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Research Article

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Genetic variability, Correlation and Path analysis for Yield and Yield attributing Traits in Cluster bean [*Cyamopsis tetragonoloba* (L.) Taub.] Genotypes

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ABSTRACT

Thirty genotypes of Cluster bean were evaluated to ascertain genetic parameters of variability, heritability, path analysis and genetic advance in Cluster bean was studied during Rabi season of 2012-2013 & 2013-2014 at the Horticulture Research Farm of the Department of Applied Plant Science (Horticulture), Babasaheb Bhimrao Ambedkar University, Lucknow, Uttar Pradesh, India. 30 genotypes of Cluster bean showed wider variation for all traits result revealed that highest range of variation. The research findings depicted highest range of variation for pod yield (q/ha) followed by pod yield/plant (g). The coefficient of variation was minimum for number of branches/plant at maturity followed by days to maturity whereas, under pooled data analysis, it was found minimum for days to maturity followed by pod yield/plant (g). In all the three studies, coefficient variation was maximum for pod width (cm) followed by pod breath (cm). In the first year, heritability estimates were high for all the characters except pod width (cm), pod breath (cm) and days taken for first flowering, whereas in the second year pod breath (cm), days taken for 50 % flowering, pod width (cm), pod length (cm) and number of pods/plant attain lower heritability values. Under pooled data analysis, pod width (cm), days taken for first flowering, pod breath (cm), germination (%) and days taken for 50 % flowering were found with lower heritability estimates. High heritability with high genetic advance were found with number of clusters/plant, number of pods/plant, pod yield/plant (g), plant height (cm), days to maturity, pod yield/plant (g), number of pods/plant, number of clusters/plant and pod yield (q/ha), indicating there by that selections based on phenotypic performance could be effective for improvement of these characters.

Keywords*: Genetic variability, correlation, genetic advance, path analysis, traits, cluster bean, Cyamopsis tetragonoloba, yield and yield attributes.*

INTRODUCTION

Cluster bean [*Cyamopsis tetragonoloba* (L.) Taub.], also known as guar, is arid legume crop that is cultivated mostly in the arid and semi arid areas as it is drought resistant. The long deep taproot system enables the plant to grasp all the water in the soil making it an ultimate drought resistant crop. It is self pollinated crop belongs to family *Fabaceae*. Guar originated in the India and Pakistan area and is characterized as a short day erect or bushy annual plant[15]. Cluster bean is mainly exported to USA, Germany, Netherlands, Italy, UK, Japan and France[24]. The per capita availability of protein in the country is 28g/ day, while WHO recommended it should be 80 g/day, consequently most serious problem of the malnutrition existing among the poor people, where most of the people have vegetarian diet and avoid the animal protein[14].

India produces 80% of the world's supply of guar with 70% being exported to the United States and Europe[11]. Generally diverse germplasm are expected to give high hybrid vigour and hence, it necessitates to study among the existing varieties and genotypes for the identification of parents for hybridization programme. Considering the importance of cluster bean as a vegetable cum industrial crop, its adaptability to arid drought conditions, there is a prime need for its improvement. With limited variability nothing can be achieved and the breeder will have to enrich the germplasms or genotypes or can resort to create greater variability through hybridization, mutation and polyploidy breeding. Therefore, the present investigation was undertaken to study the genetic variability for growth, seed yield and quality parameters.

India is one of the main producers of cluster bean contribute for 80 per cent of the total production of the world, whereas Rajasthan occupies the largest area (82.1%) under guar cultivation in the country. Genetic improvement for quantitative traits depends upon the nature and amount of variability present in the genetic stock and the extent to which the desirable traits are heritable[7]. Thus, the total area of cluster bean in India is 4.25 million hectare and production is 2.41 million tones with productivity of 0.57 million tones/ha in 2014 (Ministry of Agriculture Govt. of India, 2014). Assessment of the genetic variability within cultivated crops has a strong impact on plant breeding strategies and conservation of genetic resources. It is particularly useful in the characterization of individuals, accessions and cultivars in determining duplications in germplasm collections and for the choice of parental genotypes in breeding programmes. Yield is a character determined by several component characters. Hence, selection for yield should take into account the related characters also. Genetic variability exists for stress and related traits in guar and is useful in selection of drought resistance genotypes by an efficient screening technique based on a combination of morpho-physiological parameters.

In many parts of the country including Punjab, it is an important legume fodder crop grown during Kharif to produce highly nutritious and palatable fodder for the cattle. Despite the importance of this crop, only limited breeding work has been done and very little attention has been given for its genetic improvement in the past, in order to enhance the productivity levels of Kharif cluster bean. Therefore, there is a great opportunity for forage breeders in identifying the genetic make-up that are superior in green fodder yield. To reach this goal, the basic requirements are to have adequate information on the extent of variability, heritability, expected genetic gain and degree of genetic association among the different characters. In view of this, the present investigation was carried out with the objective of assessing genetic variability and characters association amongst the various yield contributing traits and quality parameters.

MATERIALS AND METHODS

The present investigation was carried out at the Horticultural Research Farm of the Department of Applied Plant Science (Horticulture), Babasaheb Bhimrao Ambedkar University, Vidya-Vihar, Rae Bareli Road, Lucknow, Uttar Pradesh, India, during *Rabi* season of 2012-13 and 2013-14. The data of both the years were pooled and analyzed. Geographically, Lucknow is situated at an elevation of 111m above the mean sea level in the subtropical tract of central Uttar Pradesh at $26^0$56' North latitude and 80^0 52' East longitudes. The place experiences winter and very hot summer with average rainfall. Agro climatically, the location represent Central Zone of the state of Uttar Pradesh, India, and is characterized by sub-tropical climate. The experimental material comprising of thirty genotypes of cluster bean was collected from different sources and maintained in the Horticultural Research Farm. All recommended package of practices were followed to raise good crop. Experimental field was laid out in randomized block design with 30 genotypes/lines and replicated thrice. Each block was further subdivided into 30 unit plots. The thirty genotypes were allotted to the 30 unit plots of each block. The plots were raised by 15cm from the ground level to avoid water-logging, if occurred. The unit plot size was 2.70m X 1.20m, the row-to-row and plant-to-plant spacing was 45cm and 30cm, respectively. Fertilizers as 15 kg N_2, 60 kg P_2O_5 and 60 kg K_2O kg/ha were applied to rise good crop. All necessary cultural operations were done as and when required during the growing period. Data was recorded on 5 randomly selected plants per entry per replication for various horticultural characters namely, Plant height (cm), germination (%), days taken for first flowering, days taken for 50% flowering, number of reproductive branches/plant, pod breath (cm),

pod length (cm), pod width (cm), number of pods/plant, number of pods/cluster, number of clusters/plant, number of branches/plant at maturity, number of seed/pod, pod yield/plant (g), pod yield/plot (kg), 100-seed weight (g), seed yield/plant (g), days to maturity and pod yield (q/ha). The data were analyzed for estimation of genotypic and phenotypic coefficient of variation following Burton[2]. Heritability in broad sense and genetic advance were calculated according to the methods of Allard[1]. Simple correlation coefficients among the characters at phenotypic and genotypic levels were analyzed following Hayes *et al*.[6] and Singh and Chaudhary[23]. Path analysis at genotypic level was done following Deway and Lu[5]. Heritability (h^2) in the broad sense (in per cent) was computed by the formula given by Johnson *et al*.[8]. The genotypic and phenotypic coefficient of variation was estimated according to the method of Panse and Sukhatme[12].

RESULTS AND DISCUSSION

The analysis of variance Table 1, 2 and 3 depicted that mean squares of treatments were significant for most of the characters indicating varietal differences for all the characters studied.

The estimates of phenotypic coefficient of variation (PCV) were higher than genotypic coefficient of variation (GCV) for all the characters under consideration. Highest range of variation was reported with pod yield (q/ha) followed by pod yield/plant (g) and plant height (cm). The coefficient of variation was minimum for days to maturity followed by days taken for 50 % flowering and maximum for number of pods/cluster. Heritability estimates for all the characters were high except pod width (cm), pod breath (cm) and days taken for first flowering (Table 1). High heritability was observed for number of pods/cluster, number of clusters/plant, pod yield/plant (g) and plant height (cm). High genetic advance was observed for pod yield/plant (g), plant height (cm), number of pods/plant and number of clusters/plant in accordance with the results of Shekhawat and Singhania[17] and Vijay[25]. Estimates of variance and other genetic parameters in cluster bean studied under second year 2013-14 depicted that highest range of variation was reported with pod yield (q/ha) followed by pod yield/plant (g). The coefficient of variation was minimum for number of branches/plant at maturity parameter followed by days to maturity and maximum for pod width (cm) followed by pod breath (cm). The magnitude of phenotypic coefficient of variation was higher in general than corresponding genotypic coefficient of variation indicating the influence of environmental factors in their expression by Johanson *et al*.[8] Heritability estimates for all the characters were high except pod breath (cm), days taken for 50 % flowering, pod width (cm), pod length (cm) and number of pods/plant (Table 2). High heritability was observed for number of clusters/plant, pod yield/plant (g), number of pods/cluster, days to maturity and plant height (cm). High genetic advance was observed for pod yield/plant (g), plant height (cm), number of clusters/plant, pod yield (q/ha) and number of pods/cluster. High genetic advance coupled with high heritability could be resulted are in accorandance with the findings of Liang and Waltre[9]. In pooled analysis, highest range of variation was reported with pod yield (q/ha) followed by pod yield/plant (g). The coefficient of variation was minimum for days to maturity parameters followed by pod yield/plant (g) and maximum for pod width (cm) followed by pod breath (cm) (Table 3). This suggested the presence of wide range of variability for different characters and it is the most important aspect while selecting a genotypes. The coefficient of variation was maximum for pod width (cm) among all the genotypes of cluster bean, phenotypic and genotypic coefficients of variations were high for number of pods/cluster and number of clusters/plant. Narrow differences between phenotypic and genotypic coefficients of variation depicted that variability existing among different genotypes of cluster bean was mainly due to genetic makeup and there is less environmental influence of the expression of these traits. The same results have been also reported by Johanson *et al*.[8] in cluster bean. GCV is helpful in the assessment of inherent variability. GCV and PCV observed the amount of variability in the available genotypes.

Heritability estimates give a measure of transmission of characters from one generation to another, thus given an idea of heritable portion of variability and enabling to the plant breeder in isolating the elite selection in the crop.

Heritability and genetic advance increase the efficiency of the selection in breeding programme by assessing the influence of environmental factors and additive gene action. Heritability estimates for all the characters were high except pod width (cm), days taken for first flowering, pod breath (cm), germination (%) and days taken for 50 % flowering (Table 3). The magnitude of heritable variability is the most important aspect of genetic constitution of the genetic material which has close bearing on the response to selection by Panse[13]. Heritability along with genetic gain is more useful criterion in predicting the resultant effect for selecting the best individual by Johanson *et al*.[8]. High heritability was observed for number of clusters/plant, number of pods/plant, pod yield/plant (g), plant height (cm) and days to maturity. High genetic advance was observed for plant height (cm), pod yield/plant (g), number of pods/plant, number of clusters/plant and pod yield (q/ha). High heritability with high genetic advance advocate that the character is governed by the additive gene action and for this simple selection is advocated. The results are in accordance with Rai *et al*.[16] and Singh *et al*.[18].

High heritability with medium genetic advance suggests that the character is governed by the dominant and epistatic gene action and for this hybridization is done. In all the studies, characters like number of pods/cluster and days to maturity were found with high heritability and medium genetic advance. In the present investigation, number of branches/plant at maturity, number of pods/plant, number of seeds/pod, pod length (cm), pod width (cm), pod breath (cm), pod yield/plant (g), pod yield (q/ha), 100-seed weight (g), are governed with non additive gene action Rai *et al*.[16] and Singh *et al*.[18]. The similar types of results were found by some researchers[3,4,10,19,20,21,22]. A relative comparison of heritability and genetic advance given an idea of gene action governing a particular character. This was with higher values in number of clusters/plant, number of pods/plant, pod yield/plant (g), plant height (cm) and days to maturity, pod yield/plant (g), number of pods/plant, number of clusters/plant and pod yield (q/ha) in both the years of studies.

Table-1: Estimates of variance and other genetic parameters in Cluster bean in first year (2012-13)

S. No.	Characters	General Mean	SEm±	Range		Co-efficient of variation			Heritability in broad sense (%)	Genetic advance (GA)	Genetic advance in % of mean
				Min.	Max.	CV (%)	PCV (%)	GCV (%)			
1	X1	80.02	4.92	55.69	109.02	7.53	17.54	15.84	81.50	23.58	29.46
2	X2	91.12	2.06	85.80	97.25	2.76	4.15	3.09	55.40	4.31	4.73
3	X3	22.16	0.974	19.77	23.74	5.38	6.48	3.60	30.90	0.91	4.10
4	X4	34.10	0.765	31.64	37.79	2.74	4.54	3.61	63.30	2.02	5.92
5	X5	5.80	0.457	4.20	7.93	9.66	20.05	17.57	76.80	1.84	31.72
6	X6	3.77	0.301	3.29	4.34	9.77	10.32	3.30	10.20	0.08	2.12
7	X7	5.72	0.344	4.52	6.90	7.37	10.53	7.52	51.00	0.63	11.01
8	X8	5.97	0.275	5.70	6.34	5.64	5.67	0.53	9.00	0.01	0.16
9	X9	56.22	3.20	41.07	76.73	6.98	15.20	13.50	78.90	13.89	24.70
10	X10	7.91	0.640	2.93	21.47	9.90	62.31	61.52	97.50	9.90	125.15
11	X11	12.02	0.919	7.00	31.13	9.36	43.03	41.99	95.30	10.15	84.44
12	X12	8.38	0.434	7.13	10.13	6.35	9.44	6.99	54.80	0.89	10.62
13	X13	6.72	0.348	5.93	7.53	6.35	8.57	5.75	45.00	0.53	7.88
14	X14	97.15	2.84	79.24	122.17	3.58	13.11	12.61	92.50	24.28	24.99
15	X15	0.57	0.00396	0.41	0.78	8.42	17.32	15.14	76.40	0.16	28.07
16	X16	3.59	0.243	2.94	4.23	8.31	11.23	7.54	45.10	0.37	10.30
17	X17	6.92	0.471	5.10	8.93	8.33	15.45	13.02	70.90	1.56	22.54
18	X18	92.59	1.20	86.73	97.87	1.59	3.55	3.17	79.70	5.40	5.83
19	X19	127.87	4.67	120.29	143.50	4.47	5.79	3.67	40.30	6.14	4.80

1. Plant height (cm) 2. Germination (%) 3. Days taken for first flowering
4. Days taken for 50% flowering 5. Number of reproductive branches/plant 6. Pod breath (cm)
7. Pod length (cm) 8. Pod width (cm) 9. Number of pods/plant
10. Number of pods /cluster 11. Number of clusters /plant 12. Number of branches /plant at maturity
13. Number of seed /pod 14. Pod yield /plant (g) 15. Pod yield /plot (kg)
16. 100- Seed weight (g) 17. Seed yield /plant (g) 18. Days to maturity
19. Pod yield (q/ha)

Table-2: Estimates of variance and other genetic parameters in Cluster bean in second year (2013-14)

S. No.	Characters	General Mean	SEm±	Range		Co-efficient of variation			Heritability in broad sense (%)	Genetic advance (GA)	Genetic advance in % of mean
				Min.	Max.	CV (%)	PCV (%)	GCV (%)			
1	X1	80.45	3.67	55.72	106.36	5.59	16.46	15.48	88.40	24.12	29.98
2	X2	91.16	3.68	87.25	97.28	4.88	4.89	0.03	57.50	4.28	4.69
3	X3	22.64	1.34	21.14	24.11	7.28	7.29	0.14	32.80	0.78	3.44
4	X4	33.00	1.43	30.98	35.22	5.33	5.49	1.33	5.90	0.22	0.66
5	X5	5.91	0.570	3.99	7.91	11.80	20.83	17.15	67.80	1.72	29.10
6	X6	3.74	0.447	3.28	4.19	14.64	14.67	0.85	3.50	0.07	1.87
7	X7	5.70	0.578	4.62	6.85	12.41	13.36	4.94	13.70	0.21	3.68
8	X8	5.93	0.822	5.66	6.34	16.95	16.96	0.53	10.50	0.03	0.50
9	X9	56.49	5.46	43.86	70.74	11.85	14.74	8.77	35.40	6.07	10.74
10	X10	7.56	0.875	4.44	18.14	14.16	53.72	51.82	93.00	7.79	103.04
11	X11	11.58	0.385	7.22	27.53	4.07	38.15	37.93	98.90	9.00	77.72
12	X12	8.44	0.00917	7.27	10.21	0.13	7.64	7.64	52.70	1.33	15.74
13	X13	6.80	0.335	5.90	7.64	6.04	8.52	6.01	49.80	0.59	8.67
14	X14	95.42	2.71	79.23	120.81	3.48	13.27	12.81	93.10	24.31	25.47
15	X15	0.57	0.0523	0.38	0.77	11.19	18.00	14.09	61.30	0.13	22.80
16	X16	3.68	0.229	3.06	4.45	7.61	11.16	8.15	53.40	0.45	12.22
17	X17	6.45	0.378	5.04	8.36	7.16	15.96	14.26	79.80	1.70	26.35
18	X18	92.47	0.852	86.10	97.13	1.12	3.35	3.15	88.60	5.65	6.11
19	X19	92.47	2.82	118.44	140.95	2.74	4.98	4.15	69.60	8.99	9.72

1. Plant height (cm) 2. Germination (%) 3. Days taken for first flowering
4. Days taken for 50% flowering 5. Number of reproductive branches/plant 6. Pod breath (cm)
7. Pod length (cm) 8. Pod width (cm) 9. Number of pods/plant
10. Number of pods /cluster 11. Number of clusters /plant 12. Number of branches /plant at maturity
13. Number of seed /pod 14. Pod yield /plant (g) 15. Pod yield /plot (kg)
16. 100- Seed weight (g) 17. Seed yield /plant (g) 18. Days to maturity
19. Pod yield (q/ha)

Table-3 Estimates of variance and other genetic parameters in Cluster bean in pooled study (2012-13 and 2013-14)

S. No.	Characters	General Mean	SEm±	Range		Co-efficient of variation			Heritability in broad sense (%)	Genetic advance (GA)	Genetic advance in % of mean
				Min.	Max.	CV (%)	PCV (%)	GCV (%)			
1	X1	80.24	3.07	55.71	107.69	6.63	17.42	16.11	85.50	24.62	30.68
2	X2	91.64	2.10	87.24	95.94	3.98	4.46	2.00	20.20	1.70	1.85
3	X3	22.40	0.831	21.07	23.83	6.42	6.91	2.54	13.50	0.43	1.91
4	X4	33.55	0.813	31.40	36.34	4.20	5.18	3.03	34.20	1.22	3.63
5	X5	5.86	0.365	4.13	7.75	10.80	19.81	16.61	70.20	1.68	28.66
6	X6	3.75	0.269	3.29	4.22	12.43	13.85	6.09	19.40	0.21	5.60
7	X7	5.71	0.336	4.57	6.66	10.20	13.34	8.60	41.50	0.65	11.38
8	X8	5.95	0.433	5.68	6.34	12.60	12.93	2.88	5.00	0.08	1.34
9	X9	56.36	3.16	42.47	73.74	9.73	15.33	11.84	59.70	10.62	18.84
10	X10	7.74	0.452	4.33	20.22	12.13	58.05	56.77	95.60	8.85	114.34
11	X11	11.80	0.498	7.25	29.33	7.31	40.47	39.80	96.70	9.52	80.67
12	X12	8.41	0.217	7.25	10.17	4.47	8.77	7.54	73.90	1.12	13.31
13	X13	6.76	0.241	5.95	7.52	6.19	9.11	6.68	53.80	0.68	10.05
14	X14	96.32	1.96	79.23	121.49	3.53	13.21	12.72	92.80	24.33	25.25
15	X15	0.57	0.032	0.39	0.76	9.89	18.20	15.27	70.40	0.15	26.31
16	X16	3.63	0.167	3.00	4.33	7.96	11.96	8.92	55.60	0.50	13.77
17	X17	6.69	0.302	4.79	8.64	7.81	15.91	13.86	75.90	1.66	24.81
18	X18	92.53	0.738	86.42	97.27	1.38	3.41	3.12	83.60	5.44	5.87
19	X19	126.93	2.72	119.40	142.23	3.72	5.80	4.45	58.80	8.92	7.02

1. Plant height (cm) 2. Germination (%) 3. Days taken for first flowering
4. Days taken for 50% flowering 5. Number of reproductive branches/plant 6. Pod breath (cm)
7. Pod length (cm) 8. Pod width (cm) 9. Number of pods/plant
10. Number of pods /cluster 11. Number of clusters /plant 12. Number of branches /plant at maturity
13. Number of seed /pod 14. Pod yield /plant (g) 15. Pod yield /plot (kg)
16. 100- Seed weight (g) 17. Seed yield /plant (g) 18. Days to maturity
19. Pod yield (q/ha)

CONCLUSION

On the basis of above results, it was concluded that number of clusters/plant, number of pods/plant, pod yield/plant (g), plant height (cm) and days to maturity, pod yield/plant (g), number of pods/plant, number of clusters/plant and pod yield (q/ha) are the important traits for selection to yield improvement in cluster bean.

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