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Studies on the Interspecific Hybrids between Mungbean and Urdbean

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A B S T R A C T

Thirty interspecific crosses (including reciprocals) involving three genotypes/varieties of greengram *(Vigna radiate (L)* Wilczek) cv. HUM 1 HUM 2 & HUM 8 and five genotypes/varieties of blackgram *(Vigna mungo* (L.) Hepper) cv. T 9, Pant U 19, PDU 1, BHUU 1 & BHUU 91-346-1 were attempted. Nine out of 30 crosses were successful only when greengram was used as seed parents. The crossability ranged from 0.0 to 61.0 per cent. Germination, survival and pod bearing habit of the F_1s hybrids were much better in *Kharif* season as compared to spring/summer season. The F_1 hybrids were intermediate for leaf shape, pod and stem hairiness and pod arrangement while they resembled the maternal parents for cotyledon colour. Purple colour of the stem appeared to be dominant over green colour. The F_1s showed positive heterosis for days to flowering and maturity, plant height, number of primary branches, pods per plant and cluster per plant while for pod length, number of seeds per pod, seed yield per plant and l00-seed weight, it exhibited negative heterosis. The mean of the pollen fertility was 15.0 per cent in F_1s and 32.5 per cent in F_2s indicating the improvement in fertility level when generation advanced. In F_2 generation, the hybrids segregated both for greengram and blackgram types. Further, the desirable transgressive segregants were observed in F_2 generation for most of the traits indicated that an elite population may be obtained through interspecific hybridization involving greengram and blackgram

Introduction

Among the several pulses grown, greengram [*Vigna radiata* (L.) Wilczek] and blackgram [*Vigna mungo* (L.) Hepper] are the important grain legumes cultivated through the world. In India, greengram and blackgram are usually grown in Kharif as well as Spring/Summer season. Due to their short duration, they can be well fitted in multiple cropping systems ultimately adding to the total production. Grain legumes are a good source of non-vegetarian protein, especially for the poor men who often cannot afford animal protein.

It also contains high amounts of macro and micronutrients, vitamins, fibre and carbohydrate for balanced nutrition (Gill *et al*., 2014; Kumar *et al*., 2016 and 2017). It also improves the soil health by fixing the atmospheric nitrogen in to the soil and enhances the yield of subsequent crop (Jat *et* *al.,* 2012). The average yield of pulses in general and greengram in particular is very low as compared to that of cereals because of the lack of suitable high yielding varieties, non-synchronous maturity, instability under varying environmental conditions and susceptibility to different diseases and pests. Thus there is an open challenge on the part of the plant breeder to develop such as a breeding programmes in greengram which can bring a revolutionary genetic improvement for high yield potential, resistant to diseases and pests and wider adaptability, especially of short duration (below 60 days), which may be well fitted in wheat/rice cropping system which occupy a major irrigated area of the country. Genetic variability is the backbone of any crop improvement programme.

The significance and importance of interspecific hybridization in crop improvement through widening the genetic variability have been recognized in several crops. A successful interspecific hybridization programme is an important means of introgression of desirable genes of one species to the other species. Greengram is an important pulse crop and cultivated in all cropping seasons in India. Due to short duration nature, it is well fitted in wheat-rice cropping system, which is prevalent in northern plain.

Hence, it contributes to increase the income of the farmers. Greengram has many desirable traits such as erect growth habit, large number of seeds per pod and easily digestible protein, whereas blackgram possesses non-shattering pods and were usually resistant to *Cercospora* Leaf Spot (CLS). The desirable traits can be transferred from one species to another by interspecific hybridization. Varying degrees of success in interspecific hybridization involving greengram and blackgram have been reported in the literature. However, interspecific hybrids obtained were often completely sterile (Chowdhary *et. al*., 1977) or partially fertile (Gosal & Bajaj 1983; Singh & Singh, 1991; Singh *et. al.* 1996 & 1997) and usually produced parental types in segregating generation (Smart, 1970). However, these results were mostly based on one or few hybrids and lesser number of F_2 progenies.

Studies based on larger number of crosses involving diverse genotypes could provide a better understanding of various aspects related with crossability, extent of variability and segregation pattern for different qualitative and quantitative traits in the derivative of interspecific hybrids involving greengram and blackgram. In view of the above facts, the present investigation was carried out to assess the interspecific hybridization as a method of improving these crops

Materials and Methods

Three cultivars/genotypes of green gram (HUM 1, HUM 2 & HUM 8) and five cultivars/ genotypes of blackgram (T 9, Pant U19, PDU l, BHUU l and BHUU 91-346-1) were raised in crossing block. Crosses were made in line x tester fashion to obtain 30 (including reciprocals) interspecific hybrids. Nine F_1s along with their parents were sown in cemented pots during *Kharif* and data were recorded for eleven characters of all the plants of F_1s and 10 randomly selected plants of the parents (Table 1). Fresh F_1's were also procured. The final experiment comprising of nine each of F_1s and F_2 s along with their parents were grown in randomized block design with two replications at Agricultural Research Farm, Institute of Agricultural Sciences, BHU, during, Spring/Summer. Each plot was consisted of single row of 2 m length with spacing of 30 and 10 cm between and within rows respectively.

Parents and F_1's had single row each while each F_2s had 3-5 rows. Data were recorded from 10 randomly selected plants from each row for eleven quantitative traits (Table-1) as well as twelve morphological traits (Table-2).

Results and Discussion

Thirty crosses were attempted in line x tester fashion involving three greengram and five blackgram genotypes. Nine out of thirty crosses were successful only when the greengram was used as seed parent. The crossability ranged from 0.0 to 61.6 per cent (HUM 1 X BHUU1) and thus showed wide variation from one cross to another which was in conformity with earlier report of Singh *et. al*. (1996) and Subramanian and Muthiah (2001B). The poor crossability may be due to injury during crossing and some physiological mechanism like formation of abscission layer (Subramanian and Muthiah, 2001 B). Another possible factors affecting crossability ought to be the genotypic differences and ecological variation of the genotypes used in the present investigation. In reciprocal crosses, either there was no pod setting at all or the pods abscissed in early stage and if pod developed, contained enviable seeds. Failure of the reciprocal crosses could be attributed due to pre-and post-fertilization barriers.

Subramanian and Muthiah, (2001A) reported that there was disintegration of pollen tube throughout the stylar region and if some of the pollen tubes gained entry into the micropylar end, they were subsequently obstructed at the point of their entry and hence fertilization could not be effected. In post fertilization, there was early abscission of the pod and embryo abortion (Gossal and Bajaj, 1983). The parental seeds were fully developed and smooth whereas, the crossed seeds were shrivelled due to poorly developed endosperm. Germination of the F_1s hybrids during, Kharif, varied from 0.0 (HUM 8 X Pant U 19 and HUM 8 X BHUU 91-346-1) to 60 per cent (HUM 2 X BHUU 91-346-1), average 24.0 per cent as compared to 96.6 per cent in the parental lines. However, the germination of the F_l progenies sown in the field during, *Spring*, ranged from 0.0 to 26.6 per cent (HUM 1 X BHUU 1) with a mean of 7.9 per cent as compared to 95 per cent in the parental line (Table-3). Similarly the survival of the F_1 progenies sown during, *Kharif*, ranged from 33.3 (HUM 2 X T 9) to 100 per cent (HUM 1X BHUU 1, HUM 1 X T 9, HUM 8 X T 9 and HUM 1 X PDU 1) average 77 per cent as compared to 100 per cent in the parental lines. In contrast, the survival of the F_1s hybrids, ranged from 0.0-75 per cent (HUM 1 X BHUU1) average only 30.8 per cent during, *Spring* (Table 3).

The differences in the germination and survival of the F_1s hybrids depend upon the genotypic differences of the parental lines involved in the crosses as well as the environmental conditions, for example, during, *Spring*, the seedlings of the crosses, HUM 2 X T 9 and HUM 2 X BHU 91-346-1, grew slowly and died in early stages (before 30 days) whereas, the seedlings of the cross, HUM 2 X BHUU 1, grew normally at early stages but due to bud necrosis and leaf crinckling, eventually died after 80-100 days. However, the same cross *i.e.* HUM 2 X BHU 1 grew normally and at least 50 per cent of the plants attained pod maturity during, *Kharif* season. Similarly, in cross, HUM 2 X PDU1, though 75 per cent of the seedling bore mature pod during *Kharif* season none of the plant even came into flowering during *Spring* season.

The better germination, survival and pod bearing habit of the F_1s in *Kharif* season as compared to *Summer* season could be due to favourable environmental conditions. It is, therefore, suggested that for better germination, survival and pod bearing habit of the inter- specific F_1 hybrids, *Kharif* season seemed to the best as compared to *Spring* season. Of the twelve morphological traits, the F_1, hybrids resembled the paternal parents for as many as five traits such as stem colour, leaf colour, calyx colour, standard petal colour and mature pod colour (Table 2) and were intermediate for pod and stem hairiness and pod arrangement. However, the F_1s resembled the maternal parent for cotyledon colour (Singh and Singh, 2006). These clear-cut morphological differences could be the most useful criteria for the identification of the true hybrids. In F_2 generation, the stem colour varied from green to deep purple and seed colour varied from green to mosaic green and greenish black to brownish black. For plant habit, F_2 segregants showed a wide variations viz, erect, bushy and intermediate type. The F_1 hybrids flowered profusely, but pod setting was very low. This was due to low pollen fertility, which ranged from 5.3 to 23.0 per cent. Low pollen fertility in such hybrids has been reported earlier (Subramanian, 1980, Singh *et. al.* 1997 and Subramanian and Muthiah, 2001 B).

Table.1 Mean, Range & Coefficient of Variation (CV%) of parents, F_1 and F_2 progenies of interspecific crosses involving greengram and blackgram during *Spring*

Character	Greengram		Blackgram		F1/F2 progenies		CV%
	Range	Mean	Range	Mean	Range	Mean	
Days to Flowering	36-42	39.2	38.0-45.0	41.5	F_1 41.0-49.0 F_2 34.0-80.0	47.0 44.0	- 22.4
Days to Maturity	75.8-82.0	79.5	81.0-85.0	83.4	F_1 104.0-115.0 F_2 95.0-144.0	107.0 125.0	- 15.3
Plant Height (cm)	48.0-54.5	51.5	39.0-42.4	40.6	F_1 28.5-114.0 F_2 26.4-134.5	93.6 64.8	- 50.6
No. of Primary Branches	2.4-5.0	3.4	2.2-4.2	3.2	F_1 4.0-6.8 F_2 5.2-9.0	5.2 6.4	- 17.2
No. of Secondary Branches	0.0-2.5	2.1	0.0-4.8	2.2	F_1 0.0-6.0 F_2 0.0-7.0	3.8 4.6	- 39.8
Clusters/Plant	9.2-14.5	13.4	14.6-16.8	15.5	F_1 7.7-52.5 F_2 2.0-38.5	38.6 26.1	- 50.1
Pods/Plant	30.0-44.5	34.2	25.0-33.0	32.8	F_1 18.0-96.8 F_2 0.0-115.0	52.3 58.9	- 74.7
Pod length (cm)	6.2-7.0	6.4	3.4-4.8	4.2	F_1 1.5-2.2 F_2 1.8-5.8	1.7 3.4	- 40.4
Seeds/Pod	8.0-12.0	9.8	5.0-8.0	3.4	F_1 1.0-3.0 F_2 1.0-6.0	1.3 2.6	- 43.8
100-Seed Weight (g)	3.7-4.4	3.9	3.8-4.3	4.2	F_1 2.9-3.6 F_2 2.5-4.4	3.2 3.4	- 27.9
Yield/Plant (g)	9.8-11.2	10.8	4.7-7.3	5.9	F_1 0.8-2.6 F_2 0.5-10.5	1.8 2.7	- 85.5

Table.2 Comparison of morphological characters of greengram, blackgram and their interspecific hybrids

Character	*Vigna radiate*	*V. radiata* X *V. mungo*	*V. mungo*
Cotyledon	Yellow	Yellow	White
Stem colour	Green	Purple	Purple
Stem hairiness	Sparsh to moderate	Moderate	Sparsh to profuse
Leaf shape	Ovate	Intermediate	Lanceolate
Leaf colour	Light green	Dark Green	Dark Green
Calyx colour	Green with purple tinge	Green	Green
Standard petal colour	Ashy Yellow	Dark Yellow	Dark Yellow
Pod arrangement	Sparse	Moderate	Profuse
Mature pod colour	Black	Blackish Brown	Blackish Brown
Pod hairiness	Non-hairy	Slightly hairy	Densely hairy
Seed colour	Green	Greenish black to brownish black	Brownish black to greenish mosaic
Plant habit	Erect	Spreading to intermediate	Erect

Low pollen fertility may be due to meiotic abnormalities such as non-orientation of bivalents at metaphase and precocious disjunction, which indicate failure of genes controlling meiotic process. Dana (1967) and Ahandabaskarn and Rangasamy (1996) have also observed similar results in such crosses. However, the pollen fertility of the F_2 progenies ranged from 11.0 to 91.8 per cent with a mean of 32.5 per cent as compared to F_1,s (15.0 per cent) indicating the improvement in fertility when generation is advanced.

In F_1 hybrids, the positive heterosis was recorded for days to flowering and maturity, plant height, number of primary and secondary branches, pods per plant and cluster per plant as was also observed by Shanmungam *et. al*. (1985), Subramanian and Muthiah (2001B) and Singh *et al.*, (2009 & 2011) in similar crosses. However, pod length, number of seeds per pod, l00-seed weight and seed yield per plant recorded high negative heterosis which was in conformity with earlier reports of Subramanian and Muthiah (2001B), Singh *et al*, (2009). The coefficient of variation (CV) was highest for yield per plant (85.5%) followed by pods per plant (74.7%), plant height (50.6%) and cluster per plant (50.1 %), indicating there by that maximum variability exists in the segregating populations for these traits (Table-1).

Subsequently the desirable transgressive segregants were observed in F_2 progenies for plant height, number of primary branches, cluster per plant and pods per plant. From this study it may be concluded that interspecific hybridization may be used to produce elite population for effective selection for the improvement of these important pulse crops.

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