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Nitrogen Utilization Potential of Prominent Blackgram Genotypes

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ABSTRACT

Background: Pulses in crop rotation are considered to be the boon for maintaining soil fertility as they are capable of fixing atmospheric nitrogen. Synchronized flowering in pulses altered source-sink relationship due to rapid translocation of nutrients from leaves to the developing pods. Nitrogen increases the biomass, methionine, tryptophan and grain protein in seed. To explore the genetic diversity of blackgram in nitrogen use pattern field experiments were conducted.

Methods: Field experiments were conducted during *kharif* season of 2019 and 2020 with four black gram cultivars. The experiment was laid out in FRBD design with factor I consisting of 4 blackgram varieties *viz*., VBN 6, VBN 8, CO6 and ADT 6 and factor II consisted of 4 levels of N *viz*., 0, 75%, 100% and 125% of recommended dose (25 kg ha^{-1}) of N. Graded levels of nitrogen (18.75, 25.00 and 31.25 kg ha^{-1}) as urea was applied as basal before sowing. Biometric observations and N utilization pattern were recorded.

Result: Among the varieties, CO6 recorded the maximum height, number of pods per plant and grain yield. Application of 125% N recorded maximum plant height and SPAD value and was on par with 100% N. Protein content of blackgram varieties ranged from 14.88 to 21.57%. The highest protein content was registered by the var.ADT6 followed by CO6.

Key words: Blackgram, Crude protein, Nitrogen, NUE, Seed yield.

INTRODUCTION

Pulses can fix atmospheric nitrogen through the symbiotic relationship between the host blackgram roots and soil bacteria and thus improves soil fertility. In general, pulses do not require to be provided with external N-application. Slow rate of dry matter accumulation during pre-flowering phase, leaf senescence during the period of pod development and low partitioning efficiency of assimilates to grain are identified as the main physiological constraints for increasing yield (Kulsum *et al*., 2007).

However, these are also highly responsive attributes to nitrogen application. For the pulse crops, nitrogen is most useful because it is the main component of protein. The management of fertilizer greatly affects the growth, development and yield of this crop. Moreover, there is evidence that application of nitrogenous fertilizers at the flowering stage is helpful in increasing the yield (Singh *et al*., 2017). An essential element of agricultural sustainability is the effective management of N in the environment (Rao *et al*., 2005). Excess fertilizer N application inhibit the nodulation there by biological N fixation (Lawn and Patel, 1974).

Enhanced nitrogen levels increases the dry matter and grain protein percent as well as methionine and triptophan contents in seed (Vidhate and Jana, 1986). The nutrient requirement is relatively very low for growth,development and production of pulse crops. but their deficiency greatly affect the physiological and metabolic processes involved in the plant that causes drastic yield loss (Meena and Sharma, 2013).

Considering the above facts, the present study was undertaken to find out the suitable nitrogen levels and blackgram variety for increasing the productivity of blackgram varieties and in addition, to find out the interaction effect of variety and nitrogen levels for increasing the productivity of blackgram.

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MATERIALS AND METHODS

Field experiments were conducted using blackgram as test crop in research farm of TNAU, Coimbatore (11.004556 N Lat, 76.961632 E Long alt. 426.7m above MSL) during *kharif* season of 2019 and 2020. Initial soil samples was analysed for nutrient status (Table 1).

The soil of experimental site was sandy loam in texture with neutral soil reaction pH (6.5), low status of organic carbon (4.50 g kg^{-1}), low in available N (156 kg ha^{-1}) and high in available P and K status. DTPA extractable Zn, Fe and Cu were deficient (Table1).

The experiment was laid out in FRBD design with blackgram varieties (VBN 6, VBN 8, CO6 and ADT 6) and levels of nitrogen (0, 75%, 100% and 125% of RDF) as factors.

Graded levels of nitrogen (18.75, 25.00 and 31.25 kg ha^{-1}) as urea was applied as basal before sowing.

Phosphorus and potassium were applied @ 50 and 25 kg ha^{-1} uniformly in all the treatments except absolute control. Biometric observations *viz*., plant height, dry matter production, crop growth rate (CGR), relative growth rate (RGR), SPAD value, pod and seed yields were recorded. Seed samples were analysed for nitrogen and crude protein contents (A.O.A.C, 1970). Nutrient uptake by grains was computed from the nutrient content in seed grain and yield of seed grain. The raw data recorded during the experimentation was statistically analyzed to draw valid differences among the treatments. The significant difference among treatments was tested by calculating critical difference (C.D) at 5% level of significance.

RESULTS AND DISCUSSION

Crop growth parameters

Among the varieties, CO6 recorded the maximum height of 61.5 cm at flowering stage. Application of 125% nitrogen recorded higher plant height of 64.8 cm as against the plant height of 51.7 cm in untreated control. The height of a plant depends on nutrient especially on nitrogen (Ferdous, 2001). Siddikee *et al.,* (2019) reported response of blackgram genotypes to N application (Table 2). VBN8 recorded the maximum SPAD value of 54.84. Application 125% N recorded the highest SPAD value. Lowest SPAD value of 48. 68 was registered in N untreated control. A strong positive correlation was found between SPAD readings and nitrogen content of the leaves of sunflower (Montemurro *et al*., 2005). A strong positive correlation found between SPAD readings and extracted chlorophyll content was also established by Dwyer *et al*. (1991) (Table 3). Variety CO6 recorded the maximum number of pods (27.40) and was on par with VBN8 (26.48). Application of 100 % N recorded the maximum no. of pods (30.00nos.) and the minimum no. of pods was registered in untreated control. No. of pods in the treatment that received 75% N was on par with 100% N (Table 4). Both remobilization of N and biological N_2 fixation during reproductive growth are important sources of N for developing pods (Neves *et al*., 1982).

Table 1: Initial characteristics of the experimental soil.

Parameters	Value
pH	6.50
EC (dS m^{-1})	0.12
Organic carbon (g Kg^{-1})	4.50
Available N (kg ha^{-1})	156
Available P(kg ha^{-1})	14.0
Available K (kg ha^{-1})	582
DTPA-Zn (mg kg^{-1})	1.10
DTPA-Fe (mg kg^{-1})	3.30
DTPA-Mn (mg kg^{-1})	4.00
DTPA-Cu (mg kg^{-1})	1.50

Grain yield

The variety CO6 recorded higher grain yield (897 kg ha^{-1}) and lowest grain was registered by ADT 6 (715 kg ha^{-1}). Maximum dry matter production of 2121 kg ha^{-1} was recorded in Variety CO6 while the dry matter production of 1358 kg ha^{-1} was registered by ADT 6 (Table 5). Yield attributes due to the application of different nitrogen sources which resulted in enhanced availability of nutrients and helped in better growth resulting in increased photosynthesis. This helped in storage of more photosynthates and their translocation towards the sink and this contributed to increased yield. These findings are in close conformity with the results of Murugan *et al.* (2011) and Bhuiya *et al*. (1986).

Variations in yield attributes among the different genotypes have been observed (Bhowaland and Bhowmik 2014). The yield of blackgram is very poor as compared to many other legume crops (Rahman, 1991). Adequate supply of nitrogen may minimize the yield reduction through reduction of some physiological constraints.

Among the N levels, application of 125% N recorded significantly higher grain yield of 903 kg ha^{-1} as compared with other N levels. Dry matter production (2165 kg ha^{-1}) was maximum in the treatment that received 125% N (Table 5)

Table 2: Effect of graded levels of nitrogen on plant height (cm) of black gram varieties.

Var.	Vegetative stage					Flowering stage				
	L_1 N_0	L_2 75% N	L_3 100% N	L_4 125% N	Mean	L_1 N_0	L_2 75% N	L_3 100% N	L_4 125% N	Mean
V_1: VBN6	7.23	7.67	9.00	11.00	8.73	50.3	52.0	66.0	77.5	61.5
V_2: VBN8	7.30	7.67	9.00	10.33	8.58	53.0	53.3	59.3	60.7	56.6
V_3: CO6	9.33	10.33	11.00	13.33	11.00	55.3	60.3	62.3	64.3	60.6
V_4: ADT6	9.00	10.00	11.00	12.33	10.58	48.2	50.3	54.3	56.7	52.4
Mean	8.22	8.92	10.00	11.75		51.7	54.0	60.5	64.8	
		CD					CD			
		(p<0.05)					(p<0.05)			
V		0.93					9.47			
N		0.93					9.50			
V×N		1.87					19.0			

(75% N: 18.75 kg ha^{-1}; 100% N: 25 kg ha^{-1}; 125% N: 31.25 kg ha^{-1}).

Table 3: Effect of levels of nitrogen on SPAD value at vegetative stage of blackgram varieties.

Variety	SPAD value				
	L_1 N_0	L_2 75% N	L_3 100% N	L_4 125% N	Mean
V_1 : VBN6	46.80	47.23	51.70	54.76	50.12
V_2 : VBN8	50.97	54.30	56.27	57.80	54.84
V_3 : CO6	47.83	50.80	51.07	51.63	50.33
V_4 : ADT6	49.13	52.23	55.23	59.27	53.97
Mean	48.68	51.14	53.57	55.87	
				CD	
				(p<0.05)	
V				7.6	
N				7.6	
V×N				15.0	

(75% N: 18.75 kg ha^{-1}; 100% N: 25 kg ha^{-1} ; 125% N : 31.25 kg ha^{-1}).

Table 4: Effect of levels of nitrogen on number of pods of black gram varieties.

Variety	No. of pods				
	L_1 N_0	L_2 75% N	L_3 100% N	L_4 125% N	Mean
V_1: VBN6	19.0	24.0	30.0	26.6	24.90
V_2: VBN8	19.3	25.3	30.0	31.3	26.48
V_3: CO6	22.6	23.0	31.7	32.3	27.40
V_4: ADT6	19.0	21.0	28.3	27.0	23.83
Mean	19.98	23.33	30.00	29.30	
				CD	
				(p<0.05)	
V				1.4	
N				1.4	
V×N				2.8	

(75% N: 18.75 kg ha^{-1}; 100% N: 25 kg ha^{-1}; 125% N: 31.25 kg ha^{-1}).

and in untreated control minimum dry matter production of 1382 kg ha^{-1} was registered (Table 5). Hasan *et al*. (2018) indicated that high yielding variety requires more nutrients than the local or wild variety

Seed N and protein contents

Protein content of different blackgram varieties ranged from 14.88 to 21.57 per cent. Highest protein content was registered by the var. ADT6 followed by CO6 Among the varieties tested, ADT 6 registered the highest seed N content of 3.45 per cent and protein content of 21.57 per cent. While VBN 6 recorded the lowest seed N content of 3.02 per cent and protein content of 18.84 per cent. Application of 125 % N registered the highest seed N content of 3.22 per cent and protein content of 20. 09 per cent. The lowest seed N content of 2.74 per cent and protein content of 17.11 per cent was registered in the untreated control (Table 6). Nitrogen increases the dry matter and protein percentage of grain as well as methionine and triptophan contents in seed with increase in level of enhanced nitrogen (Vidhate and Jana 1986). Greater leaf area is necessary to have superior yield and quality of grain legumes (Muchow, 1985).

Nitrogen use efficiency and agronomic efficiency of nitrogen

Among the black gram varieties, CO 6 registered higher nitrogen use efficiency of 46.99 followed by variety VBN 8 (45.97) in the treatment that received 75% N. CO6 registered Agronomic efficiency of N of 8.40 and VBN 8 recorded AEN of 7.68 in the treatment that received 100% N (Table 7). Genotypes with an increased N use efficiency are of commercial interest due to their high yield in low N-input agriculture and their low N wastage (Chardon *et al*., 2012; Ulas *et al*., 2013).

Interaction of nitrogen levels and variety

Interaction of nitrogen level and variety showed a significant effect on plant height at vegetative and flowering stages, pod number, SPAD value, seed yield and dry matter production of blackgram. The highest plant height at

Table 5: Effect of graded levels of nitrogen on seed yield and DMP of blackgram varieties.

Variety	Seed yield (kg/ha)					DMP (kg/ha)				
	L_1 N_0	L_2 75% N	L_3 100% N	L_4 125% N	Mean	L_1 N_0	L_2 75% N	L_3 100% N	L_4 125% N	Mean
V_1: VBN6	724	830	870	895	830	1051	1560	1625	2178	1604
V_2: VBN8	735	862	927	976	875	1636	1690	1723	2189	1810
V_3: CO6	756	881	966	985	897	1744	1831	2265	2644	2121
V_4: ADT6	670	704	730	755	715	1095	1203	1485	1647	1358
Mean	721	819	873	903		1382	1571	1775	2165	
				CD					CD	
				(p<0.05)					(p<0.05)	
V				25					288	
N				25					288	
V×N				51					577	

(75% N: 18.75 kg ha^{-1}; 100% N: 25 kg ha^{-1} ; 125% N: 31.25 kg ha^{-1}).

Table 6: Effect of graded levels of nitrogen on seed nitrogen and protein contents.

Variety	Seed N content (%)					Seed protein content (%)				
	L_1 N_0	L_2 75% N	L_3 100% N	L_4 125% N	Mean	L_1 N_0	L_2 75% N	L_3 100% N	L_4 125% N	Mean
V_1: VBN6	2.84	2.98	3.10	3.14	3.02	17.73	18.67	19.37	19.60	18.84
V_2: VBN8	2.00	2.20	2.52	2.80	2.38	12.50	13.75	15.75	17.50	14.88
V_3: CO6	2.89	3.19	3.28	3.34	3.18	18.12	19.95	20.53	20.85	19.86
V_4: ADT6	3.21	3.49	3.51	3.59	3.45	20.07	21.82	21.95	22.42	21.57
Mean	2.74	2.97	3.10	3.22		17.11	18.55	19.40	20.09	

Table 7: Nitrogen use efficiency (NUE) and agronomic efficiency of N (AEN) of black gram varieties.

Variety / N levels	NUE				AEN			
	0	75% @ 18.75 kg N / ha	100% @ 25 kg N/ha	125% @ 31.25 kg N/ha	0	75% @ 18.75 kg N /ha	100%@ 25 kg N/ha	125%@ 31.25 kg N/ha
V_1: VBN 6	-	44.27	34.80	28.64		5.65	5.84	5.47
V_2: VBN 8	-	45.97	37.08	31.23	-	6.77	7.68	7.71
V_3: CO 6	-	46.99	38.64	31.52	-	6.67	8.40	7.33
V_4: ADT 6	-	37.55	29.20	24.16	-	1.81	2.40	2.72

* NUE = Grain yield / amt. of N applied;** Agronomic efficiency of N = Yield in N fer-Yd.unfer /amt, of N applied.

vegetative stage (13.33 cm), number of pods plant^{-1} (32.3), SPAD value (51.63), seed yield (985 kg ha^{-1}) and dry matter production (2644 kg ha^{-1}) was recorded from the combination of black gram variety CO 6 and 125% RD of N level. In comparison, the lowest plant height at vegetative stage (7.23 cm), number of pods plant^{-1} (19.0), SPAD value (46.80) and dry matter production (1051 kg ha^{-1}) was recorded from the combination of black gram variety VBN 6 and untreated control. Difference in utilization of N among the various genotypes was reported (Sial *et al*., 2007).

CONCLUSION

Among the varieties, CO6 recorded the maximum height and seed yield. Application of 125% N recorded maximum plant height, SPAD value and was on par with 100% N. Protein content of blackgram varieties ranged from 14.88 to 21.57 per cent . The highest protein content was registered by the var. ADT6 followed by CO6. Among the blackgram varieties, CO6 registered higher nitrogen use efficiency (47.0) and agronomic efficiency of N (8.40).

Conflict of interest: None.

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