

Response of greengram (*Vigna radiata* L. Wilezek) varieties to molybdenum application and *Rhizobium* inoculation in respect of nodulation and yield

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A field experiment was conducted at 'C' Block Farm, Bidhan Chandra Krishi Viswavidyalaya during summer season of 2002 to study the response of greengram varieties to molybdenum application and *Rhizobium* inoculation in a split plot design with two varieties V₁ (Pusa Baisakhi) and V₂ (Sonali), two levels of *Rhizobium* inoculation viz. uninoculated control (R₀) and inoculation with IGR-6 Strain (R₁) and three levels of molybdenum viz. M₀ i.e. no molybdenum application, M₁, i.e. application of .75 kg Mo/ha and M₂, i.e., application of 1.5 kg Mo/ha. Both the varieties, Pusa Baisakhi and Sonali (B-1) were grown on sandy clay loam soil with recommended doses of 20 kg N/ha, 40 kg P₂O₅ /ha and 20 kg K₂O/ha and were sown on February 2002 at 25 cm × 10 cm inter and intra row spacings. Results indicated that *Rhizobium* inoculation and molybdenum application improved all parameters pertaining to growth and yield of greengram for both the varieties. Among the molybdenum levels M₁, proved to be best in all respects of growth and yield components over M₀ and M₂ with *Rhizobium* inoculation. Although molybdenum application and *Rhizobium* inoculation improved all the growth characters and yield for both the varieties, the best result was obtained in case of V₁ (usa Baisakhi). Among all the treatment combinations V₁R₁M₁ was found to be best in respect of all the characters and grain yield of greengram and it produced the maximum seed yield (1175.06 kg/ha).

Key words : *Rhizobium*, nodulation, Pusa Baisakhi, Sonali, molybdenum, inoculation, nodule strain

INTRODUCTION

Among the pulses green gram (*Vigna radiata* L. Wilezek) is one of the most important crop with an excellent source of high quality protein amounting to 25%. Now, in India mungbean is cultivated in 3.08 ha of land with production of 1.31m. tonnes and the productivity of 425 kg/ha (Survey of Indian Agriculture, 2000). It is primarily a rainy season crop in most of the states of the country but its cultivation during summer season started about two decades ago in certain areas of the country (Sharma *et al.*, 1993) where early maturing (60-65 days) varieties were grown. Several improved varieties of greengram have been introduced like B-105, T44, which are high yielder, yielding upto 0.8 -1.6 t/ha (Chatterjee and Khan, 1982) and variety B-1 (Sonali) which can give yield up to 10 t/ha (Sinha *et al.*, 1988).

Molybdenum as a nutrient is almost entirely essential for nitrogen fixing mechanisms. In molybdenum deficient soil although the plant grows perfectly well and roots will be nodulated but fails to fix nitrogen. Further, it stimulates the activities of nitrogenase, hydrogenase responsible for nitrogen reduction in biological nitrogen fixation. (Singh *et al.*, 1993). Increase in height of plant with *Rhizobium* inoculation was also observed by Sahu and Behara (1972) and Prasad and Ram (1988). Grain yield and yield component of greengram have been reported to be greatly influenced by *Rhizobium* inoculation and molybdenum application (Brar and Lal, 1991). On the basis of these studies programme was undertaken to study the comparative performances of two mungbean cultivars in respect of growth, nodulation and yield.

MATERIALS AND METHODS

The study was made during the pre-kharif season of 2002 at B.C.K.V. Farm, Kalyani, West Bengal. The experiment was laid out in split-plot design with 12 treatments combination of 3 factors and 3 replications. Among the treatments variety in main plot, *Rhizobium* in subplot and molybdenum in sub-plot were allotted randomly. Twelve treatment combinations of 2 varieties of greengram, pusha Baisakhi (T_{44}) and Sonali (B_1), 2 levels of *Rhizobium* i.e. R_0 (without *Rhizobium*) and R_1 (with *Rhizobium*) and 3 levels of molybdenum i.e. M_2 (no molybdenum), M_1 (0.75 kg molybdenum per hectare) and M_2 (1.5 kg molybdenum per hectare) as ammonium molybdenum were employed. Normal agronomical practices for cultivation of greengram were done for maintaining growth and vigour of the crop. Different biometrical observations like height of the plant, dry weight of the shoot, number of nodule per plant were recorded and finally yield of the crop was also recorded.

RESULTS AND DISCUSSION

Effect of variety on plant height at different stages of plant growth

Greengram cv. Baishakhi gave significantly higher plant height over Sonali (Table 1) at 25 DAS, 45 DAS and at harvest (75 DAS). The maximum plant height was 66.46 cm in Pusa Baisakhi at harvest which was 1.87% higher than that of Sonali (65.24 cm) at harvest. The plant height obtained at 45 DAS in Pusa Baisakhi was 31.95 cm which was 4.99% higher over Sonali (30.43 cm.).

Effect of Rhizobium inoculation on plant height at different stages of growth

Seed inoculation increased plant height significantly over uninoculated control of 25 DAS and at harvest (Table 1). Inoculation stimulated better nodulation which resulted in higher rate of N-fixation which produced maximum height of the plant (68.78 cm) over that recorded under no inoculation (62.93 cm) at harvest. The increase

was 9.29% higher over no inoculation. Increase in height of plant with inoculation was also observed by Sahu and Behara (1972) and by Prasad and Ram (1988).

Table 1 : Effects of variety, *Rhizobium* inoculation and molybdenum of plant height (in cm.) at different stages of plant growth of greengram.

Treatments	25 DAS	45 DAS	At harvest (75 DAS)
Variety			
V_1 (Pusa Baisakhi)	12.29	31.95	66.46
V_2 (Sonali)	11.8	30.43	65.24
S Em \pm	0.04	0.03	0.09
CD 5%	0.12	0.10	0.53
Levels of Inoculation			
R_0 (Uninoculated)	10.82	29.57	62.93
R_1 (Inoculated)	13.28	32.81	68.78
S Em \pm	0.03	0.03	0.07
CD 5%	0.10	0.13	0.26
Levels of Molybdenum			
M_0 (0 kg Mo/ha)	10.48	28.76	60.89
M_1 (0.75 kg Mo/ha)	13.34	33.43	69.98
M_2 (1.5 kg Mo/ha)	12.33	31.38	66.69
CD 5%	0.10	0.08	0.19

DAS = Days after sowing

Effect of molybdenum on plant height at different stages of growth

Molybdenum application influenced the height significantly (Table 1). The data revealed that 0.75 kg Mo/ha recorded maximum height of 69.98 cm at harvest which was significantly higher than the plant height that was 0 and 1.5 kg Mo/ha was 14.92% and 4.93% more than that of 0 kg Mo and 1.5 kg Mo/ha respectively.

Effect of interaction among variety, inoculation and molybdenum on dry matter accumulation (g/m²) at 45 DAS and 65 DAS.

The interaction effect among variety, inoculation and molybdenum on dry matter accumulation was significant at 45 and 65 days after sowing (Table 2). Dry matter of 58.46 and 198.61 g/m² obtained from Pusa Baisakhi which combination of 0.75 kg Mo/ha and seed inoculation which *Rhizobium* at 45 and 65 DAS respectively which were superior to all other combinations. Greengram cv. Pusa Baisakhi produced dry matter of 192.68 g/m² with combination of 0 kg Mo and with *Rhizobium*

inoculation was statistically at par with dry matter (192.54 g/m²) produced by Sonali with 1.5 kg Mo and without inoculation at 65 DAS. Again, dry matter (190.6 g/m²) produced by Pusa Baisakhi with combination of 1.5 kg Mo and without inoculation.

Table 2 : Effects of interaction among variety, inoculation and molybdenum on dry matter accumulation (g/m²) at 45 & 65 DAS of greengram

Treatments	Days after sowing 45	Days after sowing 65
V ₁ R ₀ M ₀	49.55	174.73
V ₁ R ₀ M ₁	54.84	194.72
V ₁ R ₀ M ₂	51.65	190.6
V ₁ R ₁ M ₀	53.49	192.68
V ₁ R ₁ M ₁	58.46	198.61
V ₁ R ₁ M ₂	57.08	195.34
V ₂ R ₀ M ₀	48.63	173.26
V ₂ R ₀ M ₁	53.67	192.54
V ₂ R ₀ M ₂	52.22	188.84
V ₂ R ₁ M ₀	52.64	190.57
V ₂ R ₁ M ₁	57.46	195.86
V ₂ R ₁ M ₂	56.22	193.54
CD 5%	0.042	0.410

V₁ = Pusha Baisakhi R₀ = No Rhizobium M₀ = No Molybdenum
V₂ = Sonali R₁ = With Rhizobium M₁ = 0.75 kg Mo/ ha
M₂ = 1.5 kg Mo/ ha

Effect of interaction among variety, inoculation and molybdenum on number of nodules / plant at 25 DAS and at 65 DAS

A significant highest number of nodules per plant of 16.46, 25.0 and 11.99 were obtained at 25 DAS, 45 DAS and at 65 DAS respectively from greengram cv. Pusa Baisakhi with application of 0.75 kg Mo/ha in inoculated plant (Table 3). The number of nodules obtained at 25 DAS from variety Pusa Baisakhi with combination of 0 kg Mo + no inoculation (11.63) was the lowest but statistically at par with that obtained from Sonali with combination of 0 kg Mo + inoculation (11.86). Again, the nodule number obtained from Pusa Baisakhi with combination of 0 kg Mo + inoculation (14.16) was statistically at par with that obtained from Sonali with combination of 0.75 kg Mo + inoculation (14.36).

At 45 DAS the number of nodules obtained from Greengram cv. Sonali (Table 3) with inoculation and application of 0.75 kg Mo/ha (22.83) was statistically at par with that obtained from variety.

Pusa Baisakhi with combination of 0 kg Mo + inoculation (22.5), was again statistically at par with nodule number obtained from Sonali with combination of 1.5 kg Mo + inoculation (22.13). The number of nodules found from Sonali without inoculation of seed and application of 0.75 kg Mo/ha (21.3) was statistically at par from the same variety with combination of 0 kg Mo + inoculation. Again the nodule number of 19.86 obtained from variety pusa Baisakhi without inoculation and application of 1.5 kg Mo/ha was statistically at par with the nodule number obtained from variety Sonali with the application of 1.5 kg Mo and without seed inoculation.

Table 3 : Effects of interaction among variety, inoculation and molybdenum on number of nodules per plant (greengram) at 25 DAS, 45 DAS and 65 DAS.

Treatments	25 DAS	45 DAS	65 DAS
V ₁ R ₀ M ₀	11.63	18.6	8.7
V ₁ R ₀ M ₁	14.83	23.63	10.99
V ₁ R ₀ M ₂	12.0	19.86	8.74
V ₁ R ₁ M ₀	14.16	22.5	10.53
V ₁ R ₁ M ₁	16.46	25.0	11.99
V ₁ R ₁ M ₂	15.9	24.76	11.75
V ₂ R ₀ M ₀	10.9	17.7	7.66
V ₂ R ₀ M ₁	12.5	21.3	9.37
V ₂ R ₀ M ₂	11.2	19.7	8.5
V ₂ R ₁ M ₀	11.86	21.17	9.01
V ₂ R ₁ M ₁	14.36	22.83	10.64
V ₂ R ₁ M ₂	13.66	22.18	10.22
CD 5%	0.36	0.57	0.26

DAS = Days after sowing

V₁ = Pusha Baisakhi R₀ = No Rhizobium M₀ = No Molybdenum
V₂ = Sonali R₁ = With Rhizobium M₁ = 0.75 kg Mo/ ha
M₂ = 1.5 kg Mo/ ha

At 65 DAS nodule number obtained from greengram (Table-3) cv. Pusa Baisakhi (11.99) with combination of 0.75 kg Mo and inoculation was statistically at par with the number of nodules obtained from same variety with 1.5 kg Mo/ha and inoculation (11.75). A nodule number of 10.64 obtained from variety Sonali with combination of 0.75 kg Mo/ha and with seed inoculation was statistically at par with nodule number 10.53 which was obtained from variety Pusa Baisakhi with application of 0 kg Mo and seed inoculation with *Rhizobium*. Again the nodule number that was 8.75 obtained from variety Pusa Baisakhi with 0 kg Mo + no seed inoculation was statistically at par with the nodule number of 8.74 obtained from

Pusa Baisakhi with 1.5 kg Mo and without inoculation. It was also statically at par with nodule number obtained from variety pusa Baisakhi with 1.5 kg Mo and without inoculation. It was also statistically at par with nodule number obtained from variety Sonali (8.5) with combination of 1.5 kg Mo and without inoculation.

Effect of interaction among variety, inoculation and molybdenum on seed yield (kg/ha) of greengram

Highly significant interaction effect among variety, inoculation and molybdenum on the seed yield of greengram. Significantly different yields from two varieties were obtained in all the combinations of inoculation and molybdenum levels. Variety Pusa Baisakhi could record its supremacy over variety Sonali at all the combined levels of inoculation and molybdenum. Inoculation with *Rhizobium* could also produce favourable effect over uninoculated seed in all the combinations of varieties and molybdenum levels.

Table 4 : Effects of interaction among variety, inoculation and molybdenum on seed yield (kg/ha) of greengram.

Treatments	Yield (kg/ha)
V ₁ R ₀ M ₀	723.39
V ₁ R ₀ M ₁	1010.23
V ₁ R ₀ M ₂	955.91
V ₁ R ₁ M ₀	985.63
V ₁ R ₁ M ₁	1175.06
V ₁ R ₁ M ₂	1099.84
V ₂ R ₀ M ₀	694.13
V ₂ R ₀ M ₁	851.43
V ₂ R ₀ M ₂	775.26
V ₂ R ₁ M ₀	844.18
V ₂ R ₁ M ₁	1055.47
V ₂ R ₁ M ₂	990.76
CD 5%	20.39

V₁ = Pusa Baisakhi R₀ = No *Rhizobium* M₀ = No Molybdenum
 V₂ = Sonali R₁ = With *Rhizobium* M₁ = 0.75 kg Mo/ ha
 M₂ = 1.5 kg Mo/ ha

Levels of molybdenum had a significant effect on the seed yield of greengram in both the varieties either inoculated or uninoculated.

The highest seed yield (1175.60 kg/ha) was

obtained from cultivar pusa baisakhi (Table 4) receiving seed inoculation and 0.75 kg Mo/ha which was significantly higher than the yield obtained from any other treatment combination. The seed was the lowest (694.13 kg/ha) from variety V₂ (Sonali) when sown uninoculated and receiving no molybdenum dose. Seed yield obtained from V₂ (Pusa Baisakhi) when sown inoculated but supplied with no molybdenum dose was statistically superior to that obtained from V₁ R₀ M₁ level but was at par with the yield obtained from V₂ R₁ M₂ combination.

Statistically parity was also noticed between variety Sonali when sown uninoculated and receiving 0.75 kg Mo/ha (V₂ R₀ M₁) and the same variety when sown inoculated and receiving molybdenum @ 0 kg Mo/ha (i.e. V₂ R₁ M₀) in respect of seed yield of greengram. Grain yield and yield component of greengram has been reported to be greatly influenced by *Rhizobium* inoculation and molybdenum application (Brar and Lal, 1991).

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