Interspecific cross-compatibility of beach pea (*Vigna marina)* with related *Vigna* species

abstract :

Wide hybridization is useful for transferring desirable characters from related species to cultivated ones. The beach pea (*Vigna marina*) is an unexploited *Vigna* species having great drought tolerant and salt tolerance capacity. To incorporate these desirable traits into cultivated species, the crosses were made between beach pea and green gram (Vigna radiata) (VBN (Gg) 3) and black gram (VBN 6). There is no pod set occurs in the above crosses, indicating the presence of cross-incompatibility between these two species. The other crosses and their reciprocals were made between the beach pea with two cowpea genotypes (VBN 1 and IC347367) to investigate their cross compatibility as well as the germination potential of respective F_1 hybrid seeds. The hybrids were obtained in both directions, indicating the presence of cross-compatibility between the two species. These results indicated that there is a great opportunity to utilize beach pea in the cowpea genetic improvement program. Keywords: cowpea, beach pea, *Vigna marina*, cross-compatibility

Introduction

Interspecific crosses have been widely used by plant breeders to expand the gene pool of cultigen. However, the cross between species may be incompatible due to the existence of a set of pre and post-zygotic barriers. In pulse crops, the genus *Vigna* is a large Pantropical genus with 82 species distributed among seven subgenera (Marechal *et al.,* 1978). In the genus Vigna, only subgenus *Ceratotropics* has its centre of species diversity in Asia. To diversify and broaden the genetic base of cultivated *Vigna* species, hybridization with wild relatives is inevitable. Many scientists have attempted interspecific hybridization among *Vigna* species and used special techniques to overcome the barriers for getting hybrids (Gopinathan *et al.,* 1986; Thiyagu *et al.,* 2008; Bharathi *et al.,* 2008; Dhiman *et al.,* 2013; Rashid *et al.,* 2013;Nishant Banu *et al.,* 2018).

The beach pea (*Vigna marina*) is one of a wild relative of *Vigna* species (Sanjeewani *et al.,* 2012), distributed throughout the tropic and shows great similarity in floral structure of green gram, blackgram and cowpea having chromosome number 2n=22 (Verdcourt, 1971; Marechal *et al.,* 1978). It is occasionally cultivated as fodder crop and also as cover crop and soil

fertilizer. The species has two subspecies (*Vigna marina* ssp. *oblonga* and *Vigna marina* ssp. *marina*) and one closely related species *Vigna luteola* (Pudulosi and Ng, 1993; Sonnante *et al.,* 1997). It also possesses agronomically important traits like drought and salinity tolerance (Ng,1990; Padulosi and Ng, 1990) and has early domesticated traits such as non-shattering pods and bigger seed size (Smartt, 1978) which could be usefully transferred into related *Vigna* species. The genetic diversity of *Vigna marina* (Awnindra *et al.,* 2016) and *Vigna luteola* reported by the researchers (Sonnante *et al.* 1997). The crossability of *Vigna marina* with *Vigna luteola* was reported by Chankaew *et al.* (2014). However, the cross compatibility of *Vigna marina* with other cultivated *Vigna* species has not yet been studied. Hence, the present breeding program was formulated to make crosses between the cultivated green gram, black gram, and cowpea with beach pea to enhance the genetic potential of the respective primary gene pool.

Materials and Methods

The three *crop species*(Greengram (VBN3),Blackgram(VBN 6)and Cowpea (VBN 1 and IC347367) obtained from National Pulses Research Centre,Vamban (TNAU) along with Beach pea (*Vigna marina*) which were collected from Radha Nagar beach of Andaman Nicobar Islands were grown during Rabi 2021 in the Experimental Farm of the Department of Plant Breeding and Genetics, Anbil Dharmalingam Agricultural College and Research Institute, Tiruchirappalli. The staggered sowing was done in all four crop species for the continuous availability of the flower buds for the hybridization program. The interspecific crosses and their reciprocals were attempted by hand emasculation at 5-6 AM and pollination at 8-9 AM upon flowering. The data were recorded on the number of flower buds emasculated and pollinated, the number of mature pods obtained, and the number of mature seeds obtained.

Results and Discussion

In the present study, there is no hybrid seed obtained in the green gram x beach pea and black gram beach pea crosses and their reciprocals. This indicates that the presence of pre and post-fertilization barriers, viz., lack of pollen germination, pollen tube penetration, slow pollen tube growth release of male gametes, the union of male and female gametes, and embryo abortion may be the problem for obtaining hybrid seeds. Whereas hybrid pods were collected in the cowpea x beach pea crosses and their reciprocals. The hybrid pod resulting from these crosses is smaller than the selfed one (Fig 1) (Fatokun, 1991).

The results of the hybridization program showed that 58.57 % of 300 crosses were successful, which yielded 176 pods, producing 162 hybrid seeds when the cowpea was used as a female parent (Table 1). A significant difference in the percentage of successful crosses was observed between the two cowpea genotypes with VBN 1 (55.29%) performing better than IC3473671 (51.56%). Similar results have been reported by Mohammed *et al.,* 2010; Ogunsola and Igun, 2019: Amusa *et al.,* 2021), highlighting different crossability responses from different genotypic combinations.

The number of hybrid seeds and hybrid germination percentage differed significantly between the two cowpea genotypes used as female parents. This result differed from that of Ogunsola and Igun (2019) in that the performance of female parent was similar in their study. Bhanu(2018) and Bhanu *et al.,* 2018 recorded that the variation in cross-compatibility among interspecific *Vigna* female parents was attributable to intraspecific barriers. There is no or little abortion, and viable seeds were observed in the naturally pollinated flower buds of both cowpea genotypes. This implied that the cowpea genotypes had a self and cross-compatible pollen recognition mechanism for the success of pollination. The interaction between genic and cytoplasmic factors could lead to low production of viable seeds from crosses between cowpea genotypes when out-crossing is enforced (Ogunsola and Igun, 2019; Owusu *et al.* 2018).

In the reciprocal crosses, when the beach pea was used as a female parent, the pod development was observed, which is being reported for the first time, indicating that pollen tubes of the cultivated cowpea used are capable of growing through stigma and style and of delivering the male gamete effected fertilization of the beach pea ovules.

The hybrid seed germination is an indirect measure of the degree of similarity between the number or size of parental chromosomes and genomes. About fifty percent of hybrid seeds produced seedlings. The causes of embryo abortion and poor germination may occur due to the improper development of endosperm or embryo, embryo-endosperm incompatibility, or seed dormancy (Kinoshita, 2007). However, the performance of F_1 hybrids needs to be studied to continue with the breeding of cultivated cowpea germplasm.

Conclusion

Interspecific hybridization play is important in plant breeding as a tool for gene transfer from one genotype, usually a wild species, to a cultivated genotype that does not have that gene. In the present study, it is apparent that there exists a barrier to the direct exchange of genes between beach pea and the cultivated green gram and black gram. There are some special

techniques, *viz.,* bud pollination, use of bridge species, and application of hormones, that may be followed to increase the success rate of obtaining hybrids in these crosses. On the other hand, the direct crossing of beach pea (*Vigna marina*) with cowpea is possible and directly used as a parent in the cowpea breeding programme to broaden their genetic base.

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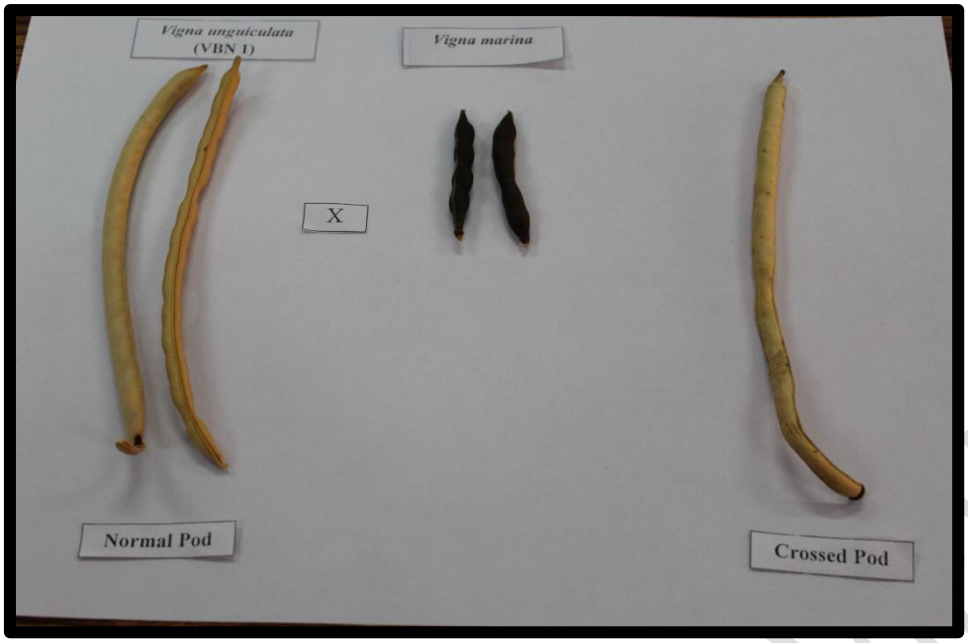
Table.1 Crossability of beach pea with other *Vigna* species

Cross combination	**No. of flowers pollinated**	**No. of crossed pods obtained**	**Pod setting percentage**	**Total F_1 seeds**	**Germination (%)**	**Seedlings obtained**
Green gram (VBN 3) x Beach pea	152	-	-	-	-	-
Beach pea X Green gram (VBN 3)	167	-	-	-	-	-
Black Gram(VBN 6) x Beach pea	143	-	-	-	-	-
Beach pea X Black Gram(VBN 6)	149	-	-	-	-	-
Cowpea VBN 1 X Beach pea	176	104	59.09	105	37.5	39.37
Cowpea (IC 347367) X Beach pea	124	72	58.06	157	26.0	40.82
Beach pea X Cowpea VBN 1	134	69	51.49	63	87.5	55.13
Beach pea X Cowpea (IC 347367)	102	46	45.09	82	25.0	20.50

Fig 1 Mature hybrid pods of cowpea X beach pea interspecific hybridization



Cow pea (female) × Beach pea (male)

Beach pea (female) × Cow pea (male)