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MORHOLOGICAL STUDIES ON INTERGENERIC AND INTERSPECIFIC HYBRIDS OF SOME GRAIN LEGUMES

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ABSTRACT

For the first time intergeneric/interspeficic hybrids between *Cajanus cajan* × *Vigna mungo*, *Vigna unguiculata* × *Vigna mungo* and *Vigna unguiculata* × *Lablab purpureus* have been produced. In general all the hybrids resembled female parents with some altered morphological traits. All the hybrids exhibited delayed flowering and maturity. *V. unguiculata* × *V. mungo* hybrid did not flower and perished in vegetative phase after producing few buds. *C. cajan* × *V. mungo* hybrid was highly sterile which produced some pods with non- viable seeds. *V. unguiculata* × *L. purpureus* hybrid produced only two flowers and single small pod with two seeds which upon sowing produced two F_2 plants, which died at an early stage. The character expressions of F_1's surpassing both the parents either in positive or negative direction were comparable to transgression effect. Resemblance to either of the parents and intermediate characters expressions were attributed to dominance and partial dominance gene action respectively.

Key words: *Cajanus cajan, Vigna unguiculata, Vigna mungo, Lablab purpureus*, wide hybrids.

Pulses (grain legumes) often suffer from low grain yield, flower drop, disease and insect susceptibility, photosensitivity etc. [1]. The genetic improvement of the pulses could not be done upto desired level on account of occurrence of narrow genetic variability in most of the grain legumes [2-5]. Recombination through distant hydridization is one of the useful breeding method to create genetic variability and to broaden the narrow genetic base of crop species. Ahuja and Singh [6] have pointed out that such hybridization between compatible species helps in broadening narrow genetic base, improving productivity and transfer of desirable genes. The present investigation was therefore undertaken to explore the possibilities of obtaining hybrids among some grain legumes having 22 chromosomes in common and to study their behaviour. For the first time intergeneric/interspecific hybrids between *Cajanus cajan* × *Vigna mungo*, *Vigna unguiculata* × *Vigna mungo* and *Vigna unguiculata* × *Lablab* *purpureus* have been produced by us (Dundas, [7] personal communication) and their morphological study is being reported here.

MATERIAL AND METHODS

Different cultvars of *Cajanus cajan* and *Vigna unguiculata* ssp. *unguiculata* were taken as female parents and *Vigna mungo, Vigna radiata, Canavalia ensiformis, Lablab purpureus, Phaseolus vulgaris* and *Vigna aconitifolia* as male parents. Reciprocal crosses of both female parents were also attempted. For hybridization work both female and male parents were sown in separate crossing blocks. Staggered sowing of *V. unguiculata* and all the male parents was done to facilitate crossing work round the year, leaving rainy and high temperature months. Staggered sowing of *C. cajan* was not necessary since it produced flowers round the year, however periodic removal of selfed pods was necessary to obtain good bloom.

The buds at right stage were selected in both the female parents. Two buds in *V. unguiculata* and upto 4 buds in *C. cajan* were kept in twig removing others to avoid over crowding and self pod set. A similar emasculation technique was used in both the female parents. The buds were held at the base of calyx between thumb and first finger of one hand and with the nails of thumb and first finger of other hand an incision was made across standard and wing at about two-third the length of bud towards base. Petals were teared and pulled upward removing petals and anthers alongwith filaments. Pollination was done next day morning between 7 A.M. to 12 noon by applying pollens on stigma from freshly opened flowers. Emasculated and pollinated buds were covered with paper bags to avoid otherwise pollinations.

RESULTS AND DISCUSSION

Successful parental combinations of wide hybrids: Different cultivars of all the parents mentioned under materials and methods were taken for hybridization work but hybrids were obtained only between *C. cajan* (cv. Prabhat) × *V. mungo* (cv. PU 30), *V. unguiculata* (cv. GC 82-7) × *V. mungo* (cv. PU 30) and *V. unguiculata* (cv. GC 82-7) × *L. purpureus* (cv. Arka Jai). Datta and Saha [8] reported hybrid between *C. cajan* and *L. purpureus* whereas wide hybrids between *V. unguiculata* × *Phaseolus vulgaris, P. vulgaris* × *C. cajan* and *P. vulgaris* × *L. purpureus* have been reported by Mohamed *et al.* [9]. The parents involved in successful production of wide hybrids in our case and those reported by others, all having 2n = 22 chromosomes indicated that such wide hybrids may be produced between most of the grain legumes with similar chromosome numbers (2n = 22). Although only three wide hybrids were obtained between above mentioned parents in our case, the possibilities of obtaining hybrids between other species/ genera included in present study can not be ruled out. A very high damage of developing seeds by insects and failure of germination of hybrid seeds in some combinations was observed by us.

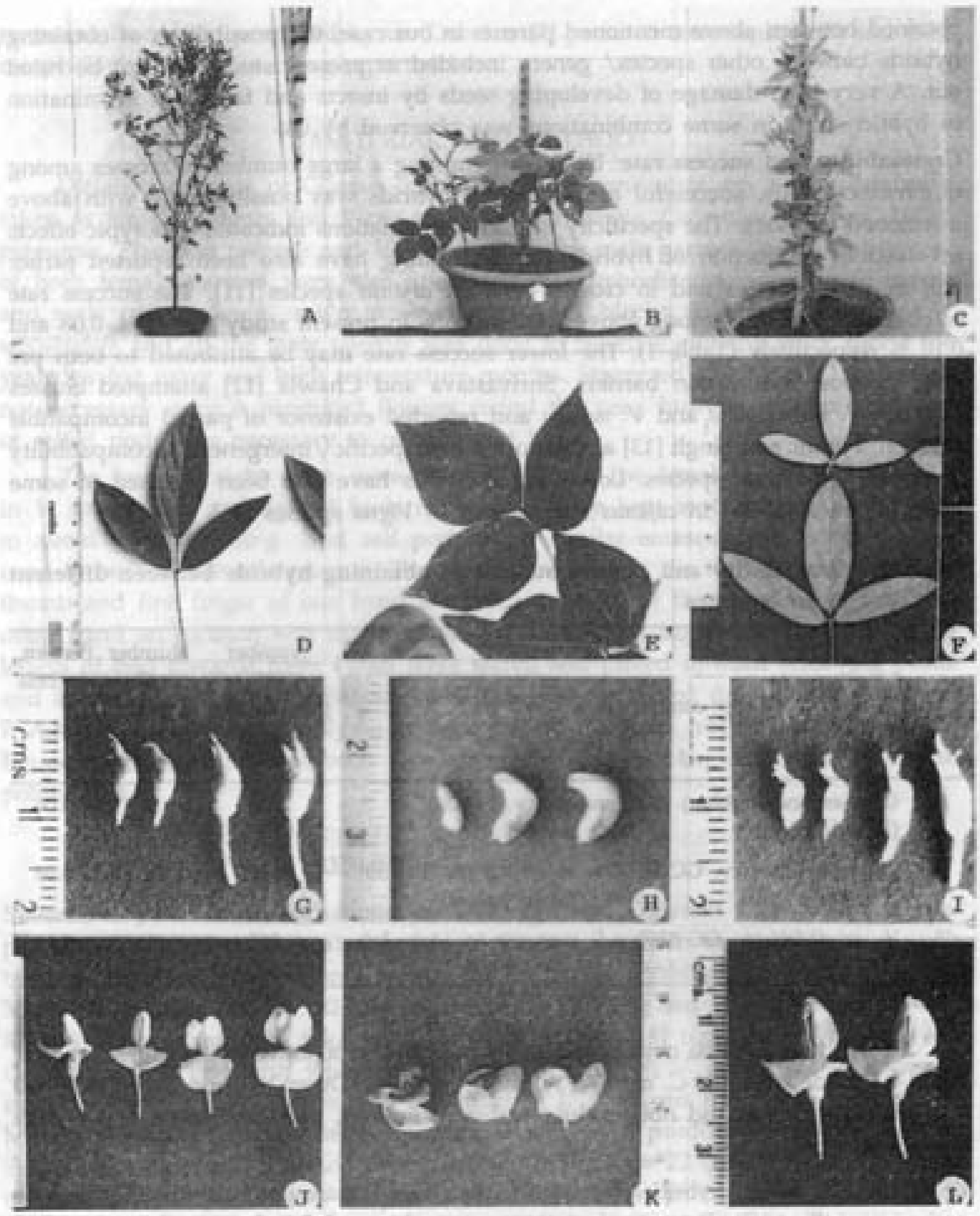
Crosssability and success rate: Despite attempting a large number of crosses among different cultivars, successful production of hybrids was possible only with above mentioned cultivars. The specificity of such combinations indicated genotypic effects involved in production of hybrids. Similar finding have also been reported earlier [10] in *Vigna* species and in crosses between *cajanus* species [11]. The success rate of obtaining hybrids among above combinations in present study was 0.04, 0.08 and 0.10 % respectively (Table 1). The lower success rate may be attributed to both pre and/ or post fertilization barriers. Shrivastava and Chawla [12] attempted crosses between *V. unguiculata* and *V. mungo* and reported existence of partial incompatible reaction. Pundir and Singh [13] also reported interspecific /intergeneric incompatibility in crosses of *cajanus* species. Lower success rates have also been reported in some grain legumes [13-15] in *cajanus* species and in *Vigna* species [16].

Table 1. Crossability and percent success of obtaining hybrids between different grain legumes

S.No.	Cross combinations	Number of pollinations made	Number of hybrid seeds obtained	Percent success
1.	*C. cajan* (cv. Prabhat) × *V. mungo* (cv. PU 30) (Female parent) (Male parent)	2240	1	0.04
2.	*V. unguiculata* (cv. GC 82-7) × *V. mugno* (cv. PU 30) (Female parent) (Male parent)	2600	2	0.08
3.	*V. unguiculata* (cv. GC 82-7) × *L. purpureus* (cv. Arka Jai) (Female parent) (Male parent)	945	1	0.10

Of the three hybrids obtained, detailed morphological and cytological [17] studies could be made only for *C. cajan* × *V. mungo* hybrids. Other hybrids either perished without flowering or did not produce sufficient flowers, pods and seeds hence were studied in brief.

C. cajan* × *V. mungo hybrid: The hybrid resembled female parent with poor growth and vigour (Fig. 1C). Extreme deviations were observed for days to flowering (203



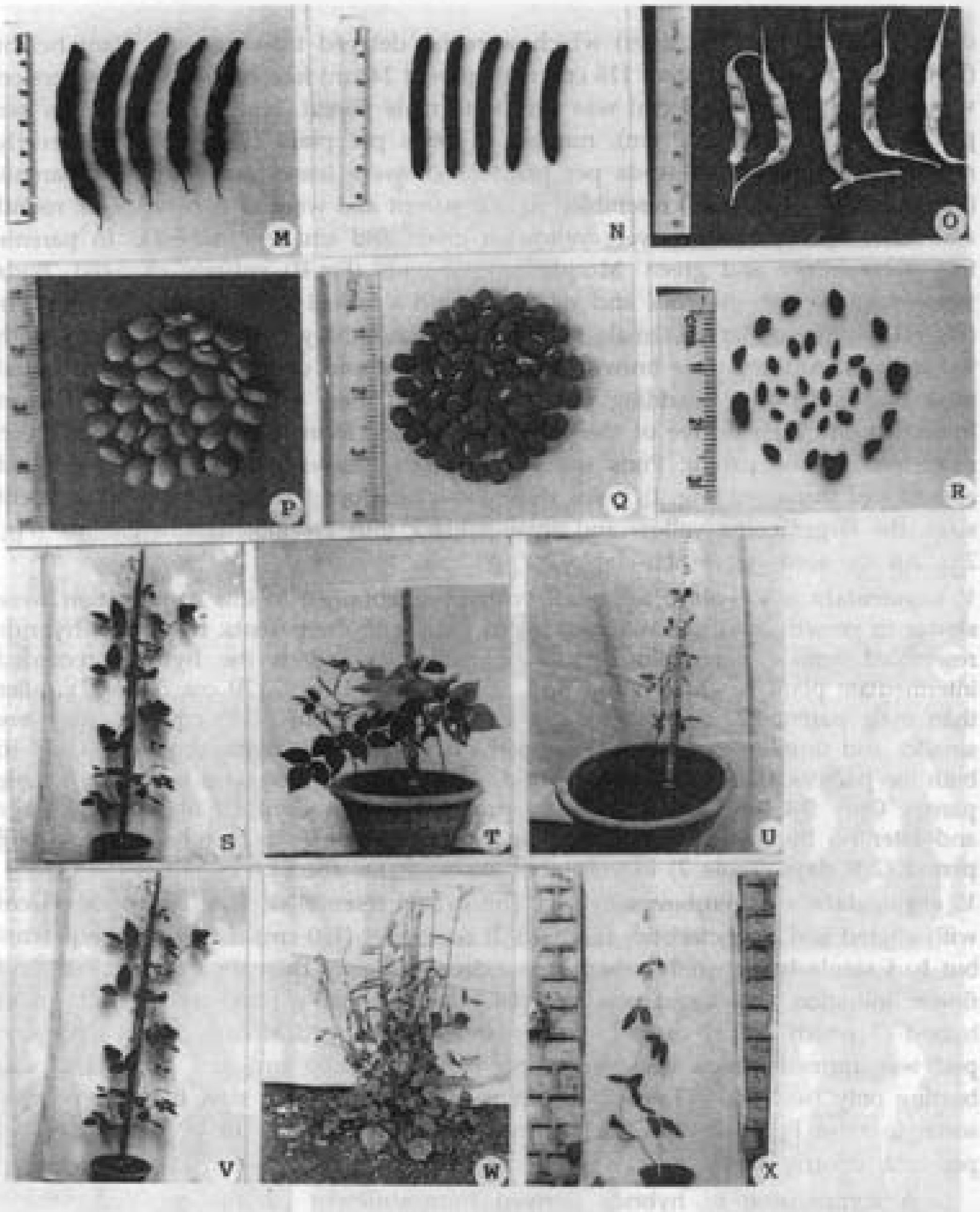
Figs. 1. A-L. Variation in morphological characters of hybrid between *C. cajan* × *V. mungo* and parents. 1 A, D, G, J represents female parent *C. cajan*, *1 B,E,H,K* male parent *V.mungo* and 1 C,F,I,L hybrid between *C. cajan* × *V. mungo*.

days) and maturity (264 days) which were far delayed than parents. Plant height (Hybrid 56 cm, female parent 116 cm, male parent 24 cm) has intermediate expression whereas pod length (4.83 cm) was similar to male parent. Number of branches per plant (7), pod girth (1.20 cm), number of pods per plant (8) which was greatly reduced and number of seeds per plant (3.63) were lesser than both the parents (Table 2). Leaves (Fig. 1F) resembled female parent and were of two types i.e. round and acute apexed. Leaves were yellowish green and smaller, whereas in parents they were larger and green. Morphology of buds (Fig.1I) entirely changed. Buds were long, angular, glabrous and yellowish with a forked structure at apex. Flowers (Fig. 1L) were similar to female parent but were light yellow and deformed with 9+1 anthers. Anthers were brown, chaffy, deformed and under developed. At initial stage bud and flower shedding was observed and there were no pod formation in hybrid due to high degree of sterility. Later on pod formation was observed which resembled female parent. Pods were light yellow, lesser stripped, longer pointed apexed and shrivelled (Fig. 2). Seeds were under developed, shrivelled and of different sizes, the larger being yellow and smaller black thus resembled both parents (Fig. 2R). All the seeds were non-viable.

V. unguiculata* × *V. mungo hybrid: Two hybrids obtained in this combination were slower in growth and had reduced vigour than both the parents. In general hybrids resembled female parent in morphology (Fig. 2U). Both the hybrids recorded intermediate plant height (Hybrid no.1, 35 cm; hybrid no. 2, 70 cm, Table 2), taller than male parent (30 cm) but smaller than female parent (145 cm). Leaves were smaller and number of branches per plant was extremely reduced as compared to both the parents. Bud initiation in hybrid was very late i.e. 60 days later than female parent. Only 3-4 buds per plant were produced which dropped off at early stage and later no bud or flower production was observed. After surviving for a long period (270 days, Table 2) in vegetative phase, it perished in summer.

V. unguiculata* × *L. purpureus hybrid: The hybrid resembled more to female parent with altered leaf characteristics (Fig. 2X). It was taller (180 cm) than both the parents but had single branch only which was extremely lesser than the parents. Bud and flower initiation (104 days) was very late. A total of 5-6 buds were produced in hybrid of which only 2 came to flower and rest dropped at early stage. Only one pod was formed which was very short in length (4.60 cm) and girth (1.80 cm) bearing only two seeds (Table 2) which were intermediate in size. Both seeds were sown to raise F_2 generation, they germinated and gave rise to two plants which perished at early stage.

A comparision of hybrids derived from different parents revealed many similarities. In general, all hybrids resembled female parents in morphological appearance. All the hybrids showed far delayed flowering and maturity, reduced vigour and growth than their respective parents. The two hybrids obtained between



Figs. 2. M-X. Variation in morphological characters of hybrid between *C. cajan* × *V. mungo*, *V. unguiculata* × *V. mungo* and *V. uniuiculata* × *L. purpureus* and parents. 2 M, P represent female parent *C. cajan* N, O male parent *V. mungo* and 2 O R hybrid between *C. cajan* × *V. mungo*. 2 S represents female parent *V. unguiculata*. 2 T male parent *V. mungo* and 2 U hybrid between *V. unguiculata* × *V. mungo*. 2 V represents female parent *V. unguiculata*, 2 W male parent *L. purpureus* and 2 X hybrid between *V. unguiculata* × *L. purpureus*.

Table 2. Morphological characteristics of different hybrids and their parents

S. No.	Hybrids and parents	Days to flowering	Days to maturity/ mortality*	Plant height (cm)	No. of branches/ plant	No. of pods/ plant	Pod length (cm)	Pod girth (cm)	No. of seeds/ pod
1.	*C. cajan* × *V. mungo* hybrid	203	264	56	7	8	4.83	1.20	3.63
2.	*V. unguiculata* × *V. mungo* hybrid Plant No. 1	-	270*	35	1	-	-	-	-
	Plant No. 2	-	270*	70	2	-	-	-	-
3.	*V. unguiculata* × *L. purpureus* hybrid	104	168	180	1	1	4.60	1.80	2.00
4.	*C. cajan* (Female parent)	80	126	116	10	98	5.12	2.16	4.00
5.	*V. unguiculata* (Female parent)	44	86	145	6	12	15.80	2.04	12.20
6.	*V. mungo* (Male parent)	41	85	24-30	9	32	4.80	1.64	6.40
7.	*L. purpureus* (Male parent)	51	92	80	7	23	8.20	3:02	4.00

V. unguiculata and *V. mungo,* differed in plant height and number of branches per plant which were doubled in hybrid no. 2. However days to maturity were similar for both hybrids. Possibly the difference in height might be due to seed factor and fertility effects. Variation in plant height of male parent *V. mungo* was also noted when grown in different seasons (24 and 30 cm, Table 2). Plant height in hybrid *V. unguiculata* × *L. purpureus* exceeded both parents, whereas other hybrids recorded reduced plant height. Numbr of branches per plant was greatly reduced in all hybrids except *C. cajan* × *V. mungo* which had moderate branching (7, Table 2). Number of pods per plant was extremely low in all the hybrids while *V. unguiculata* × *V. mungo* hybrid did not produce any flower and pod. Pod length was similar to male parent in hybrid between *C. cajan* × *V. mungo* whereas pod girth was closer to female parent in *V. unguiculata* × *L. purpureus* hybrid. Seeds per pod were closer to female parent in hybrid between *C. cajan* and *V. mungo* whereas it was lower than both parents in *V. unguiculata* × *L. purpureus* hybrid. The expression of the characters in hybrid surpassing both the parents either in positive or negative direction may be comparable to transgression effect. The intermediate character expressions may be attributed to partial dominance whereas resemblance to either of the parents may be due to dominant gene action. Somewhat similar findings have been reported earlier in hybrid between *cajanus* species [1,18-21] and in hybrid between *Vigna* species [22-26]. Further more meiotic studies made by Patel and Verma [17] in hybrid between *C. cajan* and *V. mungo* revealed high degree of pairing between chromosomes derived from parents and near normal meiotic behaviour, despite high degree of sterility. Thus these results suggested that gene exchange is possible between parental species/genera of different grain legumes.

Pulses often suffer from late maturity, low seed yield, pest and disease susceptibility and certain quality aspects. It is therefore imperative to aim for breeding objective to evolve early maturing, high yielding varieties alongwith resistance and improved quality characters. Although improved cultivars have been evolved but still the improvement is not upto desired level. Wide hybridization can be employed to transfer desired characters existing in wild/cultivated species/genera to cultivated agro-base cultivars. Many useful characters in wild/related species can be transferred to cultivated pulse crops [3,26-28] and in many cases successful gene transfer have also been achieved [29].

From the present findings it can be suggested that some desirable characters like earliness, high yield, quality characters, resistance etc. can be combined in hybrids. In order to achieve such character expressions a large number of crosses should be attempted to get more F_1 plants. Such hybrids may be used to raise a sizable F_2 population from which selection can be made for desired segregants or may be used to produce amphidiploids with desired character expressions.

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