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Response of blackgram (*Phaseolus mungo*) to fertilization and rhizobium inoculation

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ABSTRACT

A field experiment was conducted during the rainy season of 1991 and 1992 to study the influence of fertilizers, manures and rhizobium inoculation of seeds on seed yield of blackgram (*Phaseolus mungo* L.) and N, P and K uptake by blackgram. Changes in available N, P and K in soil were also recorded under these treatments. Application of 25 kg N/ha (as urea) + 50 kg P/ha (as single superphosphate as enriched farmyard manure (FYM) in 750 kg/ha + 6.25 tonnes/ha FYM as basal and diammonium phosphate spray 25 kg/ha twice at flower initiation and 15 days after FC to the crop sown with rhizobium inoculated seeds was found optimum and recorded 75.0 and 54.5% more seed yield than the control in the first and second crops respectively. Besides, the protein content of the seeds increased by 14.5 and 15.4% over the control. For N, P and K uptake by seeds and available N, P and K in the soil also increased significantly by the above combination of treatment over the absolute control treatment.

Greengram (*Phaseolus mungo* L.) can meet its nitrogen requirement by symbiotic fixation of atmospheric nitrogen (Thakur and Negi, 1985). However, a starter dose of nitrogen increases the grain yield of pulses as well as the crude protein content significantly (Solaiappan and Ramiah, 1990). Under Indian conditions, blackgram shows little response to potassium (Nandal *et al.* 1987). Limited information is available on the response of blackgram to application of a combination of inorganic, organic and biofertilizers in an integrated approach to bring out the genetic potential of the pulse crop, especially blackgram. Therefore the present study was taken up.

MATERIALS AND METHODS

A field trial was conducted during the rainy season 1991 at Millet Breeding Station, Tamil Nadu Agricultural University, Coimbatore, on a Alfisol soil. It had pH 7.4, electrical conductivity 0.39 dS/m available N, P and K, 185, 9.8 and 475 kg/ha respectively. The trial was carried out in randomized block design with 4 replications and 7 treatments as follows. T_1, absolute control; T_2, N 25 kg/ha + P_2O_5 50 kg/ha + 6.25 tonnes/ha farmyard manure (FYM); T_3, T_2 + 750 kg/ha enriched FYM; T_4, T_3 + seeds inoculation with rhizobium; T_5, T_4 + diammonium phosphate (DAP) spray (2.5 kg/ha) twice—at flower commencing (FC) and 15 days after flower commencement (DAF); T_6, T_5 + naphthalene ecetic acid (NAA) spray (40 ppm) 55 days after sowing (DAS), and T_7, T_6 + KCl spray (1.75 kg/ha) in 250 litres water) at 55 and 70 DAS. Ni-

trogen was applied as urea and phosphorus as single superphosphate. Farmyard manure was basal applied 15 days before sowing and incorporated into the soil. Blackgram cv. 'CO 5' was sown as the test crop as per the treatment schedule.

At harvest, the seed yield was recorded treatment-wise. The grain samples were dried in an oven at 65°C, ground to powder and analysed following the procedure recommended by Humphries (1956) for total N and by Jackson (1973) for total P and K. Nutrient uptake by seeds was calculated. Post-harvest soil samples were processed and analysed for available N, P and K as per the methods described by Subbiah and Asija (1956), Olsen *et al.* (1954) and Hanway and Heidal (1952) respectively.

The trial was repeated with an additional treatment T_8, in which seeds were treated with fungicides and rhizobium only without any fertilizers in a neighbouring field during rainy season (*kharif*) 1992 following the same statistical design and replications on a soil with the characteristics : pH 8.1, electrical conductivity 0.2 dS/m, available N, P and K 257, 14.6 and 440 kg/ha respectively. At harvest seed and soil samples were collected and analysed for nutrients as for the first crop. The data were subjected to statistical analysis (Snedecor and Cochran, 1967).

RESULTS AND DISCUSSION

Seed yield

Seed yield of first crop of blackgram ranged from 4.15 q/ha in the control (T_1) to 7.20 q/ha in T_5 (Table 1). The seed yield of second crop ranged from 4.00 q/ha in T_1 to 6.18 q/ha in T_5. Rhizobium inoculation of seeds along with NP and FYM increased it by 50.6 and 28.3% over the control respectively in first and second crop. T_5 recorded the highest seed yield in both the years, the increase over control being 73.5 and 54.5% and over T_2 being 33.3 and 26.6% in the first and second crops respectively. Phosphorus application at the flowering phase of the crop could have helped in proper grain setting. Similar response to nitrogen, phosphorus and rhizobium inoculation of seeds was recorded by Sahu (1973) and Ajay Kumar and Verma (1988).

Protein content

The protein content of blackgram seed ranged was 22.8% in T_1 and 26.1% in T_4 in the first crop and 22.6% in T_1 and 26.3% in T_5 during the second crop. It was significantly increased to 24.1 and 23.8% respectively in first and second crops under T_2 treatment. When the plots received enriched FYM at 750 kg/ha and were sown with rhizobium-treated seeds (T_4), the increase in protein content was 14.5% over the control for first crop and 16.4% for the second crop. There was no further increase in protein content (with further addition as inputs as in T_5–T_7); infact there was a significant decrease in both the crop. This may be due to significant increase in yield under T_5, and this might have diluted the protein content in the seeds. However, protein yield increased. Seed inoculation of rhizobium in addition to T_3 (viz T_4) recorded an additional 6.1% protein in the first crop and 5.6% in the second crop.

Nutrient uptake

The data indicated that the uptake of N, P and K in all the treatments increased significantly over the control in both the crops. The increase in N uptake ranged from 38.4 to 91.4% in the first crop and from 29.4 to 72.9% in the second crop over their respective control plots. Treatment T_5 resulted in

Table 1. Response of blackgram for integrated nutrient management in first crop

Treatment	Grain yield (q/ha)	Crude protein (%)	Nutrients uptake (kg/ha)			Available nutrients (kg/ha)		
			N	P	K	N	P	K
T_1	4.15	22.8	15.1	0.98	5.0	177	9.0	385
T_2	5.40	24.1	20.9	1.50	7.2	194	9.3	400
T_3	5.73	24.6	22.5	1.69	7.9	203	8.8	403
T_4	6.25	26.1	26.1	1.86	8.9	208	11.0	390
T_5	7.20	25.1	28.9	2.52	10.4	206	10.0	428
T_6	6.93	24.3	26.9	2.23	10.3	209	8.4	423
T_7	6.80	24.0	26.1	2.18	10.8	207	9.0	438
CD (P = 0.05)		0.5	1.5	0.14	0.6			

Treatment details are given in text

the highest uptake of N (28.9 kg/ha), the increase being 91.4% over the control and 38.4% over T_2 in the first crop, 72.9% over the control and 33.9% over T_2 in the second crop. Inoculation of seeds with rhizobium over and above T_3 resulted in an additional uptake of 16.0% N in the first and 8.0% in the second crop.

Phosphorus uptake ranged from 0.98 to 2.52 kg/ha and 1.24 to 2.91 kg/ha in the first and second crop respectively. The T_2 registered an increase of 53.1 and 41.9% over the control while T_5 recorded 157.1 and 134.7% increase over the control in the first and the second crops respectively. The trend of results was similar to that of N uptake.

Potassium uptake ranged from 5.0 to 10.8 kg/ha and 5.0 to 9.9. kg/ha in the first and second crops. Though it was not applied to the crop and since initial available K in soil was high, there was an increased K uptake by treating the plots with N and P. Treatment T_2 recorded 44 and 18% increase over the control in first and second crops. When seeds were inoculated with rhizobium in addition to T_3, the increase in K uptake was 12.7 and 9.4% in first and second crops respectively. This beneficial influence might be due to better root establishment by nodulation, nitrogen fixation from the atmosphere (Ajay Kumar and Verma, 1988). The highest K uptake was recorded in T_7 in the first crops, which was on par with T_5 in the first crop. In the second crop the highest K uptake was in T_5 which was significantly higher than T_7.

Available nutrients

The changes in available N, P and K status of the soil due to integrated nutrient application are presented in Tables 1 and 2. The available N, P and K contents decreased in the control plots compared to the initial soil nutrient availability. The contents were significantly lesser than the treated plots. The N and P contents progressively built up in the treated plots than the initial level, while K level remained sufficiently lesser due to the fact that potassic fertilizer was not applied to the soil. However, the built-up K in the treated plots is due to the beneficial effects of NP fertilization and the root proliferation and mineralization due to organic manures and rhizobium inoculation.

Table 2. Response of blackgram to integrated nutrient management in second crop

Treatment	Grain yield (q/ha)	Crude protein (%)	Nutrient uptake (kg/ha)			Available nutrients (kg/ha)		
			N	P	K	N	P	K
T_1	4.00	22.6	14.4	1.24	5.0	250	10.7	430
T_2	4.88	23.8	18.6	1.76	5.9	255	14.3	429
T_3	5.00	24.9	19.9	1.95	6.4	264	15.0	433
T_4	5.13	26.3	21.5	2.05	7.0	267	15.3	439
T_5	6.18	25.2	24.9	2.91	9.9	279	15.7	445
T_6	5.70	24.1	22.8	2.54	9.0	276	14.7	446
T_7	5.50	24.1	21.2	2.37	7.9	268	14.4	448
T_8	4.45	22.6	16.1	1.82	6.6	265	14.2	435
CD (P = 0.05)		0.2	2.9	0.29	1.2			

Treatment details are given in text

The available, N, P and K contents after the harvest of second crop ranged from 250 to 279 kg/ha, 10.7 to 15.7 kg/ha and 429 to 448 kg/ha respectively. The control plots registered the lowest and were substantially lesser than the initial soil status. Fertilized plots regained their initial status and progressively increased to record the higest N and P in T_5 and highest K in T_7, which was on par with T_5 and T_6.

Thus inorganic N at 25 kg/ha and P at 50 kg/ha enriched in 750 kg FYM + 6.25 tonnes/ha FYM as basal dressing + DAP spray at 2.5 kg/ha twice to blackgram crop sown with rhizobium inoculated seeds not only gave significantly higher grain yield but also showed higher N, P and K uptake, protein content in the grains and at the same time the available nutrient status was maintained.

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