant and consistent increases with increasing the level of nitrogen fertilizer up to the heaviest i.e., 120 Kg N/fed., whether maize was grown alone or associated with soybean. The highest values of grain, straw and biological yield was obtained when maize was grown alone and fertilized with 120 Kg N/fed.. These results are in agreement with those obtained by several investigators such as Metwally (1973, 1988), Table (26): Effect of interaction between cropping system and N levels on yield and yield components of maize in 1999 and 2000 seasons.

Treatments	N levels (Kg/fed.)	Ear length (cm)	Ear diameter (cm)	No. of rows /ear	No. of kernels /row	Ear weight (g)	Kernels weight /ear (g)	100-kernel weight (g)	Shelling (%)	Grain yield (ton/fed.)	Straw yield (ton/fed.)	Biological yield (ton/fed.)	Oil (%)	Crude Protein (%)
		First season 1999												
Intercropping	0	18.11	4.18	12.14	31.14	146.70	125.08	33.08	85.27	2.03	2.73	4.76	3.92	7.75
	60	19.59	4.31	11.64	33.69	169.27	145.78	37.16	86.14	2.49	3.20	5.69	3.95	8.00
	90	20.20	4.35	11.84	35.03	171.63	149.18	35.96	86.90	2.77	3.34	6.11	4.02	8.02
	120	20.65	4.42	12.39	35.47	180.96	156.78	34.41	86.64	3.10	3.75	6.85	4.06	8.07
Pure stand	0	18.66	4.23	12.17	35.35	170.51	145.92	33.78	85.61	3.19	3.81	7.00	4.29	8.13
	60	19.66	4.31	11.67	37.69	191.81	165.27	37.57	86.22	3.81	4.45	8.26	4.37	8.44
	90	20.37	4.37	11.89	39.28	194.53	169.65	36.33	87.21	4.28	4.64	8.92	4.41	8.46
	120	20.79	4.45	12.83	39.78	205.41	178.11	34.88	86.68	4.73	5.39	10.12	4.43	8.50
L.S.D. at 0.05		0.91	0.15	0.43	2.28	17.80	15.18	2.35	0.75	0.34	0.40	0.74	0.14	0.17
		Second season 2000												
Intercropping	0	18.73	4.65	12.86	34.95	176.98	151.01	33.58	85.33	2.48	3.01	5.49	4.12	8.12
	60	20.26	4.79	12.34	37.99	205.21	176.85	37.72	86.21	3.08	3.55	6.63	4.15	8.39
	90	20.89	4.83	12.55	39.51	208.08	180.99	36.50	86.96	3.46	3.73	7.19	4.21	8.40
	120	21.36	4.92	13.14	42.10	222.88	193.23	34.94	86.71	3.94	4.34	8.28	4.26	8.46
Pure stand	0	19.30	4.71	12.90	36.03	186.13	159.40	34.29	85.68	3.53	4.20	7.73	4.50	8.52
	60	20.33	4.80	12.36	38.31	209.57	180.70	38.13	86.29	4.24	4.94	9.18	4.58	8.84
	90	21.07	4.86	12.60	39.90	212.51	185.47	36.88	87.28	4.81	5.19	10.0	4.62	8.86
	120	21.51	4.95	13.60	40.55	225.15	195.36	35.40	86.75	5.38	6.06	11.44	4.64	8.90
L.S.D. at 0.05		0.95	0.17	0.46	2.50	20.58	17.58	2.38	0.75	0.40	0.45	0.83	0.16	0.17

Gunanseva *et al* (1979), Galal and Metwally (1982) and Sahar-Sherif (1993). They revealed that yield of maize increased with increasing the level of nitrogen fertilizer when maize was grown in pure stand or intercropped with soybean.

Crude protein and oil percent in maize grain were statistically influenced also by the interaction of cropping system and nitrogen levels. Generally values of these traits increased with increasing nitrogen fertilizer level up to the heaviest in both season. The results also revealed that the values of these traits of maize grown in pure stand were always relatively higher than those grown in association with soybean under same respective level of N fertilizer. Grains of maize grown alone and given 120 Kg N/fed. had the highest values of crude protein and oil percentage.

5. Interaction effect of cropping system with bacterial inoculation of Azospirillum.

Significant interaction effects of the cropping system with bacterial inoculation on most yield components were recorded in Table (27). Moreover, a two dimension effect predominated the interaction effect.

Values of these traits of pure stand were always higher than those of maize intercropped with soybean under the two treatments of inoculation. This was true in both seasons of 1999 and 2000. inoculated maize grown in pure stand gave the highest values of ear length and weight, number of rows/ear and kernels/row as well as kernel weight/ear. Nevertheless, the results in Table (27) revealed insignificant differences in case of ear diameter, 100-kernel weight and shellıng percent in both

Table (27): Effect of interaction between cropping system and bacterial inoculation on yield and yield components of maize in 1999 and 2000 seasons.

Treatments	Bacterial inoculation	Ear length (cm)	Ear diameter (cm)	No. of rows /ear	No. of kernels /row	Ear weight (g)	Kernels weight /ear (g)	100-kernel weight (g)	Shelling (%)	Grain yield (ton/fed.)	Straw yield (ton/fed.)	Biological yield (ton/fed.)	Oil (%)	Crude protein (%)
		First season 1999												
Intercropping	Uninoculated	19.33	4.29	11.93	33.31	160.49	138.26	34.78	86.11	2.45	3.11	5.56	3.88	7.80
	Inoculated	19.94	4.33	12.08	34.35	173.78	150.15	35.52	86.37	2.74	3.40	6.14	4.10	8.12
Pure stand	Uninoculated	19.64	4.31	12.01	37.71	186.15	160.65	35.40	86.28	3.85	4.38	8.23	4.26	8.21
	Inoculated	20.10	4.37	12.26	38.34	194.98	168.82	35.88	86.58	4.16	4.77	8.93	4.50	8.55
L.S.D. at 0.05		0.65	N.S	0.31	1.61	12.59	10.73	N.S	N.S	0.24	0.28	0.52	0.10	0.12
		Second season 2000												
Intercropping	Uninoculated	19.99	4.77	12.64	37.81	195.83	168.82	35.31	86.17	3.06	3.52	6.58	4.07	8.17
	Inoculated	20.62	4.82	12.80	39.47	210.74	182.21	36.06	86.43	3.42	3.79	7.21	4.30	8.51
Pure stand	Uninoculated	20.31	4.80	12.73	38.38	203.31	175.58	35.94	86.35	4.31	4.88	9.19	4.46	8.60
	Inoculated	20.79	4.86	13.00	39.03	213.37	184.88	36.42	86.65	4.68	5.32	10.00	4.71	8.96
L.S.D. at 0.05		0.67	N.S	0.32	N.S	14.56	12.43	N.S	N.S	0.28	0.32	0.59	0.11	0.12

seasons. Grain, straw and biological yield of maize were also significantly affected by the interaction of cropping system and inoculation. The increases in grain yield/fed. of maize inoculated with Azospirillum over those left uninoculated were estimated to 8.03 and 11.87% when maize was grown in pure stand or in association with soybean plant respectively in 1999 season and 8.59 and 11.53% in 2000 seasons. These results are in harmony with those obtained by Abo-Taleb (1991) and El-Kholy (1993).

Crude protein and oil percent of inoculated maize grain increased over those of maize remained uninoculated. These observations hold true under both cropping system and in both seasons. The results also revealed that values of these traits when maize was grown alone exceeded those when maize was intercropped with soybean. These results were in agreement with those obtained by El-Kholy (1993) who revealed slight increases in crude protein, oil percentages in grain tissues compared with uninoculated treatment.

6. Effect of interaction of nitrogen fertilizer levels and bacterial inoculation with Azospirilla.

The interaction effect of nitrogen fertilizer level and inoculation with Azospirillum inocula on yield and yield components of maize were significant in both seasons, Table (28). The results indicate clearly that all values of yield components as well as yield parameters increased with increasing nitrogen fertilizer level up to (120 Kg N/fed.), whether maize was inoculated with Azospirillum or remained uninoculated. On other hand, all values of these traits when maize was inoculated with Azospirillum exceeded those of

Table (28): Effect of interaction between N levels and bacterial inoculation on yield and yield components of maize in 1999 and 2000 seasons.

Treatments: N levels (Kg/fed.)	Treatments: Bacterial inoculation	Ear length (cm)	Ear diameter (cm)	No. of rows /ear	No. of kernels /row	Ear weight (g)	Kernels weight /ear (g)	100-kernel weight (g)	Shelling (%)	Grain yield (ton/fed.)	Straw yield (ton/fed.)	Biological yield (ton/fed.)	Oil (%)	Crude protein (%)
		First season 1999												
0	Uninoculated	17.66	4.16	12.11	32.96	155.19	132.27	32.95	85.22	2.50	3.11	5.61	3.99	7.69
	Inoculated	19.11	4.25	12.20	33.53	162.01	138.73	33.91	85.67	2.72	3.43	6.15	4.22	8.19
60	Uninoculated	19.57	4.31	11.61	34.77	173.96	149.66	37.06	86.12	3.00	3.66	6.66	4.05	8.09
	Inoculated	19.69	4.31	11.70	36.60	187.12	161.39	37.67	86.25	3.30	4.00	7.30	4.27	8.36
90	Uninoculated	20.13	4.33	11.77	36.96	180.26	156.58	35.95	86.83	3.43	3.89	7.32	4.10	8.10
	Inoculated	20.44	4.38	11.95	37.36	185.89	162.26	36.34	87.29	3.62	4.10	7.72	4.33	8.38
120	Uninoculated	20.60	4.41	12.39	37.35	183.88	159.32	34.40	86.63	3.66	4.34	8.00	4.13	8.14
	Inoculated	20.84	4.46	12.83	37.90	202.48	175.57	34.89	86.71	4.17	4.81	8.98	4.36	8.43
L.S.D. at 0.05		0.91	0.15	0.43	2.28	17.80	15.18	2.35	0.75	0.34	0.40	0.74	0.14	0.17
		Second season 2000												
0	Uninoculated	18.26	4.63	12.84	35.28	177.66	151.51	33.45	85.28	2.87	3.42	6.29	4.19	8.06
	Inoculated	19.76	4.73	12.93	35.70	185.45	158.90	34.42	85.72	3.14	3.80	6.94	4.43	8.58
60	Uninoculated	20.24	4.79	12.30	37.24	200.14	172.30	37.62	86.18	3.49	4.05	7.54	4.25	8.47
	Inoculated	20.36	4.80	12.40	39.07	214.64	185.24	38.24	86.31	3.83	4.44	8.27	4.49	8.75
90	Uninoculated	20.81	4.82	12.48	39.51	207.09	180.00	36.49	86.89	4.02	4.34	8.36	4.29	8.48
	Inoculated	21.15	4.87	12.67	39.90	213.50	186.45	36.89	87.35	4.25	4.58	8.83	4.54	8.78
120	Uninoculated	21.31	4.91	13.14	40.33	213.38	185.00	34.92	86.68	4.36	4.99	9.35	4.33	8.53
	Inoculated	21.56	4.96	13.60	42.32	234.65	203.59	35.42	86.76	4.97	5.41	10.38	4.57	8.82
L.S.D. at 0.05		0.95	0.17	0.46	2.50	20.58	17.58	2.38	0.75	0.40	0.45	0.83	0.16	0.17

uninoculated maize. These results hold true in both seasons. The highest values of ear length and diameter, number of rows/ear and kernel/row, ear weight and kernel weight were recorded in inoculated plants fertilized with 120 Kg N/fed.. The highest 100 kernel weight and shelling percentage were obtained in inoculated plants given 60 and 90 Kg N/fed. respectively. However, the analysis of data also revealed that the excess in grain yield of maize received heaviest dose of nitrogen and were inoculated with Azospirillum over those left uninoculated and received no nitrogen was estimated to 66.80 and 73.17% in 1999 and 2000 seasons respectively. Symbiotic fixer bacteria, such as Azospirillum, Rizobium and Azotobacter were considered as a nitrogen fertilizer for improving growth and yield of different crops (Fedrov 1940, Ionvacichus *et al* 1970 and Palissa and Koepke, 1970). Nevertheless a controversry and a variety of opinions were offered about optimum dose of nitrogen fertilizer to increase growth and yield to their maximals. Several investigators support the small doses coupled with inoculation with symbiotic fixer bacteria of nitrogen to enhance growth and yield of crops such as Saleh *et al* (1986) and Zaghloul *et al* (1996) who found that half of the normal level of nitrogen fertilizer (120 Kg N/acre applied as NH_4No_3) was enough to stimulate growth and increased nitrogenase activity in soil rhizosphere of maize plants. Reiad *et al* (1987) indicated that 90 Kg N/fed. was adequate to increase growth and yield of maize. El-Ganbeehy (1994) also indicated that biofertilization with Azospirillum plus moderate level of N application to wheat had favourable effect on yield components of wheat. Abdel-Gawad *et al* (1995a) revealed that treatment with the starter N dose slightly increased harvest index, seed index and ear characters. Monib *et al* (1982), also indicated that applying a low level of 22.5 Kg N /fed. led to higher yield rather than application with high dose of 90 Kg N/fed.. That low dose of N improved establishment of Azospirillum inoculum. Yield of fodder maize with 75 Kg N alone was 9.34 t/ha while 75 Kg N/ha, in addition to inoculation with Azospirillum gave a mean yield of 13.21 t/ha (Patil *et al*, 1992). Inoculating maize with Azospirillum and given 45 Kg N/fed. (half of the recommended level) can save 50% of normal N application to maize (El-Demerdash 1994). Application of 50 Kg N/ha alone gave similar green fodder yield of maize to application of 25 Kg N/ha in addition to inoculating seeds with Azospirillum Nanda *et al* (1995), Fallik and Okon (1996), concluded that there was no effect of inoculating maize with Azospirillum when was grown in heavier soil nor when N-fertilizer application was high. The highest increment level in yield of maize (9 and 12%) were recorded with Azospirillum inoculation and 178.5 Kg N/ha was applied at El-Gemmeza and El-Nubaria, respectively, rather than addition of 119 or 238 Kg/ha. Nitrogen level of 85 Kg/fed. gave the highest values of yield and yield components of maize and produced about 25% increase over the check when plants were inoculated with combinations of four bacterial inoculation as compared with zero, 45, 65 and 105 Kg N/fed.. (Mehasen 1999). On other hand, Amer (1982), indicated that application of urea (90 Kg N/fed.) inhibited both Azospirilla number and nitrogenase activity. Hegazi *et al* (1983) found that application of 200 Kg N/ha significantly reduced nitrogenase activity as well as Azospirilla activity. It could be concluded that plant response to inoculation and the level of nitrogen fertilizer varied much according to the nutritive status of the soil and the number of the symbiotic fixer bacteria existed in maize root rhizosphere.

Crude protein and oil percents of maize seeds was also statistically influenced by the interaction effect. There were increases in the values of these traits with increasing nitrogen fertilizer level, whether maize seeds were inoculated with Azospirillum or left uninoculated. Inoculated plants had the highest protein and oil content when fertilized with 120 Kg N/fed.. Chela *et al* (1993) supported these results on crude protein, although Rohitashav *et al* (1993) obtained contradictory results. Hassanein *et al* (1997), also revealed that inoculation with N fixer bacteria coupled with nitrogen fertilization had no any measurable effect on protein and oil contents of maize grain.

7. Effect of cropping system, nitrogen fertilizer levels and bacterial inoculation with Azospirillum.

Results in Table (29) indicate that all yield components of maize were also governed by the course of change of the three main variables, i.e., inoculating maize seeds with Azospirillum inocula, nitrogen fertilizer level and the cropping system. Increases in yield component values with increasing N fertilizer level up to the heaviest whether maize seeds were inoculated or left uninoculated and whether maize was grown in pure stand or in association with soybean were recorded. Values of these traits when seeds were inoculated with Azospirillum were always higher than those recorded when maize was grown without

Table (29): Effect of interaction among cropping system, N levels and bacterial inoculation on yield and yield components of maize in 1999 and 2000 seasons.

Treatments		Characters	Ear length (cm)	Ear diameter (cm)	No. of rows /ear	No. of kernels /row	Ear weight (g)	Kernels weight /ear (g)	100-kernel weight (g)	Shelling (%)	Grain yield (ton/fed.)	Straw yield (ton/fed.)	Biological yield (ton/fed.)	Oil (%)	Crude protein (%)
	N levels (Kg/fed.)	Bacterial inoculation	First season 1999												
Inter cropping	0	Uninoculated	17.32	4.13	12.07	30.92	142.32	120.93	32.38	84.98	1.92	2.53	4.45	3.81	7.50
		Inoculated	18.89	4.23	12.20	31.36	151.08	129.23	33.78	85.56	2.15	2.93	5.08	4.03	7.99
	60	Uninoculated	19.54	4.31	11.57	32.63	161.86	139.25	36.85	86.09	2.34	3.03	5.37	3.85	7.88
		Inoculated	19.64	4.31	11.70	34.75	176.68	152.30	37.46	86.20	2.65	3.38	6.03	4.05	8.13
	90	Uninoculated	19.97	4.33	11.73	34.75	167.08	145.05	35.58	86.79	2.68	3.23	5.91	3.91	7.88
		Inoculated	20.43	4.36	11.95	35.31	176.18	153.31	36.33	87.02	2.87	3.45	6.32	4.13	8.16
	120	Uninoculated	20.51	4.41	12.33	34.94	170.72	147.81	34.31	86.59	2.88	3.66	6.54	3.95	7.95
		Inoculated	20.80	4.43	12.45	35.99	191.19	165.74	34.52	86.70	3.32	3.85	7.17	4.17	8.20
Pure stand	0	Uninoculated	17.99	4.19	12.14	35.00	168.07	143.61	33.52	85.46	3.09	3.68	6.77	4.17	7.88
		Inoculated	19.33	4.27	12.20	35.70	172.95	148.22	34.03	85.77	3.30	3.94	7.24	4.41	8.39
	60	Uninoculated	19.59	4.31	11.64	36.91	186.06	160.06	37.26	86.15	3.67	4.28	7.95	4.25	8.30
		Inoculated	19.74	4.32	11.70	38.46	197.57	170.47	37.88	86.30	3.95	4.62	8.57	4.49	8.58
	90	Uninoculated	20.28	4.34	11.82	39.16	193.44	168.10	36.32	86.87	4.19	4.55	8.74	4.29	8.32
		Inoculated	20.46	4.40	11.95	39.41	195.61	171.20	36.35	87.56	4.37	4.74	9.11	4.53	8.60
	120	Uninoculated	20.70	4.42	12.45	39.77	197.04	170.03	34.50	86.66	4.45	5.01	9.46	4.31	8.34
		Inoculated	20.89	4.49	13.21	39.80	213.78	185.39	35.26	86.71	5.02	5.78	10.80	4.55	8.65
L.S.D. at 0.05			1.29	0.22	0.61	3.23	25.18	12.47	3.32	1.06	0.48	0.57	1.04	0.20	0.23

Table (29): Cont.

Treatments		Characters	Ear length (cm)	Ear diameter (cm)	No. of rows /ear	No. of kernels /row	Ear weight (g)	Kernels weight /ear (g)	100-kernel weight (g)	Shelling (%)	Grain yield (ton/fed.)	Straw yield (ton/fed.)	Biological yield (ton/fed.)	Oil (%)	Crude protein (%)
	N levels (Kg/fed.)	Bacterial inoculation	Second season 2000												
Inter cropping	0	Uninoculated	17.91	4.59	12.80	34.76	171.97	146.23	32.87	85.04	2.33	2.78	5.11	4.00	7.86
		Inoculated	19.54	4.70	12.93	35.14	181.99	155.78	34.29	85.62	2.62	3.24	5.86	4.24	8.38
	60	Uninoculated	20.21	4.79	12.27	36.94	196.93	169.54	37.41	86.15	2.89	3.35	6.24	4.04	8.25
		Inoculated	20.31	4.79	12.40	39.05	213.48	184.15	38.03	86.26	3.26	3.75	7.01	4.26	8.52
	90	Uninoculated	20.65	4.81	12.43	39.26	202.88	176.25	36.12	86.85	3.34	3.60	6.94	4.09	8.25
		Inoculated	21.13	4.85	12.67	39.75	213.28	185.72	36.88	87.08	3.57	3.86	7.43	4.33	8.55
	120	Uninoculated	21.21	4.90	13.07	40.26	211.53	183.27	34.83	86.65	3.68	4.36	8.04	4.14	8.32
		Inoculated	21.51	4.93	13.20	43.93	234.23	203.19	35.04	86.76	4.21	4.33	8.54	4.38	8.59
Pure stand	0	Uninoculated	18.61	4.66	12.87	35.80	183.35	156.78	34.03	85.52	3.41	4.05	7.46	4.38	8.25
		Inoculated	19.99	4.75	12.93	36.27	188.91	162.01	34.55	85.83	3.66	4.35	8.01	4.62	8.79
	60	Uninoculated	20.26	4.79	12.33	37.54	203.35	175.06	37.82	86.21	4.09	4.75	8.84	4.45	8.69
		Inoculated	20.41	4.80	12.40	39.08	215.80	186.33	38.45	86.36	4.40	5.13	9.53	4.72	8.98
	90	Uninoculated	20.97	4.82	12.53	39.77	211.30	183.75	36.87	86.93	4.70	5.08	9.78	4.50	8.72
		Inoculated	21.16	4.89	12.67	40.04	213.72	187.18	36.90	87.62	4.92	5.30	10.22	4.74	9.01
	120	Uninoculated	21.41	4.91	13.20	40.39	215.23	186.73	35.02	86.72	5.03	5.62	10.65	4.52	8.74
		Inoculated	21.60	4.99	14.00	40.71	235.06	203.99	35.79	86.77	5.73	6.50	12.23	4.76	9.06
L.S.D. at 0.05			1.34	0.24	0.65	3.54	29.11	24.86	3.37	1.06	0.56	0.63	1.18	0.23	0.25

inoculation under same respective level of fertilizer and cropping system. It is also evident that values of these traits when maize was grown in pure stand were generally and relatively higher than those recorded of maize grown in the intercrop under same respective N fertilizer level and whether seeds of maize were inoculated with Azospirillum or left uninoculated. Moreover, the analysis of variance revealed significant differences among these traits. Inoculated maize plants fertilized with 120 Kg N/fed. had the highest values of yield components where grown in pure stand. Grain, straw and biological yield of maize were significantly influenced by the interaction of the three studied factors.

However, maximum values were obtained when maize was grown in pure stand and received heaviest dose of nitrogen (120 Kg N/fed.) and seeds were inoculated with Azospirillum inocula, whereas, minimum values were obtained when maize was grown in association with soybean, received no nitrogen and seeds remained untreated with inocula. Crude protein and oil percents of maize grain were influenced by the interaction effect, similar to the effect of the combined interaction on yield and yield components of maize. Further, the results revealed significant differences among the treatment imposed in both sesons. Inoculated maize plants grown in pure stand and fertilized with 120 Kg N/fed. had protein and oil grain content.

The data in 1999 season shown in Table (30) indicate clearly that the adjusted grain yield of maize plant per unit of area is one fold the actual yield, since the intercrop pattern was in equal ratio (2:2) under all the interacted treatments.

Table (30): Effect of interaction among cropping system, N levels and bacterial inoculation on yield of maize in 1999 and 2000 seasons.

Treatments		Characters	Actual Grain yield (ton/fed.)	Adjusted * Grain yield (ton/fed.)	Actual Grain yield (ton/fed.)	Adjusted (+) Grain yield (ton/fed.)
	N levels (Kg/fed.)	Bacterial inoculation	First season 1999		Second season 2000	
Inter cropping	0	Uninoculated	1.92	3.84	2.33	4.66
		Inoculated	2.15	4.30	2.62	5.24
	60	Uninoculated	2.34	4.68	2.89	5.78
		Inoculated	2.65	5.30	3.26	6.52
	90	Uninoculated	2.68	5.36	3.34	6.68
		Inoculated	2.87	5.74	3.57	7.14
	120	Uninoculated	2.88	5.76	3.68	7.36
		Inoculated	3.32	6.64	4.21	8.42
Pure stand	0	Uninoculated	3.09	3.09	3.41	3.41
		Inoculated	3.30	3.30	3.66	3.66
	60	Uninoculated	3.67	3.67	4.09	4.09
		Inoculated	3.95	3.95	4.40	4.40
	90	Uninoculated	4.19	4.19	4.70	4.70
		Inoculated	4.37	4.37	4.92	4.92
	120	Uninoculated	4.45	4.45	5.03	5.03
		Inoculated	5.02	5.02	5.73	5.73
L.S.D. at 0.05			0.48	1.00	0.56	0.94

*** Adjusted yield : Grain yield was adjusted according to unit area basis.**

However, the results evidenced that the adjusted grain yields of intercropped maize exceeded those of the actual yield of pure stand maize within any interaction. Differences were also significant. The increases in the adjusted grain yield of the intercropped maize in comparison with with those recorded for the pure stand maize might be due to lower interspecific competition with the intercrop treatments rather than the intra specific competition among solid plants when maize was grown in pure stand under the same interacted treatment. It seemed also that more shading effect of maize plants resulted in the reductions in seed yield of pure stand maize. Superiority of the adjusted grain yield /unit area of the intercropped maize over the yield of sole cropped maize was demonstrated by El-Douby (1992) in some intercrop combinations. From another angel of data the adjusted grain yield of maize followed the pattern of change as influenced by the treatments effect. There were gradual and consistent increases with increasing nitrogen fertilizer rate up to the heaviest i.e, 120 Kg N/fed. Coupled with higher values of the inoculated treatment as compared with the uninoculated treatments under any level of the interacted treatmennts. The trend of change in 2000 season was more or less the trend in 1999 season. Moreovere, there was no any deviation from the general trend. Khalil (1994) came to similar results. It is interesting to not that the value of adjusted grain yield of maize plants inoculated with Azospirilla and received 60 Kg N/fed. surpassed the grain yield obtained from pure stand maize plants received 120 Kg N/fed. whether inoculated or kept uninoculated with N_2 fixer bacteria which might explain the higher value of LER at 60 Kg N/fed. and inoculated with the N_2fixer bacteria.

II. Competitive relationships.

1. The effect of both inoculating maize and soybean plants with N-fixer bacteria and adding different levels of N fertilizer on the Land Equivalent Ratio (L. E. R.).

Results in Table (31) show the interaction effect of nitrogen fertilizer level and inoculating both legume and cereal components with the Rhizobia and Azospirillum, respectively on the competitive relationships. The results evidenced that increasing nitrogen fertilizer level under inoculation with inocula or keeping the plants without inoculation followed distinctive patterns of change. Increasing nitrogen fertilizer level up to 60 Kg/fed. increased relative yield of soybean, thereafter, a slow down in the relative yield was observed at 90 nitrogen level. Another increase was associated with increasing the nitrogen level up to the heaviest, i.e., 120 Kg N/fed.. This trend was quite conspicuous whether the plants were inoculated with the Rhizobia or remained uninoculated. These results were also observed in both seasons. Relative yield of maize was also influenced with different levels of nitrogen fertilizer as interacted with inoculation with N-fixer bacteria. Nevertheless, the trend was distinctive in both states of inoculation. While increasing nitrogen level was associated with parallel increases in the value of relative yield of maize plants left uninoculated in both seasons, the trend was similar to the inoculated soybean when maize was inoculated with Azospirillum in both seasons. It seemed that the trend of both components when inoculated with N-fixer bacteria was tenaciously bound by the effect of inoculation with the N-fixer bacteria. From another angle of

Table (31): Effect of nitrogen levels and bacterial inoculated on Competitive relationships in 1999 and 2000 seasons.

Treatments / Characters		Land Equivalent Ratio (LER)			Relative Crowding Coefficient (RCC)			Aggressivity (A)		Competitive Ratio (CR)		Area Time Equivalent Ratio (ATER)
N levels (Kg/fed.)	Bacterial inoculated	L_s	L_m	LER	K_s	K_m	K	A_s	A_m	CR_s	CR_m	
First season 1999												
0	Uninoculated	0.431	0.620	1.051	0.757	1.633	1.236	- 0.189	+ 0.189	0.695	1.439	0.834
	inoculated	0.441	0.651	1.092	0.789	1.864	1.471	- 0.210	+ 0.210	0.677	1.476	0.867
60	Uninoculated	0.458	0.638	1.096	0.845	1.762	1.489	- 0.180	+ 0.180	0.718	1.393	0.868
	inoculated	0.471	0.670	1.141	0.889	2.031	1.806	- 0.199	+ 0.199	0.703	1.423	0.904
90	Uninoculated	0.454	0.640	1.094	0.832	1.777	1.478	- 0.186	+ 0.186	0.709	1.410	0.867
	inoculated	0.468	0.656	1.124	0.879	1.910	1.679	- 0.188	+ 0.188	0.713	1.402	0.890
120	Uninoculated	0.467	0.646	1.113	0.878	1.825	1.602	- 0.179	+ 0.179	0.723	1.383	0.881
	inoculated	0.478	0.661	1.139	0.914	1.950	1.782	- 0.183	+ 0.183	0.723	1.383	0.902
Mean		0.458	0.648	1.106	0.848	1.844	1.568	- 0.189	+ 0.189	0.708	1.414	0.877
Second season 2000												
0	Uninoculated	0.347	0.685	1.032	0.532	2.176	1.158	- 0.338	+ 0.338	0.507	1.974	0.829
	inoculated	0.355	0.717	1.072	0.551	2.536	1.397	- 0.362	+ 0.362	0.495	2.020	0.862
60	Uninoculated	0.368	0.708	1.076	0.583	2.424	1.413	- 0.340	+ 0.340	0.520	1.924	0.864
	inoculated	0.378	0.741	1.119	0.608	2.861	1.739	- 0.363	+ 0.363	0.510	1.960	0.899
90	Uninoculated	0.360	0.710	1.070	0.562	2.449	1.376	- 0.350	+ 0.350	0.507	1.972	0.859
	inoculated	0.371	0.725	1.096	0.589	2.637	1.553	- 0.354	+ 0.354	0.512	1.954	0.880
120	Uninoculated	0.374	0.732	1.106	0.597	2.731	1.630	- 0.358	+ 0.358	0.511	1.957	0.888
	inoculated	0.382	0.735	1.117	0.618	2.771	1.712	- 0.353	+ 0.353	0.520	1.924	0.897
Mean		0.367	0.719	1.086	0.580	2.573	1.497	- 0.352	+ 0.352	0.510	1.961	0.872

* L_s (relative yield of soybean).
* L_m (relative yield of maize).

RESULTS AND DISCUSSION

results it is evident while relative yield of soybean never exceeded 50% of sole planting productivity under all nitrogen fertilizer levels (were going round 40%), LERm of maize exceeded half the sole planting productivitys (were going round 60%) under and all nitrogen fertilizer levels whether plants were inoculated with N-fixer bacteria or left uninoculated. However, these results were true in both seasons.

Results on total LER evidenced that the trend of change was associated more by inoculation state rather than nitrogen fertilizer level. Although, generally increasing nitrogen level increased the values of land equivalent ratios, yet an exception was observed in both seasons when N level was increased from 60 N unit to 90 N unit, there, a slight slow down was observed, probably due to magnitude of activation occurred by the N-fixer bacteria. The results also revealed that although, all values obtained were higher than the unit under both states of inoculation and all N fertilizer level, yield advantage obtained from any treatment was not appreciable and never exceeded 13%. Maximum values of land equivalent levels were obtained when plants received 60 Kg N/fed. and were inoculated with N-fixer bacteria whereas plants received the highest level of nitrogen and inoculated ranked the second, indicating that 60 Kg N/fed. still had the power to obtain maximum yield adventage. On other hand, plant received neither nitrogen dose nor were inoculated with the bacteria had least land equivalent ratio value. The results also evidenced that under all levels of N, inoculating plants with N-fixer bacteria had remarkable and favorable effects on land equivalent ratio values. These results were true in both seasons. However, Sahar-Sherif (1993) obtained increased yield advantage with increasing nitrogen fertilizer level when maize was intercropped with soybean.

2. **The effect of inoculating maize and soybean plants with N-fixer bacteria and adding different levels of N fertilizer on the Relative Crowding Coefficient (R. C. C.).**

Relative Crowding Coefficient (R. C. C.) parameters followed the same pattern of change as the Land Equivalent Ratio parameters. The results revealed that all values of K of soybean was lower than those of maize under any level of nitrogen. The abruptly slow down in K values of soybean whether inoculated or not and received 90 Kg N/fed. were evident in both seasons. Same trend was also observed in K values of maize in both seasons. Results on R.C.C. followed also the same trend as Land Equivalent Ratio, i.e., all values obtained for all interaction treatments exceeded the unit in both seasons indicating yield advantage. Maximum values were also associated with 60 Kg N/fed. and inoculated with N-fixer bacteria. Plant received heaviest dose and inoculated with N fixer bacteria ranked the second. On the other hand least values were obtained when plants received no nitrogen fertilizer and left uninoculated. These results were true in both seasons and are in agreement with those obtained by Ewies (1987), Kamel *et al* (1990), El-Dobby (1992) and Sahar-Sherif (1993).

3. **The effect of both inoculating maize and soybean plants with N-fixer bacteria and adding different levels of N fertilizer on Aggressivity (A).**

Agressivity results indicate that in all levels of nitrogen fertilizer and whether plants were inoculated with N-fixer bacteria, maize was the dominant component, whereas, soybean was the dominated. These results were evident in both seasons. On other hand, all values obtained were not high enough to exert heavy competitive pressure on the component of the intercrop either. Maximum value were obtained when plants received no nitrogen and inoculated with the bacteria in both seasons. It is also noteworthy that a regular trend of change can be detected, was by contrast to the general trend which dominate growth and yield. Agressivity values of inoculated maize decreased consistantly with increasing nitrogen up to 120 Kg N/fed. the reverse hold true in case of inoculated soybean. On other hand agressivity results revealed that values of uninoculated maize decreased up to 60 Kg N/fed then increased up to 90 Kg N/fed. rather decline was associated with 120 Kg N/fed. the reverse hold true in case of uninoculated soybean.

4. **The effect of both inoculating maize and soybean plants with N-fixer bacteria and adding different levels of N fertilizer on Competitive Ratio (C R.).**

Competitive ratio results which measure the exact degree of competition of each component revealed that CR of maize was ever higher than that of soybean under any level of nitrogen or whether inoculated or left uninoculated with N-fixer bacteria. Values of CR of soybean were going round half the value of CR of maize in any interaction. While CR of maize received no nitrogen and inoculated with N-fixer bacteria was the highest, CR of soybean of the same treatment was the lowest. Competitive ratio values of maize reached their maximal when the crop received no nitrogen and inoculated with N-fixer bacteria whereas reached their minimal with soybean grown by the same respective treatments. These results were true in both seasons.

5. The effect of both inoculating maize and soybean plants with N-fixer bacteria and adding different levels of N fertilizer on Area Time Equivalent Ratio (ATER).

Results on Area Time Equivalent Ratio (ATER) indicated lower values than those recorded on LER as time the crops remained on land elongated as compared with the crops grown in pure stand. Nevertheless, results revealed that there were increases with increasing nitrogen fertilizer level up to 60 Kg N/fed. thereafter a slow down was observed at 90 Kg N/fed. another increase was observed at the highest level (120 Kg N/fed.). These results were valid in both seasons. From another angle of results there were ever higher value when plants were inoculated with N-fixer bacteria as compared with uninoculated plants under the same respective treatment. However, it note worthy that all values obtained were lower than the unit indicating no any yield advantage in both seasons.

IV. Cereal Units (CUs).

Results on the yield of intercrops in terms of cereal unit Table (32) indicate that none of the interaction treatments of the intercropped maize could produce more cereal units than the

Table (32): Effect of nitrogen levels and bacterial inoculated on Cereal Units (CUs) in 1999 and 2000 seasons.

Characters / Treatments		Maize intercropped with soybean							Maize in pure stand			Soybean in pure stand		
		Intercropped maize			Intercropped soybean			Total	kernels	Stalk	Total	Seeds	Straw	Total
N levels (Kg/fed.)	Bacterial inoculated	kernels	Stalk	Total	Seeds	Straw	Total							
		First season 1999												
0	Uninoculated	19.15	2.531	21.681	8.42	1.656	10.076	31.757	30.88	3.683	34.563	19.54	3.846	23.386
	inoculated	21.46	2.929	24.389	10.32	2.031	12.351	36.740	32.97	3.938	36.908	23.40	4.602	28.002
60	Uninoculated	23.40	3.032	26.432	12.36	2.433	14.793	41.225	36.68	4.281	40.961	26.98	5.310	32.290
	inoculated	26.46	3.375	29.835	13.98	2.748	16.728	46.563	39.49	4.617	44.107	29.70	5.844	35.544
90	Uninoculated	26.78	3.227	30.007	9.82	1.932	11.752	41.759	41.85	4.548	46.398	21.62	4.254	25.874
	inoculated	28.67	3.453	32.123	12.78	2.514	15.294	47.417	43.68	4.737	48.417	27.32	5.379	32.699
120	Uninoculated	28.76	3.660	32.420	15.48	3.048	18.528	50.948	44.52	5.009	49.529	33.12	6.519	39.639
	inoculated	33.15	3.849	36.999	18.68	3.675	22.355	59.354	50.15	5.775	55.925	39.12	7.698	46.818
		Second season 2000												
0	Uninoculated	23.33	2.784	26.114	5.90	1.158	7.058	33.172	34.05	4.052	38.102	16.98	3.339	20.319
	inoculated	26.22	3.237	29.457	7.22	1.419	8.639	38.096	36.56	4.353	40.913	20.32	3.996	24.316
60	Uninoculated	28.92	3.354	32.274	8.64	1.698	10.338	42.612	40.85	4.748	45.598	23.46	4.614	28.074
	inoculated	32.61	3.746	36.356	9.78	1.923	11.703	48.059	44.01	5.127	49.137	25.86	5.088	30.948
90	Uninoculated	33.40	3.603	37.003	6..76	1.329	8.089	45.092	47.04	5.082	52.122	18.78	3.696	22.476
	inoculated	35.70	3.859	39.559	8.80	1.734	10.534	50.093	49.24	5.304	54.544	23.74	4.671	28.411
120	Uninoculated	36.81	4.355	41.165	10.78	2.121	12.901	54.066	50.29	5.621	55.911	28.84	5.673	34.513
	inoculated	42.07	4.326	46.396	13.00	2.556	15.556	61.952	57.25	6.501	63.751	34.04	6.696	40.736

pure stand maize at the same respective treatment. From another angle, all values under any level of nitrogen fertilizer were higher when maize was inoculated with the bacteria as compared with the uninoculated maize. These observations hold true with increasing nitrogen fertilizer level up to 120 Kg N/fed. in both seasons. The results also hold true for kernels stalks and the total cereal units produced from both. These results are concordant with those obtained by Khalil (1995) who found that cereal unit produced from intercropped maize was ever lower than those obtained from the pure stand maize.

Cereal units produced from soybean plants intercropped with maize were also ever lower than those produced from pure stand soybean under the same respective treatment. However, the treatment effect followed a distinctive pattern rather than that prevailed of maize component. It is evident that the trend was governed and resembled the treatment effect on growth, yield and yield components of soybean. The results revealed that cereal units produced from pure stand or intercropped plants increased when first dose of nitrogen fertilizer was added (60 Kg N/fed.) thereafter a slow down was observed at 90 Kg N/fed.. Another increase in the cereal unit was also observed at 120 Kg N/fed.. These results hold fairly true in both seasons. The results also revealed that all values of cereal units when soybean plants were inoculated with N-fixer bacteria were always higher than those obtained from uninoculated plants under any level of nitrogen fertilizer. These observations also hold true in both seasons. It is note worthy to consider that total cereal units produced from maize when plants were inoculated with N-fixer bacteria and received 120, 90, 60 and 0 Kg N/fed. exceeded those obtained from plants left uninoculated by 12.49, 12.88, 7.05 and 14.12% and 12.80, 12.65, 6.91 and 12.71% under intercropping system and 6.79, 7.68, 4.35 and 12.91% and 7.38, 7.76, 4.65 and 14.02% in case of pure stand in 1999 and 2000 seasons, respectively whereas, in case of soybean plants, the percent increases were 22.58, 13.08, 30.14 and 20.66% and 22.40, 13.20, 30.23 and 20.58% under intercropping system and 19.74, 10.08, 26.38 and 18.11% and 19.67, 10.24, 26.41 and 18.03% in case of pure stand for the same respective treatments and same seasons.

Data also revealed that the total cereal unit resulted from the intercrop system (soybean/maize) was at maximal when both crops were inoculated with N_2fixer bacteria and received 120 kg N/fed. And exceed total cereal unit produced from maize pure stand by 6.13% in 1999 season. Total cereal units produced from pure stand soybean by 26.78, 52.08% in 1999 and 2000 seasons, respectively.