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Metroglyph Analysis for Morphological Variation in Advanced Lines and Cultivars of Intervarietal and Interspecific Crosses in Blackgram (*Vigna mungo* L. Hepper)

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Abstract The present research was carried out to determine the pattern of morphological variation for eight characters in 34 advance lines and cultivars of intervarietal and interspecific crosses of blackgram including one mungbean genotype BDYR-1 and two check varieties, Pant U 31 and Pant U 40 by Metroglyph and Index score analysis. Two most variable characters, pod length and grain yield/plant for X and Y axis, respectively. The scatter diagram revealed that four groups could be distinguished on the basis of morphological variation and maximum numbers of genotypes (13) were found in group II. Metroglyph and Index score analysis revealed maximum variability for different characters in third and fourth group which comprised thirteen and six genotypes, respectively. Maximum genotypes (7) occurred at an index score of thirteen and highest index score of eightteen was observed for one genotypes, PU 06–24 ; the scatter diagram and index score of genotypes as brought about by metroglyph analysis can be used as a measure of relative genetic distance among the lines, identifying groups of genotypes with yield enhancing traits and in the selection of superior genotypes.

Keywords Metroglyph, Intervarietal, Interspecific, Index score, Yield.

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Introduction

Pulse crops play an important role in Indian agriculture besides being rich in protein, pulses constitute the main source of essential amino acids. Their ability to use atmospheric nitrogen through biological nitrogen fixation is economically more sound and environmentally acceptable.Among pulses, blackgram or urd (*Vigna mungo* L. Hepper) belonging to tribe *phaseola* of family leguminoseae is of immense importance and is an important short duration grain legume cultivated over a wide range of agro-climatic conditions. The total area under the crop has increased progressively from 1.98 million ha in 1964-65 to 2.67 million ha in 2008-09. Similarly, the production has increased from 0.64 million tones to 1.17 million tones during same period [1]. Directorate of Economics and Statistics, Department of Agriculture and Cooperation, 2010. Increase in both area and production has been observed in Andhra Pradesh, Karnataka, Maharashtra, Rajasthan, Uttar Pradesh and Tamil Nadu. It is diploid with 2n = 22 and is highly prized pulse being rich in phosphoric acid. Urd is said to have originated in India where it is most widely grown and highly esteemed grain legume and was domesti-

cated from *Vigna mungo* var. *sylvestris*. It is an important grain legume for South and South-East Asia and India is most important producer of all. It ranks fourth in area and production after chickpea, pigeonpea and mungbean and cultivated under a wide range of predominantly rainfed farming system in dry and intermediate agro ecological zones on marginal lands with low moisture and fertility conditions. The experiment was conducted with an aim to evaluate the genetic potential of blackgram genotypes for yield and yield component characters by metroglyph analysis and to develop a selection criterion. Information thus obtained could be used for the development of comprehensive breeding program to evolve high yielding blackgram cultivars. Metroglyph analysis initially given by Anderson was mainly for establishing relationship among races and biotypes of crop plants. This method was used to assess genetic diversity by species, Rashid et al. [2] in basmati rice mutants, Khan et al. [3] in cotton and Bhargava et al. [4] in *Chenopodium* species. The major objectives of this study were to classify the available blackgram genotypes into distinct groups on the basis of their genetic diversity by using Metroglyph and Index score analysis.

Materials and Methods

The material for the present investigation comprised 34 advance lines and cultivars of intervarietal and interspecific crosses of blackgram including one mungbean genotype BDYR-1 and two check varieties (Pant U-31 and Pant U-40). The material represented a wide range of geographic diversity. The experiment was carried out in a randomized block design with three replications at Crop Research Center, G. B. Pant University of Agriculture and Technology, Pantnagar during *kharif*, 2008-09. Each plot consisted of 6 rows measuring of 4 m length. The spacing adopted between rows and between plants was 30 cm and 10 cm, respectively. The data on days to 50% flowering, days to maturity, plant height, pods/plant, pod length, seeds/pods, 100 seed weight and grain yield/plant were recorded on five randomly selected labeled plants for all the entries in each replication. All the observations except days to 50% flowering were taken at maturity. The mean data was subjected to statistical analysis using Anderson's Metroglyph technique to study the patterns of morphological variations in different genotypes.

Plotting of glyph on the graph

A small circle by which the position of the genotype or line was represented on the graph was called the glyph. For plotting of glyph on the graph two most variable traits (pod length and grain yield/plant) were drawn on X-axis and Y-axis, respectively. Except these traits other traits were represented as rays on the glyph, where each glyph represented a genotype thus forming a scatter diagram. The traits were represented by different length of rays. The length of ray assigned to each trait was according to the index value of genotypes set for that trait. The mean value of X for each genotype were plotted on the graph against the mean value of Y. Thus each line occupied a definite position on the graph called glyph. The line akin to mungbean and akin to blackgram were represented by open glyph with dot in center, open glyph and half solid glyph, respectively for easy identification.

Depiction of variation

Variation for remaining characters of each genotype was displayed on the respective glyph by rays. Each character occupied a definite ray position. Variation for each character was depicted by the length of ray. Thus the length of ray for a particular character on the glyph may be short or medium or long depending on the index value of a genotype.

Construction of index score

For this purpose the variation for each character was divided into 3 groups, viz., low, medium and high. The genotypes with low, medium and high value were given index score 1, 2 and 3 respectively. The worth of a genotype was calculated by adding the index value of all the characters. Thus the maximum and minimum score of on the individual will be 3n and n respectively, where n was the total number of characters included in the study.

X co-ordinate for each circle being the pod length and Y co-ordinate for each circle being grain yield/plant. Remaining seven characters have been repre-

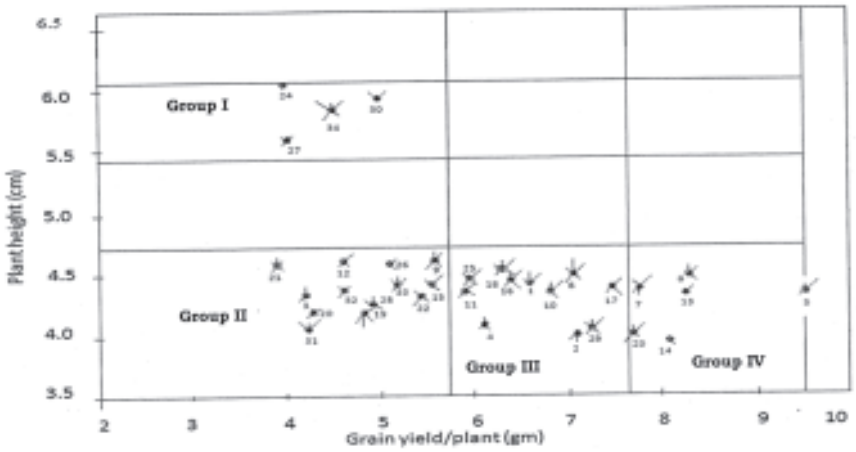

Fig. 1. Scatter diagram of Metroglyph analysis of advance lines and cultivars of blackgram, mungbean and checks (Pant U 31 and Pant U 40).

sented by rays of different positions on the glyph and the range by length of rays i.e., a line having low value with no ray, medium value with short ray and high value with long ray. The index values were divided into three classes i.e., 1-no ray, 2 -short ray and 3-long ray. The total index values were taken by adding up the index scores of all the eight characters studied. All the genotypes were divided into different groups in the scatter diagram and the genotypes aggregating closely were kept in one group.

Results and Discussion

The Metroglyph and Index score analysis was carried out for 8 characters. The index score and signs used for different characters for metroglyph analysis were presented in Table 1. The scatter diagram revealed that four groups could be distinguished on the basis of morphological variation (Fig. 1), which was prepared on the basis of index score. Blackgram genotypes are represented by a circle with red color

Table 1. Index scores and signs used for characters for Metroglyph analysis of 34 genotypes of blackgram and mungbean.

	Score 1		Score 2		Score 3	
Character	Value less than	Sign	Value from-to	Sign	Value more than	Sign
Days to 50% flowering	35.5	o	35.5–37.7	\o	37.7	\o
Days to maturity	86.3	o	86.3–88.3	o/	88.3	o/
Plant height (cm)	49.4	o	49.4–57.3	/o	57.3	/o
Pods / plant	18.2	o	18.2–21.3	o\	21.3	o\
Pod length (cm)	4.7		4.7–5.4	–	5.4	–
Seeds / pod	5.8	o	5.8–6.6	o|	6.6	o|
100-seed weight (g)	3.94	o	3.94–3.94	o|	3.94	o|
Grain yield / plant	5.78	–	5.78–7.66	–	7.66	–

Table 2. Mean values and scores used in scatter diagram of blackgram and mungbean for Metroglyph analysis.

Entry	Days to 50% flowering	Days to maturity	Plant height (cm)	Pods/ plant	Pod length/ (cm)	Seeds/ pod	100-seed weight (g)	Grain yield/ plant (g)	Index score
1	35.6 (2)	89.6 (3)	47.9 (1)	17.4 (1)	4.4 (1)	5.6 (1)	5.21 (3)	6.63 (2)	14
2	33.3 (1)	86.3 (1)	55.4 (2)	18.2 (1)	4.0 (1)	5.7 (1)	3.97 (2)	7.19 (2)	11
3	34.6 (1)	86.3 (1)	51.0 (2)	17.3 (1)	4.3 (1)	5.4 (1)	4.25 (2)	4.33 (1)	10
4	34.3 (1)	85.0 (1)	52.6 (2)	19.4 (2)	4.1 (1)	5.7 (1)	4.54 (2)	6.14 (2)	12
5	35.0 (1)	89.6 (3)	52.3 (2)	18.2 (1)	4.3 (1)	4.9 (1)	4.29 (2)	9.53 (3)	14
6	34.6 (1)	87.3 (2)	46.9 (1)	20.5 (2)	4.5 (1)	5.7 (1)	4.01 (2)	8.38 (3)	13
7	35.6 (2)	89.3 (3)	53.2 (2)	18.7 (1)	4.3 (1)	5.8 (2)	3.81 (1)	7.84 (3)	15
8	35.6 (2)	89.0 (3)	57.8 (3)	19.4 (2)	4.5 (1)	4.9 (1)	5.69 (3)	7.01 (2)	17
9	34.6 (1)	87.3 (2)	59.9 (3)	18.6 (2)	4.6 (1)	5.2 (1)	4.50 (2)	5.63 (1)	13
10	35.0 (1)	90.0 (3)	49.2 (1)	18.4 (2)	4.3 (1)	5.7 (1)	4.39 (2)	6.86 (2)	13
11	35.0 (1)	89.6 (3)	50.3 (2)	19.6 (2)	4.3 (1)	5.5 (1)	3.73 (1)	5.94 (2)	13
12	34.3 (1)	90.3 (3)	51.8 (2)	20.8 (2)	4.6 (1)	5.3 (1)	3.61 (1)	4.59 (1)	12
13	34.3 (1)	87.6 (2)	42.5 (1)	18.2 (1)	4.4 (1)	5.6 (1)	3.60 (1)	8.30 (3)	11
14	34.6 (1)	86.3 (1)	44.8 (1)	19.1 (2)	4.0 (1)	5.5 (1)	3.87 (1)	8.10 (3)	11
15	35.6 (2)	90.0 (3)	46.6 (1)	16.5 (2)	4.4 (1)	5.3 (1)	3.76 (1)	5.67 (1)	12
16	34.6 (1)	87.3 (2)	60.1 (3)	22.6 (3)	4.4 (1)	5.0 (1)	4.45 (2)	6.46 (2)	15
17	34.0 (1)	89.3 (3)	56.3 (2)	22.0 (3)	4.3 (1)	5.6 (1)	3.35 (1)	7.56 (2)	14
18	36.0 (2)	89.0 (3)	51.8 (2)	21.8 (3)	4.5 (1)	5.3 (1)	4.22 (2)	6.41 (2)	16
19	35.0 (1)	88.0 (2)	65.3 (3)	24.3 (3)	4.2 (1)	7.6 (3)	3.07 (1)	4.86 (1)	15
20	35.3 (1)	88.3 (2)	53.4 (2)	15.2 (1)	4.2 (1)	5.2 (1)	3.14 (1)	4.34 (1)	10
21	36.3 (2)	88.3 (2)	54.8 (2)	19.8 (2)	4.6 (1)	5.2 (1)	3.93 (2)	3.91 (1)	13
22	36.3 (2)	86.3 (1)	61.6 (3)	20.4 (2)	4.3 (1)	5.3 (1)	3.67 (1)	5.49 (1)	12
23	37.0 (2)	88.6 (3)	57.7 (3)	20.2 (2)	4.0 (1)	5.5 (1)	4.40 (2)	7.73 (3)	17
24	33.6 (1)	84.3 (1)	48.6 (1)	17.5 (1)	6.1 (3)	5.3 (1)	3.08 (1)	3.98 (1)	10
25	37.6 (2)	89.6 (3)	53.9 (2)	19.0 (2)	4.4 (1)	5.5 (1)	3.64 (1)	5.98 (2)	14
26	34.6 (1)	87.0 (2)	45.5 (1)	20.1 (2)	4.6 (1)	5.7 (1)	3.54 (1)	5.19 (1)	10
27	37.0 (2)	88.3 (2)	49.6 (2)	18.0 (1)	5.6 (3)	5.2 (1)	3.88 (1)	4.06 (1)	13
28	35.6 (2)	85.0 (1)	46.4 (1)	19.0 (2)	4.2 (1)	5.4 (1)	3.94 (2)	4.87 (1)	11
29	36.0 (2)	89.6 (3)	55.2 (2)	19.0 (2)	4.1 (1)	5.2 (1)	4.34 (2)	7.25 (2)	15
30	38.3 (3)	90.0 (3)	41.5 (1)	17.2 (1)	5.9 (3)	5.4 (1)	3.74 (1)	5.01 (1)	14
31	40.0 (3)	89.0 (3)	45.4 (1)	16.4 (1)	4.1 (1)	5.4 (1)	4.37 (2)	4.22 (1)	13
32	37.6 (2)	88.3 (2)	52.5 (2)	15.9 (1)	4.3 (1)	5.1 (1)	3.93 (1)	4.67 (1)	11
33	37.0 (2)	87.6 (2)	54.6 (2)	17.8 (1)	4.4 (1)	5.5 (1)	4.34 (2)	5.26 (1)	12
34	38.3 (3)	89.3 (3)	60.4 (3)	18.6 (2)	5.8 (3)	5.1 (1)	4.33 (2)	4.50 (1)	18

and mungbean genotype is presented by a circle with green color. X-coordinate for each circle being the pod length (cm) and Y-coordinate the grain yield/ plant (the most variable characters). The remaining six characters are represented by rays at different positions on the glyph and the range of the characters by the length of rays.

In the scatter diagram four groups could be distinguished on the basis of the phenotypic variation. Mean values and scores for the genotypes and checks used in scatter diagram are represented in Table 2. The I group was represented by the four genotypes, one of mungbean (BDYR-1) and three of blackgram (PU 06-16, PU 08-19, PU 06-24) with low grain yield / plant, low pods/plant and low plant height. The II group was characterized by low to average grain yield/ plant and average pod length with average 100-seed weight and less days to 50% flowering and high days to maturity. This group consisted of 13 blackgram progenies (PU-08-11, PMU-02, PU 06-15, PU 08-8, PU 08-3, PU 06-21, PU 06-22, PMU-03, PU 06-23, PU 06-17, PMU-01, PU 08-14 and Local-60).

The III group was represented by 11 blackgram genotypes (PU 06-14, PU 08-10, PU 08-7, PU 08-4, PU

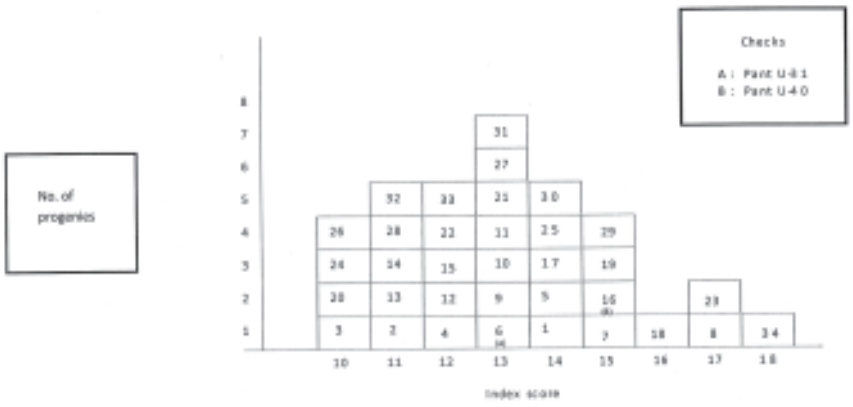

Fig. 2. Pattern of distribution of 31 genotypes of blackgram and mungbean scored for 8 characters.

08-1, PU 08-9, PU 07-7, PU 08-15, PU 08-2 and PU 06-18) including one check, Pant U-40. The genotypes in this group have average grain yield/plant and average pod length. This group is also characterized by low to high 100-seed weight and average plant height. The IV group was represented by 6 blackgram genotypes (PU 08-6, DPU 88-31, PU 08-13, PU 08-12, PU 08-5) including one check, Pant U-31. This group is characterized by average grain yield / plant, average pod length and average 100-seed weight. The frequency diagram (Fig. 2) showed the index score values for all characters. The range of index score was from 10 to 18. Maximum genotypes (7) occurred at an index score of 13 and highest index score of 18 was observed for one genotype, PU 06-24 ; followed by (PU 08-2 and PU 08-1) occurred around an index score of 17 and 16, respectively. Whereas minimum index score 10 was observed for four genotypes, PU 08-3, PMU-02, BDYR-1 (greengram) and PU 06-15, respectively.

Metroglyph analysis was conducted to study the extent of variation in 34 advance lines and cultivars of intervarietal and interspecific crosses of blackgram including one mungbean genotype and two check varieties. On the basis of morphological variation in genotypes, a scatter diagram was prepared. The scatter diagram arranged the genotypes into four groups. Maximum number of genotypes were present in group II (13) followed by group III (11) and IV group 960. Minimum number of genotypes were present in group I (4). The majority of genotypes had average pod length and average grain yield / plant. In present study metroglyph technique was found useful in identifying groups of genotypes with yield enhancing traits among the collection of diverse genotypes and thus suggesting its potential value in blackgram improvement. The success of any plant breeding program aimed at the evolution of high yielding, better quality and disease resistant varieties depends upon the selection of suitable genotypes to be utilized in breeding program. The study of genetic diversity among genotypes is helpful in formulating effective crop breeding strategy. An effective hybridization program must include the genotypes of group III and IV to yield better segregants that may result in the evolution of high yielding blackgram varieties. Findings of the present study suggested that genotypes in different groups can be used for crossing program for harnessing maximum variability of good combinations of characters and also helped to ascertain the diversity for various characters among the 34 genotypes. An examination of scatter diagram revealed that within group morphological variations were of a low order while between groups morphological variations were high.

A wide range (10 to 18) of index score were observed which itself indicated the large amount of variation in the study material. This variation can be utilized in further breeding program for recovery of superior transgressive segregants. From these results one can foresee which genotype is undesirable or otherwise weak in some traits and can identify the

desirable cross combinations. The information furnished here will be helpful to the breeder in the selection of superior genotypes which may be directly improved or utilized as parents in hybridization program for the development of future varieties.

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