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Research Article

PERFORMANCE OF SOME PROMISING GENOTYPES OF CLUSTER BEAN (*Cyamopsis tetragonoloba* L. Tabu) UNDER VARYING LEVELS OF PRIMARY PLANT NUTRIENTS AND ROW SPACING

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Abstract- A field experiment consisting of 2 fertility levels *viz.* 50 % of recommended dose of fertilizer (RDF) and 100 % RDF (20: 40: 20 kg ha^{-1} of N: P_2O_5: K_2O); 2 row spacings (30 and 45 cm) and 3 genotypes (HG-100, HG-8-1 and HG-563(c)) was conducted at the Research Farm, College of Agriculture, Gwalior, India during *kharif* 2010 to find out their effects on grain, stover and grain-protein yield and production economics of cluster bean. The experiment was laid out in factorial randomized block design with 12 treatment combinations and 3 replications. The highest grain, stover and grain-protein yield could be recorded in 100 % RDF, 45 cm row spacing and HG-100 and that were significantly superior to other treatment combinations. Cluster bean genotype HG-100 sown at 45 cm row spacing with 100 % RDF appeared to be better combination for higher production and net return. However, to get maximum dividend in terms of the highest benefit: cost ratio, HG-100 sown at 45 cm row spacing with 50 % RDF was found to be economical.

Keywords- Cluster bean, fertility level, row spacing, genotype

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Introduction

Cluster bean (*Cyamoposis tetragonoloba* L. Tabu), an annual *kharif* arid legume, commonly known as '*guar*', was traditionally grown for cattle feed, fodder, medicine and soil improvement. Apart from its present uses as green fodder, vegetable, green manure and grain purposes, its utility in explosive, textile, paper, food, gum and cosmetic industries also fetches foreign currencies. This crop plays great role in nitrogen (N) economy of the succeeding crops though N-fixation from atmosphere and also by addition of organic matter.

Although cluster bean can be grown in nutrient starved soils and in areas of erratic rainfall but growing of improved genotypes with judicious nutrient management have been effective in improving its productivity. Significantly higher yield of *guar* has been reported by application of the recommended dose of fertilizers i.e. 20: 40: 20 kg ha^{-l} of N: P_2 O_5: K_2O than 50% of the recommended dose [1]. Proper plant population is the main key for higher yield of cluster bean and thus higher yield and quality could be achieved with proper row spacing and plant stand. Though the genotypes have their own ability for growth, development, and yield, yet some promising genotypes of *guar* have shown considerable variations particularly in yield potentials under varying levels of soil fertility. No such work has yet been done to elucidate such interactions between soil fertility, row spacing and genotypes of *guar* in Gird region of Madhya Pradesh. In view of above scenario, a field experiment was laid out to study the effects of the levels of soil fertility and row spacing on the performance of some promising genotypes.

Materials and Methods

Experimental site and climate

The experiment was conducted during *kharif* 2010 at the Research Farm of the College of Agriculture, Gwalior, Madhya Pradesh, India located 208 m above the mean sea level and exactly at 26^0 13'north latitude and 74^0 4' east longitude enjoying sub-tropical climate. The summer is extremely hot (46 ^{0}C) and winter is chilled reaching at below 1^{0}C. The annual rainfall ranges from 650 to 751 mm with maximum downpour during last week of June to last week of September. Drought is a common phenomenon. The soil was sandy loam having pH, organic carbon, available nitrogen, phosphorous and potash of 8.0, 0.045%, 212.5, 14.7 and 282 kg ha^{-l}, respectively. The cropping history of the site indicated *guar*-wheat cropping system for last 3 consecutive years.

Experimental design and treatments

Among the 3 treatments *viz.* nutrients, spacing and genotypes, the primary plant nutrients (N: P_2O_5: K_2O) were applied at 2 levels *viz.* F_1: 50 % RDF (10:20:10 kg ha^{-l}) and F_2:100% RDF (20:40:20 kg ha^{-l}); 2 rows spacing *viz.* S_1: 30 cm and S_2: 45 cm; and 3 genotypes *viz.* V_1: HG-100, V_2: HG-8-1 and V_3: HG-563(c). The experiment was laid out in factorial randomized block design (2 x 2 x 3) with 3 replications. All fertilizers as per treatment were applied at the time of sowing as basal and the crop was raised rainfed without any irrigation.

Agronomic practices

The land was harrowed followed by ploughing in criss-cross manner and the recommended dose of chemical fertilizers were added to each plot just before the final land preparation and leveling. Seeds of 3 genotypes were sown in solid rows at spacing of 30 and 45 cm between lines depending on different treatment combinations. Seedlings were thinned at 15 days after sowing (DAS) at 10 cm intra-row spacing. Two gentle hoeing and manual weeding operations were carried out at 26 and 40 DAS. No chemical plant protection measure was adopted due to lack of disease-pest incidence superseding economic threshold level. The plant population was counted at 15 DAS and at harvesting for yield estimation. No irrigation was applied to the experimental field so as to simulate the prevailing water management practices by the farmers of this region.

Before harvesting of the crop 5 plants from each plot were taken out for recording the yield contributing characters. The grain yield and stover yield were recorded by carefully harvesting the crop and subsequently threshing after its drying in the cemented floor. The harvest index was calculated by taking in to account the economic (grain) yield and the biological (grain + stover) yields.

$$\text{Harvest index} = \frac{\text{Economic yield (kg ha}^{-1})}{\text{Biological yield (kg ha}^{-1})}$$

The total crude protein in the seeds was calculated by estimating the total nitrogen percent in it by micro-Kjelhdal method [2] and then multiplying it with 6.25. The total protein yield of the crop was calculated by taking into account the yield from respective plots.

Crude protein in seeds = Total Nitrogen (%) in seeds x 6.25

$$\text{Protein yield from crop (kg ha}^{-1}) = \frac{\text{Crude protein in seeds (\%) x grain yield (kg ha}^{-1})}{100}$$

Production economics

The cost of production incurred in each treatment was worked out by considering the prevailing market price of inputs used and the produce obtained (seed and stover). The net income was calculated by subtracting the cost of cultivation from gross monetary return. The benefit: cost ratio was obtained in Agronomist point of view as follows

$$\text{Benefit: cost ratio (BCR)} = \frac{\text{Gross return (Rs. ha}^{-1})}{\text{Cost of cultivation (Rs. ha}^{-1})}$$

Statistical analysis

The data collected were arranged in appropriate tables and analysed statistically by applying analysis of variance technique (AVNOVA) [3]. Standard error of means i.e. S.Em (±) were used in all cases. The significance of variance was tested by 'Error mean square' method of Fisher Snedecor's F-test at the probability level of 0.05 for appropriate degrees of freedom (P=0.05).

Results and Discussion

The seed (2314 kg ha^{-1}), stover (6971 kg ha^{-1}) and grain protein (794.37 kg ha^{-1}) yield from the *guar* crop applied with 100 % recommended dose of fertilizers were significantly higher than the crop grown with 50 % recommended dose [Table-1 and Fig-1]. This might be due to the complimentary effect of plant growth and yield attributing characters which in turn could have been influenced by balanced supply of plant nutrients during crop growth period. These results were in conformity with the earlier findings [4, 5].

Row spacing significantly influenced the seed, stover and grain protein yield. Wider row spacing of 45 cm resulted in significantly better seed (2497 kg ha^{-1}), stover (7812 kg ha^{-1}) and grain protein (867.03 kg ha^{-1}) yield compared to 30 cm spacing [Table-1] and [Fig-1]. It might be due to better penetration of light to the lower layers of the crop canopy and reduction of inter-row crop competition. The present result corroborated the earlier findings [6-8].

Table-1 *Effect of treatments on grain, stover and grain-protein yield of cluster bean*

Treatments	Seed yield (g $plant^{-1}$)	Straw yield (g $plant^{-1}$)	Seed yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Grain- protein content (%)	Total grain protein yield (kg ha^{-1})
Fertility level						
F_1: 50% of recommended dose of fertilizers (10:20:10 kg ha^{-1} of N: P_2O_5:K_2O)	9.46[b]	33.65[b]	2204[b]	6708[b]	33.86	751.04[b]
F_2: 100 % recommended dose of fertilizers (20:40:20 kg ha^{-1} of N: P_2O_5: K_2O)	10.03[a]	35.52[a]	2314[a]	6971[a]	34.32	794.37[a]
S.Em (±)	0.12	0.51	30.59	68.79	0.43	11.13
CD (P=0.05)	0.36	1.50	89.72	201.77	NS**	32.64
Row Spacing						
S_1: 30 cm	9.38[b]	32.31[b]	2021[b]	5868[b]	33.50	678.38[b]
S_2: 45 cm	10.11[a]	36.86[a]	2497[a]	7812[a]	34.68	867.03[a]
S.Em (±)	0.12	0.51	30.59	68.79	0.43	11.13
CD (P=0.05)	0.36	1.50	89.72	201.77	NS	32.64
Genotypes						
V_1: HG-100	10.60[a]	38.24[a]	2476[a]	7545[a]	34.94	865.81[a]
V_2: HG-8-1	9.93[b]	33.15[b]*	2204[b]*	6731[b]	33.72	745.47[b]
V_3: HG-563(c)	8.73[c]	32.36[b]	2097[b]	6243[c]	33.62	706.83[c]
S.Em (±)	0.15	0.63	37.46	84.25	0.53	13.63
CD (P=0.05)	0.44	1.84	109.88	247.11	NS	39.97

* Means followed by common letters did not differ significantly up to 5% level ** NS: Non-significant

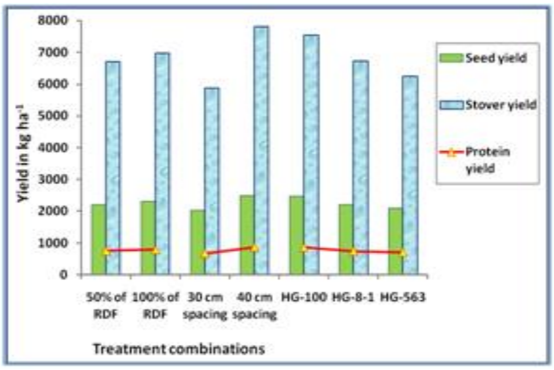

Fig-1 Seed, stover and protein yield as influenced by plant nutrients, line spacing and genotypes of cluster bean

Genotype HG-100 had the highest value in terms of yield and quality parameters. Significantly the highest seed (2476 kg ha^{-1}), straw (7545 kg ha^{-1}) and protein (865.81 kg ha^{-1}) yields were found in HG-100 as compared to other two genotypes [Table-1] and [Fig-1]. The grain yield of HG-100 was 12.34 % and 18.07 % higher than HG-8-1 and HG-563(c), respectively. The latter 2 genotypes also lagged behind in recording stover yield with 10.79 % and 17.29 % reductions from the former genotype. HG-8-1 had 5.1 %, 7.82 % and 5.47 % higher grain, straw and protein yield than HG-563(c) but the difference was at par in grain yield. There was no significant difference in terms of harvest index due to any 3 treatments under consideration.

Although no significant difference was observed in grain protein content of seeds of *guar* due to varietal effects but HG-100 could over ride other 2 genotypes in recording the highest total grain protein with 16.14 % and 22.49 % superiority over HG-8-1 and HG-563(c). Such statistical differences in total grain protein yield inspite of at par seed protein content could only be ascribed to significantly higher grain yield. Similar results were also reported by earlier researchers due to varietal effects [8-10].

The economics of production [Table-2] and [Fig-2] indicated the maximum net return (Rs.46,815/- ha^{-1}) from the treatment combination $F_2S_2V_1$ i.e. HG-100 sown at 45 cm row spacing with 100 % recommended dose of fertilizers (20: 40: 20 kg ha^{-1} of N: P_2O_5: K_2O). This was ensued by $F_1S_2V_1$ (Rs.46,554/- ha^{-1}). On the other hand, the treatment combination $F_1S_1V_3$ i.e. HG-563(c) sown at 30 cm row spacing with 50% of recommended dose of fertilizers (10: 20:10 kg ha^{-1} of N: P_2O_5: K_2O) recorded lowest net return (Rs.28,549/- ha^{-1}).

Table-2 *Economics of production of cluster bean as influenced by different treatment combinations*

Treatment combinations	Return from (Rs. ha^{-1})		Gross return (Rs. ha^{-1})	Total cost (Rs. ha^{-1})	Net return (Rs. ha^{-1})	Benefit: cost ratio (BCR)
	Seeds	Stover				
$F_1S_1V_1$	45833	3521	49354	9805	39549	5.03
$F^1S_1V_2$	38333	2625	40958	9805	31153	4.18
$F_1S_1V_3$	35833	2521	38354	9805	28549	3.91
$F_1S_2V_1$	52320	4039	56359	9805	46554	5.75
$F_1S_2V_2$	48148	3796	51945	9805	42140	5.30
$F_1S_2V_3$	43982	3623	47604	9805	37799	4.86
$F_2S_1V_1$	46666	3375	50041	10580	39461	4.73
$F_2S_1V_2$	38333	2958	41292	10580	30712	3.90
$F_2S_1V_3$	37500	2604	40104	10580	29524	3.79
$F_2S_2V_1$	53240	4155	57395	10580	46815	5.42
$F_2S_2V_2$	51482	4083	55565	10580	44985	5.25
$F_2S_2V_3$	50463	3738	54202	10580	43622	5.12

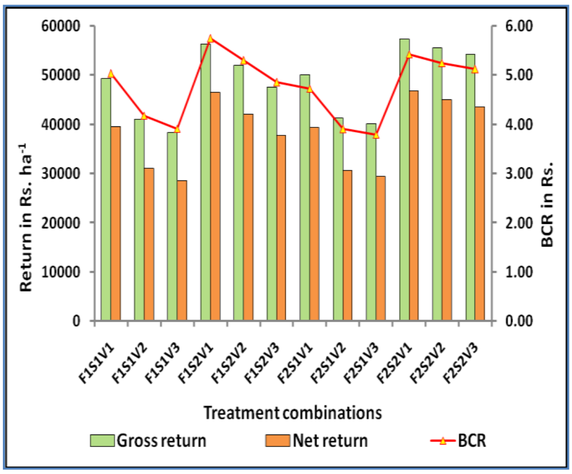

Fig-2 Economics of production of cluster bean as influenced by different treatments

Although the highest net return was obtained in $F_2S_2V_1$ followed by $F_1S_2V_1$ but the highest benefit: cost ratio (BCR) in $F_1S_2V_1$ i.e. HG-100 sown at 45 cm row spacing with 50% recommended dose of fertilizers (10: 20: 10 kg ha^{-1} of N: P_2O_5: K_2O) was the highest (5.75:1) among all treatment combinations. It was ensued by $F_2S_2V_1$ with BCR of 5.42. On the contrary, the lowest BCR (3.79) was recorded with $F_2S_1V_3$ i.e. HG-563(c) sown at 45 cm row spacing with 100 % recommended dose of fertilizers (20: 40: 20 kg ha^{-1} of N: P_2O_5: K_2O).

Conclusion and applicability of findings

To get maximum dividend in terms of the gross and net profits, cluster bean genotype HG-100 sown at 45 cm row spacing with 100 % RDF appeared to be better combination. However, to get the highest BCR with gross and net profits slightly lower but of second order, the same genotype sown at 45 cm line spacing with 50 % RDF should be recommended for the farmers of Gird region of Madhya Pradesh, India during *kharif*.

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Author Contributions: All author equally contributed

Abbreviations

BCR: Benefit: cost ratio

RDF: Recommended dose of fertilizer

DAS: Days after sowing

Ethical approval

This article does not contain any studies with human participants or animals performed by any of the authors.

Conflict of Interest: None declared

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