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EFFECT OF RHIZOBIUM INOCULATION, NITROGEN LEVELS AND TIME OF NITROGEN APPLICATION ON MUNGBEAN UNDER SANDY SOIL CONDITIONS.

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ABSTRACT: Two field trials were conducted in extension field, Ezat Sharf village at El-Tal –El-Kabeer, Ismilia district (Ismilia Governorate) during the two successive seasons 1994 and 1995 to study the effect of rhizobium inoculation (inoculated and un-inoculated) and nitrogen application before sowing, i.e. (zero, 20 and 30 kg N/fad.) and three levels of nitrogen application after planting i.e. (zero, 20 and 30 kg N/fad.) on yield and its attributes of mungbean.

The results showed that rhizobium inoculated plants were significantly superior than un-inoculated ones in plant height, number of branches/plant, number of pods/plant, seed yield(g)/ plant, pod thickness(cm), pod yield (ton/fad.), seed yield (ton /fad.) and straw yield (ton/fad.). While, the increase was not significant in weight of pods/plant, seed index and length of pod (cm). Highly significant response were found in all studied characters due to increasing nitrogen fertilizer under the two times of application. In general, 30 kg N/fad. gave the highest values, except, weight of pods/plant, seed yield (g /plant) and length of pod (cm) showed that the differences between 20 and 30 kg N/fad. in nitrogen application before sowing were non significant.

The results indicated that, seed yield appeared positive and highly significant correlation with all studied characters.

Multiple linear and stepwise regression analysis indicated that number of branches /plant ($R^2 = 81.265$ %) and ($R^2 = 89.696$ %) was the most closely important variable toward seed yield/fad.

Path analysis revealed that number of branches /plant was the main seed yield component, and the relative contributions direct and indirect were about 69.09, 7.20 and 18.78 % in respective order.

INTRODUCTION

Mungbean or green gram (*Vigna radiata L.* Wilczek.)* is an annual summer seed legume crop and is a newly introduced one in Egypt.

Most of pulses grown in Egypt are winter season crops competing wheat in the rotation. Local production of grown pluses is not sufficient to meet the increasing demand for human utilization. Thus, introducing high yielding food crops with short growing season is considered effective for narrowing the food gap in Egypt (Ashour *et al.* (1991 and 1992).

For increasing mungbean productivity in Egypt, agricultural practices such as seed inoculation with bacteria strains (Rhizobium) and fertilization treatment are needed.

Regarding rhizobium inoculation, several investigators, recorded significant increases in seed yield and yield attributes of mangbean compared with untreated ones. Haydock *et al.* (1980) in Pakistan, found that the highest mungbean dry weight/plant was obtained by seed inoculation. Gill *et al.* (1985) in Pakistan, reported that inoculation of mungbean seed with rhizobium significantly increased number of branches/plant, pods/plant, straw and seed yields. Moreover, Jamwal *et al.* (1989), Daterao *et al.* (1990) and Singh *et al.* (1993) showed that rhiozobium inoculation of mungbean seed significantly increased seed yield.

Johal and Chahal (1994), studied the effect of rhizobium inoculation on growth characteristics of mung bean. They found that rhizobium inoculation increased the growth characteristics compared with the uninoculation treatments. Thakuria and Panwar (1995) in India, indicated that inoculation of mungbean plants increased plant height compared with untreated ones. El-Naggar (1998) reported that rhizobium inoculation in mungbean caused superior increase in 1000-seed weight, seed yield/plant, , seed, straw and biological yield ton/fad. Hessien (2000) reported that rhizobium inoculation significantly increased pods number, pods weight, plant height and pods yield (ton/fad.), during both seasons, straw yield during the first season and seed yield/plant, pod length, 1000-seed weight and seed yield (ton/fad.) in the second season.

* The previous scientific name was *Phaseolus radiatus*

It is well known that nitrogen fertilization plays an important role on the productivity of different field crops. Agrico (1985) reported that increasing nitrogen fertilizer rates from 0 to 30 and 60 kg N/ha. significantly increased seed yield of mungbean. Khada *et al.* (1986) found that increasing nitrogen rates from 12.5 to 25.0 and 37.5 kg N/ha. significantly increased number of pods /plant and seed yield of mumg bean. Differences between 25.0 and 37.5 kg N/ha. concerning seed yield /ha. were not significant.

Othman and Ismail(1987) reported that applying 60 kg N /ha. had little effect on seed yield of mungbean or number of pods/plant. Hamid (1988) reported that applying nitrogen increased most yield components and seed yield of mungbean. Said *et al.* (1998) found that increasing nitrogen fertilizer levels from 0 (without application) to 15 and 30 kg N/fad. significantly increased most of studied characters in both seasons. El-Naggar (1998) reported that increasing nitrogen fertilizer rates from zero to 15 and 30 kg N/fad. significantly increased most yield components and seed yield of mungbean. However, nitrogen application increased plant height, seed index, seed yield g/plant and seed yield ton /fad. compared to zero fertilization with no significant differences in yield components between the application of 15 kg N/fad. and 30 kg N/fad. Moreover, Patel *et al.* (1988) reported that application of 0-20 kg N/ha. had no significant effect on seed yields of mungbean.

Abd El-Lateef (1996) found that late application of N fertilization caused significant increases in mungbean.

Thus, this investigation was aimed to study the effect of rhizobium inoculation, nitrogen levels and times of nitrogen application on yield attributes of mungbean.

MATERIALS AND METHODS

Two field experiments were conducted at extension field in Ezat Sharf village at El-Tal –El-Kabeer, Ismilia district (Ismilia Governorate) during the two successive seasons 1994 and 1995 to study the effect of rhizobium inoculation and nitrogen levels and time of application on yield of mungbean (genotype, namely V2010 (Giza1)).

The experiment included 12 treatments which were the combinations of two treatments of rhizobium i.e. inoculated and un-inoculated, three levels of nitrogen application before sowing i.e. (zero, 20 and 30 kg N/fad.) and three levels of nitrogen application after sowing, which was added to soil in two equal doses, one before the first irrigation and the second one at 50% flowering. Ammonium nitrate (33.5% N)was the source of nitrogen applied. The half of seeds was inoculated with the specific strain of Rhizobium (*Bradyrhizobium japonicum*) and other seeds did not inoculate. The seeds sown on May 20th in the first season and May 25th in the second season. The new land, first time used for sowing.

Harvesting was made after 100 days from sowing in the two seasons. All normal agricultural practices except the studied treatments were performed for growing mungbean as usual.

A split-split plot design with three replicates was used with sub-sub plot area of 10.8 m^2 having six rows with three m long and 60 cm between rows. The rhizobium inoculation two treatments (inoculation and un-inoculation) were assigned to the main plots, the spilt plots included three levels of nitrogen before sowing and sub-subplot included the three levels of nitrogen after sowing. Mungbean seeds were sown on both sides of the ridge in alternative hills at 20 cm. distance and 2 plants/hill.

At harvest ten guarded plants were randomly taken to determine the following yield attributes:

Plant height (cm), number of branches/ plant, number of pods/plant, weight of pods /plant (g), seed yield g /plant, seed index (100-seed weight (gm), length of pod cm, pod thickness cm, pods yield ton/fad., seed yield ton/fad and straw yield ton /fad.

Analysis of variance was performed according to Fisher's technique described by Snedecor and Cochran (1981).Treatments were compared using the new least significant differences test (NLSD) as outlined by Waller and Duncan (1969).Simple correlation analysis and regression analysis were determined estimated as mentioned by Snedecor and Cochran (1981).

Multiple linear regression between seed yield (kg/fad) and some characters, as well as, to construct a prediction model for seed yield of mungbean according to following formula:

$$Y = a + b_1 X_1 + b_2 X_2 + \ldots\ldots bn X_n$$

Coefficient of determination, R^2, was estimated for each component to evaluate the relative contribution; (Snedecor and Cochran (1981). A stepwise multiple linear regression as applied by Draper and Smith (1966), was used to compute a sequence of multiple regression equations, to determine the best variables accounted for most variance in yield. The relative contribution was calculated as coefficient of determination R^2.

Path-coefficient (Dewey and Lu, 1959) was used in this study to estimate the relative importance of characters contributing. A path-coefficient is simply a standard partial regression coefficient and as such measures the direct influence of one variable upon another and permits the separation of the correlation coefficients into components of direct and indirect effects.

RESULTS AND DISCUSSION

1- Effect of rhizobium inoculation:

Mungbean yield and yield attributes as affected by rhizobium inoculation are presented in Tables 1, 2 and 3. The results showed clearly that inoculated plants were significantly superior in plant height, number of branches/plant, number of pods/plant, seed yield g/plant, pod thickness (cm), seed yield ton/fad. and straw yield ton /fad. compared to un-inoculated ones. The relative increase due to inoculating rhizobium in some characters amounted to seed yield g/plant (13.297 %), seed yield ton/fad. (9.459%), plant height cm (2.902 %), number of branches /plant (7.296%) and straw yield kg /fad. (10.805%). The increment in seed yield (ton fad.) might be due to increases in seed yield g /plant and number of pods/plant which were significantly increased with rhizobium inoculation and similar line; increase in straw yield of mungbean as a result of rhizobium inoculation might be due to the increase in plant height and number of branches /plant. These results are in good line with those reported by Gill *et al.* (1985), Patel and Patel (1991), Pal and Jana (1991), Chovatia *et al.* (1993), Ardeshna *et al.* (1993), EL-Naggar (1998) and Hessien (2000) who showed that rhizobium inoculation surpassed uninoculation in yield and yield components of mungbean.

2- Effect of nitrogen application before sowing:

The results in Table 1, 2 and 3 show clearly that, nitrogen levels before sowing had highly significant effect on seed yield and yield attributes, it is clear from

Table 1. Plant height (cm), number of branches /plant, number of pods /plant and weight of pods /plant (g) as affected by studied treatments for two seasons and its combined analysis.

Treatments	Plant height (cm)			Number of branches/ plant			Number of pods/ plant			Weight of pods /plant (g)		
	First season	Second season	Comb.	First season	Second season	Comb.	First season	Second season	Comb.	First season	Second season	Comb.
Rhizobium Inoculation (T):												
Inoculation	44.0	41.3	42.7	4.5	4.6	4.5	28.0	27.5	27.8	24.8	25.4	25.1
Un-inoculation	42.7	40.2	41.5	4.2	4.3	4.3	25.0	24.6	24.8	24.0	23.9	24.0
F –Test	*	N. S.	**	*	*	**	*	*	**	N. S.	N. S.	N. S.
Nitrogen levels before planting (B) :												
Zero	40.6c	39.2c	39.9c	3.7b	3.7c	3.7c	18.8c	19.8c	19.3c	21.4b	21.4b	21.5b
20 kg N/fad.	44.3b	40.9b	42.7b	4.6a	4.7b	4.6b	28.8b	27.8b	28.3b	25.1a	25.6a	25.4a
30 kg N/fad.	45.1a	42.1a	43.6a	4.7a	5.0a	4.9a	32.0a	30.9a	31.5a	26.9a	26.8a	26.9a
F-Test	**	**	**	**	**	**	**	**	**	**	**	**
L. S. D.	0.67	0.69	0.56	0.19	0.11	0.12	1.43	2.16	1.23	2.42	3.01	1.60
Nitrogen levels after planting (A):												
Zero	39.6c	38.4c	39.0c	3.4c	3.4c	3.4c	17.8c	18.6c	18.2c	19.3c	18.1c	18.7c
20 kg N/fad.	43.8b	40.2b	42.0b	4.3b	4.4b	4.3b	24.3b	25.5b	24.9b	23.7b	23.9b	23.8b
30 kg N/fad.	46.7a	43.8a	45.2a	5.4a	5.5a	5.5a	37.3a	34.0a	35.7a	30.3a	31.9b	31.1a
F –Test	**	**	**	**	**	**	**	**	**	**	**	**
L. S. D.	1.51	1.25	0.96	0.28	0.11	0.15	1.4	1.10	0.87	2.84	2.44	1.83
Interactions:												
T x B	N. S.	N. S.	N. S.	N. S.	**	*	N. S.	N. S.	N. S.	N. S.	N. S.	N. S.
T x A	N. S.	N. S.	N. S.	N. S.	**	*	N. S.	*	N. S.	N. S.	N. S.	N. S.
B x A	N. S.	N. S.	N. S.	N. S.	*	N. S.	**	**	**	N. S.	N. S.	N. S.
T x B x A	N. S.	N. S.	N. S.	N. S.	*	N. S.	N. S.	N. S.	N. S.	N. S.	N. S.	N. S.

*, ** and N.S. denote to significant at 5, 1 % levelsand non significant, respectively

Table 2. Seed yield (g /plant), seed index (g), pod length (cm) /plant and pod thickness (cm) /plant as affected by studied treatments for two seasons and its combined analysis.

Treatments	Seed yield (g) /plant			Seed index (g)			Pod length (cm)			Pod thickness (cm)		
	First season	Second season	Comb.	First season	Second season	Comb.	First season	Second season	Comb.	First season	Second season	Comb.
Rhizobium inoculation (T):												
Inoculation	9.2	8.6	8.9	6.56	6.71	6.63	9.80	9.3	9.5	0.90	0.92	0.91
Un- inoculation	7.9	7.7	7.9	6.46	6.56	6.51	9.6	9.0	9.3	0.89	0.89	0.89
F –Test	**	*	**	N. S.	N. S.	N. S.	N. S.	N. S.	N. S.	N. S.	*	*
Nitrogen levels before planting (B) :												
Zero	5.3c	6.2b	5.8b	6.22b	6.00b	6.11c	9.4b	8.6b	9.0b	0.85b	0.87c	0.86c
20 kg N/fad.	9.8b	9.0a	9.4a	6.57a	6.87a	6.72b	9.8a	9.3a	9.5a	0.91a	0.91b	0.91b
30 kg N/fad.	10.6a	9.3a	10.0a	6.78a	7.08a	6.93a	10.0a	9.6a	9.8a	0.92a	0.94a	0.93a
F-Test	**	**	**	*	**	**	*	*	**	*	**	**
L. S. D.	0.35	0.44	0.34	0.31	0.29	0.20	0.39	0.49	0.29	0.036	0.02	0.02
Nitrogen levels after planting (A):												
Zero	5.4c	5.8c	5.6c	5.84c	5.96c	5.90c	9.1c	8.6c	8.8c	0.85c	0.84c	0.84c
20 kg N/fad.	7.6b	8.7b	8.1b	6.53b	6.75b	6.64b	9.7b	9.2b	9.4b	0.88b	0.91b	0.90b
30 kg N/fad.	12.8a	10.0a	11.4a	7.15a	7.18a	8.17a	10.2a	9.7a	10.0a	0.95a	0.96a	0.96a
F –Test	**	**	**	**	**	**	**	**	**	*	**	**
L. S. D.	1.17	0.78	0.69	0.32	0.18	0.18	0.22	0.29	0.17	0.03	0.02	0.02
Interactions:												
T x B	N. S.	N. S.	N. S.	N. S.	N. S.	N. S.	N. S.	N. S.	N. S.	N. S.	N. S.	N. S.
T x A	N. S.	N. S.	N. S.	N. S.	N. S.	N. S.	N. S.	N. S.	N. S.	N. S.	*	N. S.
B x A	N. S.	N. S.	N. S.	N. S.	N. S.	N. S.	N. S.	N. S.	N. S.	N. S.	N. S.	N. S.
T x B x A	N. S.	N. S.	N. S.	N. S.	N. S.	N. S.	N. S.	N. S.	N. S.	N. S.	N. S.	N. S.

*, ** and N.S. denote to significant at 5, 1 % levelsand non significant, respectively.

Table 3. Pods yield (ton/fad.), seed yield ton /fad. and straw yield (ton/fad.) as affected by studied treatments for two seasons and its combined analysis.

Treatments	Pods yield ton /fad.			Seed yield ton /fad.			Straw yield ton /fad.		
	First season	Second season	Comb.	First season	Second season	Comb.	First season	Second season	Comb.
Rhizobium inoculation (T):									
Inoculation	0.570	0.578	0.574	0.413	0.398	0.405	0.802	0.877	0.839
Un- inoculation	0.539	0.556	0.547	0.379	0.361	0.370	0.719	0.795	0.757
F –Test	N. S.	N. S.	*	*	*	**	*	*	**
Nitrogen levels before planting (B) :									
Zero	0.510c	0.522c	0.516c	0.348c	0.340c	0.344c	0.640c	0.690c	0.665c
20 kg N/fad.	0.566b	0.576b	0.571b	0.411b	0.389b	0.400b	0.794b	0.883b	0.838b
30 kg N/fad.	0.603a	0.611a	0.607a	0.433a	0.409a	0.421a	0.860a	0.930a	0.895a
F-Test	**	**	**	*	**	**	**	**	**
L. S. D.	0.023	0.021	0.015	0.017	0.016	0.011	0.457	0.277	0.253
Nitrogen levels after planting (A):									
Zero	0.455c	0.477c	0.466c	0.294c	0.277c	0.285c	0.638c	0.713c	0.675c
20 kg N/fad.	0.555b	0.564b	0.559b	0.395b	0.353b	0.374b	0.772b	0.863b	0.818b
30 kg N/fad.	0.654a	0.660a	0.657a	0.500a	0.509a	0.504a	0.872a	0.931a	0.902a
F –Test	**	**	**	**	**	**	**	**	**
L. S. D.	0.021	0.035	0.020	0.020	0.022	0.015	0.513	0.288	0.288
Interactions:									
T x B	N. S.	N. S.	N. S.	N. S.	N. S.	**	N. S.	N. S.	N. S.
T x A	N. S.	N. S.	N. S.	N. S.	N. S.	N. S.	N. S.	N. S.	*
B x A	N. S.	N. S.	N. S.	N. S.	N. S.	N. S.	N. S.	N. S.	N. S.
T x B x A	N. S.	N. S.	N. S.	N. S.	N. S.	N. S.	N. S.	N. S.	N. S.

*, ** and N.S. denote to significant at 5, 1 % levelsand non significant,respectively.

data that, plant height (cm), number of branches /plant, number of pods/plant, weight of pods/plant (g), seed yield (g) /plant, seed index, length of pod cm, pod thickness cm, pod yield ton/fad., seed yield ton/fad. and straw yield ton/fad. recorded higher values during the two seasons and combined with nitrogen application before sowing compared to without application in the same time. The relative increases in plant height from zero to 20 and 30 kg N/fad. was (7.08 %), number of branches /plant was (22.83%), number of pods /plant was (51.13%) weight of pods/plant was (19.82 %), seed yield g /plant was (55.99%), seed index ton/fad. was (11.43%), pods yield ton /fad. was (16.95), seed yield ton/fad. was (19.94 %) and straw yield ton/fad. was (30.05%), concerning combined data. Similar results were reported by El Naggar (1998) and Said *et al.* (1998) who reported that increasing nitrogen fertilizer rates from zero to 15 to 30 kg N /fad. significantly increased most yield and yield attributes of mungbean.

3- Effect of nitrogen application after planting:

Results of two successive seasons and its combined analysis in Tables 1, 2 and 3 show that increasing level of nitrogen fertilization from zero to 20 kg N/fad. and to 30 kg N/fad. after planting had positive and highly significant effects on all yield and yield attributes characters studied. Increasing N-levels from zero up to 30 kg N/fad. increased seed yield ton/fad. and such increment reached around 31.22 and 76.84 % when N-levels increased from zero to 20 kg N/fad. and 30 kg N/fad. respectively, concerning the combined data. Such results indicated the importance rule of nitrogen in increasing the productivity of mungbean crop.

Like wise, increasing N-levels increased pods yield ton/fad. and straw yield ton/fad. The respective increase reached 40.98 and 33.58 % when N-level increased from zero to 30 kg N/fad. for pods yield ton/fad. and straw yield ton/fad., concerning the combined data. These results are in agreement with those obtained by Agrico (1985), Patel and Parmar (1986), Othman and Ismail (1987), Sharma and Choubey (1991), Sharma *et al.* (1993), Abdel-Lateef (1996) who found that late application of nitrogen caused significant increases in seed /plant and seed yield/fad. in mungbean.

4- Effect of Interaction:

The interaction effects between the rhizobium inoculation and nitrogen fertilization after planting on number of branches and straw yield ton/fad. in the combined data showed significant differences (Table 4 and Fig. 1). Results indicated that rhizobium inoculated plants recorded the highest values of number of branches /plant (5.8) and straw yield (0.945 ton/fad.) when 30 kg N/fad. was applied after planting.

Likely, the significant and highly significant interaction effects between rhizobium inoculation and nitrogen application before planting (Table 5 and Fig. 2) show that un-inoculated plants recorded the lowest values of number of branches /plant (3.7) and seed yield ton/fad. (0.331) when no nitrogen was applied before planting. Seed yield ton/fad. appeared to be gradually increased as nitrogen level applied before planting from zero to 30 kg N/fad either under inoculated or uninoculated treatments. Likely, inoculated plants produced higher seed yield ton/fad. under different levels of nitrogen applied before planting compared with uninoculated ones. Therefore, the highest seed yield (0.447 ton /fad.) was achieved by inoculated plants when 30 kg N/fad. applied before planting.

Finally, the highly significant interaction effect between nitrogen levels applied before and after planting (Table 6 and Fig. 3) show that number of pods became great with applied 30 kg N/fad. before planting under the different levels of nitrogen applied after planting. However, adding nitrogen for two time (before or after planting) tend to increase number of pods/plant. Whereas, the highest number of pods (42.8) was achieved by 30 kg N/fad. added before planting and 30 kg nitrogen applied after planting. While, zero nitrogen for the two times of applications recorded the lowest number of pods/plant (14.8).

5- The correlation coefficients

The interrelationships among seed yield of mungbean and its attributes as affected by the studied factors measured as simple correlation are shown in Table 7.

Seed yield was positively and highly significantly correlated with all characters studied i.e. plant height (0.982), number of branches/plant (0.987), number of pods/plant (0.969), seed yield gm /plant (0.959) and seed index (0.946). Similar, results were

Table 4. Interaction effect between Rhizobum inoculation and nitrogen fertilizer applied after planting on number of branches /plant and straw yield ton/fad. "combined data".

Nitrogen levels after planting / Rhizobium inoculation	Zero	20 kg N/fad.	30 kg N/fad.
	Number of branches/plant		
	C	B	A
Inoculation	3.5a	4.4a	5.8a
	C	B	A
Un- Inoculation	3.3a	4.2a	5.2b
	Straw yield ton /fad.		
	C	B	A
Inoculation	0.735a	0.838a	0.945a
	C	B	A
Un- Inoculation	0.616b	0.797b	0.859b

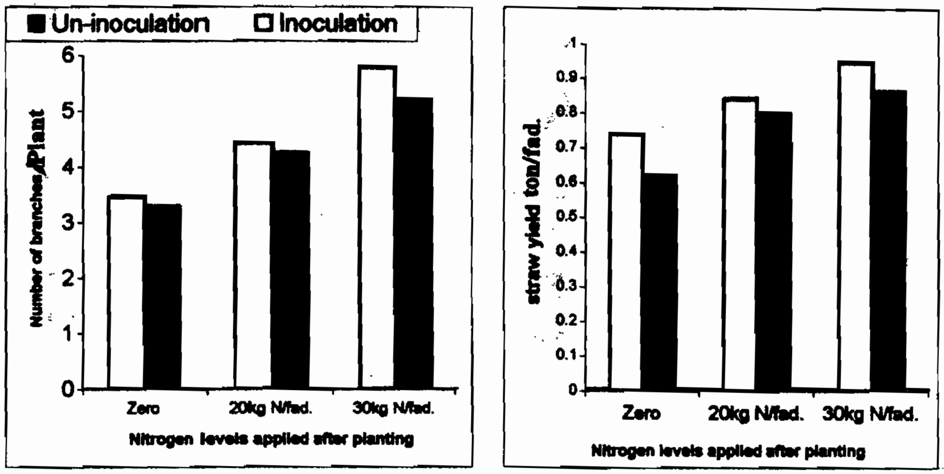

Fig.1. Means of number of branches/plant and straw yield ton/fad. as affected by the interaction between Rhizobium inoculation and nitrogen levels applied after planting in the combined data.

Table 5. Interaction effect between Rhizobum inoculation and nitrogen fertilizer applied before planting on number of branches /plant and seed yield ton/fad. "combined data".

Nitrogen levels before planting / Rhizobium inoculation	Zero	20 kg/fad.	30 kg/fad.
		Number of branches /plant	
	C	B	A
Inoculation	4.2a	4.7a	4.9a
	C	B	A
Un- Inoculation	3.7b	4.5b	4.8a
		Seed yield ton/fad.	
	C	B	A
Inoculation	0.371a	0.417a	0.447a
	C	B	A
Un- Inoculation	0.331b	0.383b	0.420b

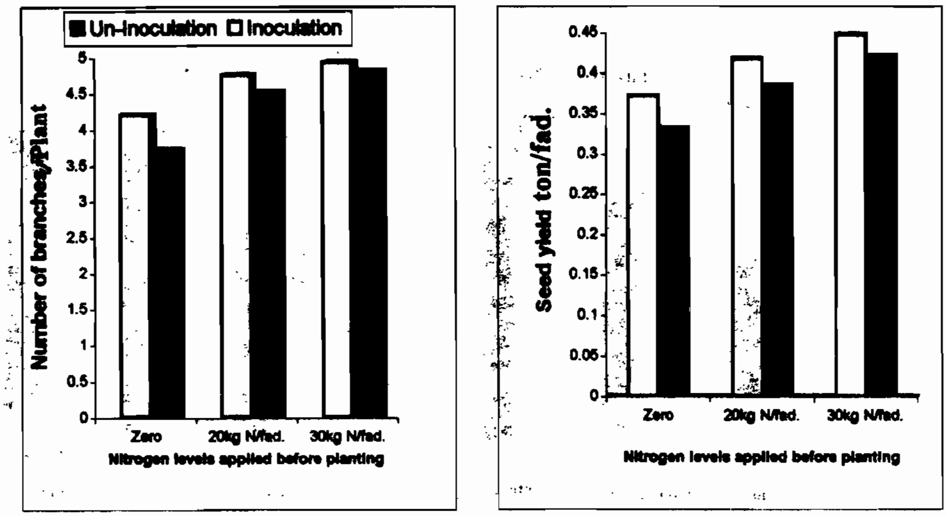

Fig.2. Means of number of branches/plant and seed yield ton/fad. as affected by the interaction between Rhizobium inoculation and nitrogen levels applied before planting in the combined data.

Table 6. Interaction effect between nitrogen fertilizer applied levels before planting and after planting on number of pods/plant. "combined data".

Nitrogen levels before planting \ Nitrogen levels after planting	Zero	20 kg N/fad.	30 kg N/fad.
Zero	C 14.8c	B 18.9c	A 28.8c
20 kg N/fad.	C 19.2b	B 27.0b	A 38.6b
30 kg N/fad.	C 21.4a	B 30.2a	A 42.8a

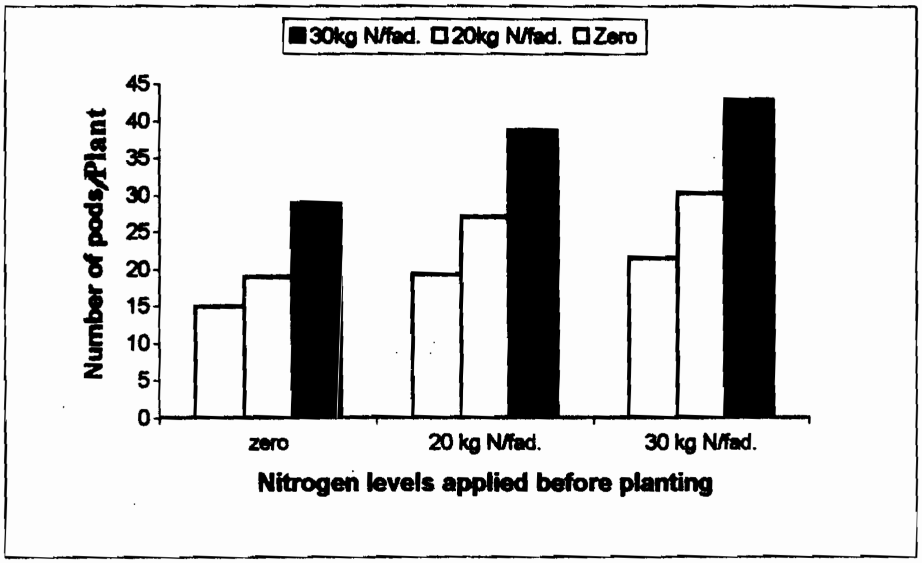

Fig.3. Means of number of pods as affected by their interaction between nitrogen levels applied before planting and nitrogen levels applied after planting in the combined data

Table 7. Correlation coefficients among seed yield and seed yield attributes of mung bean (combined data).

Characters	2	3	4	5	6	7	8	9	10	11
1-Seed yield ton /fad.	0.982**	0.987**	0.969**	0.995**	0.959**	0.946**	0.951**	0.972**	0.987**	0.880**
2-Plant height (cm)	-	0.998**	0.988**	0.988**	0.981**	0.974**	0.984**	0.979**	0.996**	0.939**
3-Number of branches/plant	-	-	0.987**	0.994**	0.974**	0.970**	0.976**	0.977**	0.995**	0.922**
4-Number of pods/plant	-	-	-	0.978**	0.980**	0.978**	0.989**	0.987**	0.986**	0.951**
5-Weight of pods (g)/plant	-	-	-	-	0.993**	0.955**	0.958**	0.972**	0.992**	0.886**
6-Seed yield (g) /plant	-	-	-	-	-	0.959**	0.976**	0.965**	0.960**	0.962*
7-Seed index (g)	-	-	-	[illegible]	[illegible]	-	0.992**	0.990**	0.979**	0968**
8-Length of pods (cm)	-	-	-	-	-	-	-	0.990**	0.984**	0.979**
9-Pod thickness (cm)	-	-	-	-	-	-	-	-	0.988**	0.952**
10-Pods yield ton/fad.	-	-	-	-	-	-	-	-	-	0.931**
11-Straw yield ton /fad.										-

obtained by Said *et al.* (1998) and Hessien (2000). Also, in general, all correlation coefficients among the studied yield attributes were positive and highly significant .

6- Multiple linear regression analysis:

Data presented in Table 8 show the relative contribution for yield variables in predicting seed yield /fad., regression coefficients and standard error. Examining this ..., indicated that the combined effects of number of branches /plant, number of pods/plant and seed index, in the manner described by regression equation, contribute significantly to the variation in yield. It can be noticed that the total variation in seed yield fad. could be linearly related to variations in all variables and 0.01 % could be due to residual. Number of branches /plant (R^2 = 81.265%) number of pods/plant (R^2= 5.977%) and seed index(R^2 = 10.406 %) were the most variables contributing toward seed yield /fad. The best prediction equation for seed yield Y is formulated as follows:

$$Y = 62.9748 + 121.3517 X_1 - 1.0037 X_2 - 23.9702 X_3$$

Where : X_1= Number of branches /plant

X_2 = Number of pods /plant,

X_3 = Seed index.

These results are in agreement with those obtained by Said *et al.* (1998) and Sharief and Keshta (2000) where number of branches/plant (R^2) was (33.17 %) and (7.59 %), respectively.

Table 8. Relative contribution (R^2), regression coefficient and standard errors for three characters in predicting seed yield on mungbean.

Variables	Regression coefficient	Standard error	Relative contribution (R^2 %)
Number of branches / plants	121.3517	43.2206	81.2657*
Number of pods/ plants	-1.0037	5.6544	5.9776
Seed index	-23.9702	49.9570	10.4066

Y intercept = 62.9748 Adjusted R^2 = 0.9625

R square = 0.9765 Multiple R = 0.9882

7- Stepwise regression analysis:

Variables acceptance and removal as well as relative contribution of yield variables in predicting seed yield/fad. are shown in Table 9. The results indicated that number of branches /plant (R^2 = 89.696%) was variable significant contributing to variation in seed yield/fad. the prediction equation of seed yield/fad. The (y) was formulated as follows:

$$Y= -39.9013 +97.4699X_1.$$

Where X_1 = number of branches/plant.

Although, the simple correlation coefficient between each of number of pods/plant (r= 0.969) and seed index (r = 0.946) was highly significant, the direct effect of both characters was negative . Therefore, the simple correlation coefficient is miss leading and partitioning of simple correlation coefficient must be done using Path analysis.

Table 9. Accepted removal variables according to stepwise analysis and their relative contribution (R^2) in seed yield variance in mungbean.

Variables	Regression coefficient	Standard error	R^2 %
Accepted variables			
1-Number of branches/plant	97.4699	5.9821	89.6966**
Removed variables			
1-Number of pods/plant	-0.2180	-0.2144	2.2587
2-Seed index	-0.1877	-0.2867	5.4447

Y intercept = -39.9013 Adjusted R^2 = 0.9706
R square = 0.9743 Multiple R = 0.9870

8- Path analysis:

Path analysis was used to determine the relative importance of umber of branches/plant, number of pods/plant and seed index to seed yield variation in mungbean. The effects of direct and indirect Path coefficient of yield components on seed yield are shown in Table 10. Number of branches /plant showed a highly direct effect on seed yield. The indirect effect through each of the number of pods and seed index were negative and low value (-0.0633) and (-0.1652). But, number of pods /plant showed negative direct effect of (-0.0642). While, the indirect effect through the number of branches /plant was positive and high value of 1.199 and the indirect effect through the seed index was negative and low value (–0.1666). The seed index effects direct and indirect same effects for number of pods/plant.

The relative importance of studied components to seed yield variation as percentage are shown in Table11. It is clear that number of branches/plant, as well as, their interaction contributed as much to

Table 10. Partitioning of simple correlation coefficient between seed yield and its components of mungbean.

Sources	Values
Number of branches /plant:	
Direct effect	1.215
Indirect effect via number of branches /plant	-0.0633
Indirect effect via seed index	-0.1652
Total (ry_2)	0.9870
Number of pods /plant:	
Direct effect	-0.0642
Indirect effect via number of branches /plant	1.1996
Indirect effect via seed index	-0.1666
Total (ry_2)	0.9690
Seed index:	
Direct effect	-0.1703
Indirect effect via number of branches /plant	1.1790
Indirect effect via seed index	-0.0628
Total (ry_2)	0.946

Table 11. Direct and Joint effects of yield components to variation of seed yield in mung bean.

Source of variance	C.D.	%
Number of branches/ plant	0.6909	69.09
Number of pods/plant	0.0019	0.19
Seed index	0.0135	1.35
Number of branches/ plant x Number of pods/plant	0.0720	7.20
Number of branches/ plant x Seed index	0.1878	18.78
Number of pods/ plant x Seed index	0.0102	1.02
R^2	0.9763	97.63
Residual	0.0237	2.37
Total	1.0000	100.00

C.D. = Coefficient of determination

% = Percentage of contributed.

seed yield variation, since R2 recorded heren was 97.63 % total yield variation. However, the residual effect contributing to seed yield was low and negligible being 2.37 % of the total variation. The data obtained showed that the most important sources of seed yield variation could be arranged according to their importance in following order: Number of branches and their interactions (number of branches /plant X number of pods /plant and number of branches /plant X seed index). Since, their values were 69.09, 7.20 and 18.78 contributing to seed yield.

From these results, it can be stated conveniently that improving the productivity of the tested varieties could be achieved when the studied treatments i.e. nitrogen fertilization and inoculation direct to be increasing number of branches/plant, seed index and number of pods/plant.

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تأثير التلقيح البكتيري ومستوي النيتروجين وميعاد إضافة النيتروجين علي فول المانج تحت ظروف الأراضي الرملية

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أقيمت تجربتان حقليتان في حقل إرشادي بعزت شرف - التل الكبير - محافظة الإسماعيلية في موسمي زراعة ١٩٩٤ و ١٩٩٥ لدراسة تأثير التلقيح البكتيري وميعاد إضافة السماد النيتروجيني بمعدلاته المختلفة قبل الزراعة (صفر ، ٢٠ و٣٠ كجم ن /فدان) وبعد الزراعة (صفر ، ٢٠ و ٣٠ كجم ن /فدان) علي محصول فول المانج في تصميم القطع المنشقة مرتين.

أظهرت النتائج تفوق التلقيح البكتيري بزيادة معنوية لمعظم الصفات تحت الدراسة مثل ارتفاع النبات وعدد فروع النبات وعدد القرون للنبات ومحصول النبات وعرض القرن بالسم ومحصول القرون طن /فدان ومحصول البذور طن/فدان ومحصول القش طن /فدان. بينما الزيادة لم تكن معنوية في كل من الصفات التالية وزن قرون النبات ودليل البذرة (١٠٠ بذرة جم) و طول القرن بالسم كما وجد ت اختلافات عالية المعنوية بزيادة النيتروجين المضاف لكلا من ميعادي الإضافة قبل أو بعد الزراعة في كل الصفات تحت الدراسة. وعموما أعطي معدل ٣٠ كجم ن /فدان أعلي القيم ماعدا وزن قرون النبات ومحصول النبات (جم) و طول القرن (سم) حيث كانت غير معنوية بين ٢٠ و ٣٠ كجم ن /فدان عند الإضافة قبل الزراعة.

كما أظهرت النتائج أن محصول البذرة أظهر ارتباط موجب عالي المعنوية مع كل الصفات تحت الدراسة.

وقد دلت نتائج معامل الانحدار المتعدد والمرحلي أن عدد فروع النبات كانت الأكثر أهمية علي محصول بذور الفدان حيث ساهمت بـ ٨١,٢٦٥ % و ٨٩,٦٩٦% علي التوالي.

كما أظهر تحليل معامل المرور أن عدد فروع النبات هو المحدد لاختلاف محصول البذرة حيث كانت قيمة مساهمته المباشرة وتداخلها ٦٩,٠٩ و ٧,٢٠ و ١٨,٧٨ %