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A DWARF DETERMINATE PLANT TYPE FOR ACHIEVING HIGHER AND STABLE YIELD IN BLACKGRAM (*VIGNA MUNGO* L. HEPPER)

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ABSTRACT

In the present study a dwarf determinate type of urdbean was used along with two traditional varieties and two elite lines to test their performance at higher plant density and nitrogen fertilizer levels. Genotype differ significantly for all the traits studied, spacing showed significant difference for total number of pods per plant, harvest index and plot yield while nitrogen levels showed significant difference for total number of pods per plant, 100 seed weight, dry weight of stem, husk, biological yield and harvest index. Closer spacing enhanced seed yield by 36.5 percent, harvest index by 29.9 percent and plot yield by 47.9 percent while higher nitrogen level enhanced dry weight of stem, husk and biological yield by 26.7, 34.1 and 17.5 percent respectively but reduced harvest index by 18.1 percent. The dwarf determinate line (V.K.6) recorded lower values of pods per plant, dry weight of stem, leaves, husk and biological yield but higher number of seeds per pod, 100 seed weight, seed yield per plant and seed yield per plot. Mean performance and stability parameter for grain yield and its component traits revealed that the genotype V.K.6 exhibited the highest seed yield per plant (2.87 g) and plot yield (60.53 g) over six environments. The dwarf determinate type showed wider adaptability and higher stable yield over environments and therefore can be recommended for cultivation by the farmers.

INTRODUCTION

Blackgram or urdbean (*Vigna mungo* (L.) Hepper) is an important pube crop of the tropic and subtropics areas and has been identified as a potential crop in many countries (Smartt, 1990; Girish *et al*., 2012). Growth habit of blackgram is prostrate / spreading or trailing which near maturity becomes a tangled mass of plant tissue producing poor harvest index. An indeterminate habit and asynchronous flowering increase stability of yield at the expense of higher yield potential possible from determinate and synchronous genotypes (Byth *et al*., 1986) and one of the causes of lower yield in most grain legumes including blackgram. Plant density can have a major effect on the final yield of most of the legumes and the general response of yield to increasing population is well documented (Singh *et. al*., 1992; Nagarjuna *et al*., 1995). Higher yield might be achieved if a suitable plant type is found which respond to higher plant density and low Nitrogen dose. In this paper, a dwarf determinate mutant (VK-6) of blackgram is reported which has good yielding capacity and also gives stable performance in different environmental condition.

MATERIALS AND METHODS

The experiment was conducted at the Departmental Field in Instructional Farm, Jaguli, B.C.K.V., Mohanpur, West Bengal in summer season. Date of sowing was 28th February 2010. The experiments were carried out in split-split plot design according to Gomez and Gomez (1976) with three replications. All the sub-plots were applied with 20 kg N/ha as basal dose and additional dose of 20 kg N/ha applied in the two diagonal sub-plots in each replication. Five genotypes of blackgram were used in the present experiment. These are V.K.1 (Cross derivative of WB 16 and T_9), Sarada (Check), V.K.3 (Cross directive of LU_9 and LBG 623), T-9 (Check) and V.K. 6 (A dwarf determinate selection). The experiment was repeated in next year and the collected data were analyzed for stability according to Eberhart and Russel (1966).

RESULTS AND DISCUSSION

The analysis of variance (Table 1) revealed that row spacing had significant effect on total number of pods per plant, harvest index and plot yield. Row spacing did not have significant effect on number of seeds per pod, 100 seed weight, seed yield per plant, dry weight of leaves, stem and husk as well as biological yield. Changes in row spacing affected significant changes in total number of pods, harvest index and plot yield. Closer row spacing increased total pods per plant. As closer row spacing did not affect dry weight of leaves, stem and husk, three components of biological yield, increase in mean of seed yield per plant (36.55%) enhanced the harvest index significantly (Table 2). As closer row spacing accommodated 20 more plants per m^2, plot yield was significantly increased (47.93%). It clearly indicated that 15 cm row spacing in the important non-monetary input for enhancing productivity of determinate or indeterminate genotypes used. Closer row spacing than 15 cm was not used in the present study, it could not be judged whether the genotypes will perform differently in such a situation. Increase in grain yield as population density is increased has been reported by many workers in black gram (Kumar and Sharma, 1989, Sekhan *et al*., 2002) and in soybean (Graterol and Montilla, 2003).

Effect of nitrogen was significant for total no. of pods per plant,

Table 1: Analysis of variance of different characters of 5 genotypes of Black gram in split-split plot design for 2010

	d.f	Total no. of pods per plant	No. of seeds per pod	100 seed weight (g)	Seed yield per plant (g)	Dry wt. of leaves per plant (g)	Dry wt. of stem per plant (g)	Dry wt. of husk per plant (g)	Biological yield (g)	Harvest Index	Plot yield
Replication	2	2.31	0.22	0.17	0.26	0.03	0.10	0.01	0.59	15.83	4.11
Spacing (A)	1	125.86**	0.001 NS	0.27 NS	4.20 NS	0.01 NS	1.06NS	0.03 NS	1.37 NS	424.58*	4663.66**
Error 1	2	0.07	0.13	0.13	0.29	0.35	0.19	0.17	1.62	20.97	2.98
Nitrogen (N)	1	190.46**	0.001 NS	0.57*	0.003 NS	0.26 NS	10.04**	2.89**	30.74**	249.57*	5.24NS
A X N	1	104.28**	0.24 NS	0.71*	4.27*	0.89*	8.02**	0.81**	0.81 NS	435.08**	1313.20**
Error 2	4	2.77	0.10	0.07	0.28	0.12	0.05	0.03	0.38	15.88	6.32
Genotype (B)	4	500.50**	0.34**	3.19**	1.93**	2.07**	14.91**	1.99**	28.21**	772.96**	1704.62**
A X B	4	79.85**	0.06 NS	0.24 NS	0.36 NS	1.38 **	2.71 **	0.44 NS	9.02**	32.28 NS	805.49**
N X B	4	33.16**	0.05 NS	0.11 NS	0.71**	0.91**	0.91**	0.24 NS	2.95 NS	76.57**	299.67**
A X B X N	4	37.25**	0.05 NS	0.14 NS	0.46 NS	0.70**	0.81*	0.51 NS	6.09**	21.81 NS	97.97**
Error 3	32	3.47	0.05	0.09	0.18	0.14	0.23	0.27	1.47	18.67	1.96

** = Significant at 1% level, * = Significant at 5% level, NS = Non significant

Table 2: Interaction between spacing, Nitrogen, Genotypes (A × B × N) on different characters in the year 2010

Characters	Total no. of pods per plant				No. of seeds per pod				100 seed weight (g)				Dry wt. of stem (g)				Dry wt. of leaves (g)			
Spacing	N_1		N_2		N_1		N_2		N_1		N_2		N_1		N_2		N_1		N_2	
Genotypes	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2
V.K.- 1	24.96	26.40	30.13	23.26	5.96	6.03	6.40	5.80	4.43	4.59	4.35	4.59	2.14	2.12	3.19	2.37	1.76	1.42	2.70	1.84
Sarada	23.43	36.16	28.00	35.93	6.13	6.33	6.26	6.26	3.03	3.38	3.27	4.43	3.19	5.03	3.74	4.46	2.11	3.05	1.66	2.84
V.K.-3	29.96	36.63	41.13	32.23	6.26	6.40	6.10	6.10	3.37	3.07	3.48	3.38	4.31	4.51	6.65	3.83	2.60	3.67	3.11	2.06
T-9	25.20	29.70	34.26	39.26	5.96	6.20	6.23	6.13	3.33	3.09	3.37	3.62	2.60	3.31	4.93	3.68	1.91	2.05	2.31	2.13
V.K -6	16.33	18.66	17.36	21.50	6.50	6.46	6.50	6.53	4.09	3.76	3.32	4.25	1.73	1.33	3.22	2.41	1.90	1.15	2.38	1.92

Characters	Dry weight of husk (g)				Biological yield (g)				Harvest index				Seed yield per plant (g)				Seed yield per Plot (g)			
Spacing	N_1		N_2		N_1		N_2		N_1		N_2		N_1		N_2		N_1		N_2	
Genotypes	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2
V.K.- 1	1.40	1.26	2.01	1.58	7.32	7.04	8.79	7.97	30.75	31.31	10.20	28.01	2.25	2.22	0.88	2.18	49.80	85.77	28.07	77.10
Sarada	1.25	1.13	1.83	1.98	7.76	10.87	8.29	11.79	15.50	15.32	12.84	21.37	1.20	1.66	1.05	2.51	48.08	36.82	28.77	54.39
V.K.-3	1.83	2.00	2.07	2.17	10.18	11.65	13.02	9.42	13.83	12.61	9.09	14.24	1.43	1.45	1.18	1.34	33.26	29.73	31.00	34.23
T-9	1.76	0.57	1.57	2.20	7.70	7.29	9.99	9.74	15.18	18.19	11.58	17.31	1.41	1.34	1.15	1.72	30.54	38.62	29.75	53.31
V.K -6	0.66	1.00	0.45	1.40	6.56	5.35	7.75	9.26	34.36	34.87	21.59	37.89	2.26	1.85	1.69	3.52	44.13	56.25	44.38	77.90

Table 3: Changes in mean values of different characters of 5 genotypes in two different row spacing for 2010

Spacing Characters	%Difference (S_2-S_1)	%Difference (N_2-N_1)
Total no. of pods/plant	10.67	13.35
No of seeds/pod	-0.16	0.16
100 seed weight	3.56	5.24
Seed yield per plant	36.55	0.58
Dry weight of leaves/plant	-1.33	6.01
Dry weight of stem/plant	-7.56	26.73
Dry weight of husk/plant	3.37	34.10
Biological yield	3.43	17.50
Harvest index	29.90	-18.14
Plot yield	47.93	1.30

100 seed weight, dry weight of stem and husk, biological yield and harvest index. Non significant effect of nitrogen was recorded for number of seeds per pod, seed yield per plant, dry weight of leaves and plot yield. Levels of nitrogen showed significant effect due to row spacing, but all these traits showed higher mean values in N_2 than in N_1. Dry weight of stem and husk per plant was increased significantly which significantly increase biological yield (17.5%). Laharia *et al.* (2004) reported favourable effect of Nitrogen fertilizer on yield and enhanced dry matter accumulation in soybean. As seed yield per plant was not affected although total number of pods per plant increased (13.35%) in N_2, harvest index (18.14%) was decreased (Table 2). Plot yield also was affected with the changes in nitrogen levels. Effect of genotypes was significant for all the traits studied. It indicated that genotypes differed significantly for all the traits. Among the five genotypes V.K.6 recorded highest seed yield per plant (2.87g) and plot yield (60.53g) followed by V.K.1 (Table 4). The genotype V.K.3 was the poor yielder (per plot as well as per plant basis) having poorest harvest index (12.21) but it recorded highest total number of pods per plant and biological yield. The check varieties T_9 and Sarada also recorded lower seed yield per plant as well as plot yield than V.K.6 and V.K.1. Therefore the superiority of these two selections has been established in comparison to the check varieties. The determinate selection registered shortest height and lowest number of pods per plant but higher number of seeds per pod and 100 seed weight. Although biological yield of V.K.6 was recorded lowest, the dry weight of leaves, stem and husk were lowest among all the genotypes, which helped the genotype to register highest harvest index. Both the check varieties were low yielder mainly due to their poor harvest index as biological yield of these two varieties was comparatively higher. Sinhamahapatra (2006) reported that the erect group recorded highest seed yield as well biological yield, the harvest index was comparable to bushy group (prostrate). Interactions of spacing x nitrogen were significant for all the characters except umber of seeds per pod and biological yield. Spacing x genotype interactions were significant for plant total number of pods per plant, dry weight of leaves and stem, biological yield and plot yield. While nitrogen x genotype interactions were significant for total number of pods per plant, seed yield per plant, dry weight of leaves and stem, harvest index and plot yield. Interactions of spacing x nitrogen x genotypes were significant for total number of pods per plant, dry weight of leaves and stem, biological yield and plot yield. All these two interactions were

Table 4: Mean and Stability parameters of yield and yield components in Blackgram

Genotypes	No. of Branches/plant			Pods/plant			Seeds/pod			Harvest Index			Seed yield/plant			Plot yield		
	$\bar{X}$	bi	s^2d	$\bar{X}$	bi	s^2d	$\bar{X}$	bi	s^2d	$\bar{X}$	bi	s^2d	$\bar{X}$	bi	s^2d	$\bar{X}$	bi	s^2d
$V.K_1$	1.95	1.11	0.10	27.22	0.22	15.41	6.20	1.40	0.02	29.95	1.45	19.22	2.59	1.10	0.07	56.89	0.58	468.04
Sharada	2.09	1.83	0.02	31.10	1.55	12.78	6.41	1.33	-0.01	21.93	0.97	3.70	2.19	0.91	0.03	50.15	1.08	59.84
$V.K_3$	2.21	1.31	0.02	34.01	1.02	22.86	6.43	1.77	0.01	18.45	0.98	3.31	2.07	1.00	0.05	42.74	0.98	146.05
T-9	1.91	0.43	0.02	31.64	1.64	7.72	6.23	0.93	-0.01	23.44	1.25	5.08	2.14	1.07	-0.02	49.11	1.34	51.29
$V.K_6$	0.38	0.32	-0.02	27.63	0.57	2.64	6.44	-0.44	-0.01	35.07	0.65	12.48	2.87	0.92	0.13	60.53	1.01	39.38
Mean	1.71	1.00	-	30.32	1.00	-	6.34	1.00	-	25.77	1.00	-	2.37	1.00	-	51.88	1.00	-
SEm(±)	0.10		-	1.64		-	0.05		-	1.69		-	0.15		-	5.54		-

non- significant for number of seeds per pod, 100 seed weight and dry weight of husk. All the genotypes recorded higher mean values in closer row spacing and higher nitrogen level (N_2) for seed yield per plant and harvest index. V.K.6 and V.K.1 recorded highest plot yield and harvest index in closer row spacing at both the nitrogen levels. V.K.6 recorded lowest dry weight of husk, low dry weight of stem and leaves, lowest biological yield at wider row spacing at both the levels of nitrogen. V.K.1 recorded highest 100 seed weight while V.K.3 recorded higher plant height in both the row spacing as well as both the levels of nitrogen. V.K.6 recorded shortest plant height and total number of pods per plant (Table 3). Lower level of nitrogen recorded lower seed yield per plant and seed yield per plot at wider row spacing but higher level of nitrogen recorded higher seed yield per plant and plot yield at closer row spacing. This result suggested that urdbean should be grown in closer row spacing with higher nitrogen level to get higher yield. Yield attributes like plant height, number of branches, total number of pods per plant, number of seeds per pod, dry weight of stem and leaves recorded highest mean values at wider spacing with higher nitrogen level. Most of the genotypes recorded higher mean values of 100 seed weight, dry weight of leaves, harvest index, seed yield per plant and plot yield at closer row spacing. V.K.6 recorded higher seed yield per plant but V.K.1 recorded higher seed yield per plot in both the row spacing at lower nitrogen level while V.K.6 recorded highest seed yield per plant as well as per plot in closer row spacing at higher nitrogen level. It suggests that V.K.1 is more suitable at lower nitrogen level in both the row spacing while V.K.6 is suitable for at both nitrogen level in closer row spacing. Arif *et al*. (2012) reported that determinate cultivars are useful for mechanized harvest and to fit the crop in various cropping system and least affected by environmental changes. Mean performance and stability parameters for grain yield and its components traits are given in Table 2. The genotype V.K.6 exhibited the highest seed yield per plant (2.37gm) and plot yield (60.53 gm) over all six environments followed by V.K.-1 Sharada, T-9 and V.K.3 The magnitude of regression coefficient and deviation from regression varied amongst genotypes indicating that genotypes were responsive towards environmental variation. The highest yielding genotype V.K.-6 recorded regression coefficient less than one and equal to one and deviation from regression around zero and least for seed yield per plant and plot yield respectively, indicating not only their wider adaptability and higher seed yield over a wide range of environmental condition but also stability under wider density of plant populations and lower management conditions. Eberhart and Russell (1966) have suggested that an ideal genotype is one which has high mean performance, average responsiveness to environment ($b_i = 1$) and least deviation from regression (S^2d) indicating stability of yield. The adverse conditions under poor environment and wider density identified the high yielding lines suitable for poor environments, wider density as well as improved environments and closer densities. This genotype may be recommended for general cultivation to impart grain yield sustainability.

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