

Creation of variability in Daincha (*Sesbania aculeata*) through interspecific hybridization

Abstract

Wide hybridization can enrich the genetic background and diversity of crops by comparing different species and integrate the different parental traits. In the present study, interspecific hybridization was performed between Daincha and two related sesbania species by hand emasculating and crossing technique. A total of 460 hybrids obtained in the *Sesbania aculeata* X *Sesbania bispinosa* cross but no hybrids were obtained in their reverse cross, indicating the same cross combination has a large difference in the reciprocal crosses, and that the hybrid has certain unidirectionality. The hybrids looked more like their *Sesbania aculeata* parent in stem and leaf characteristics. A total of 570 hybrids were obtained in the cross *Sesbania aculeata* X *Sesbania rostrata*, while no hybrids were obtained by reverse cross combination. The hybrid showed intermediate morphological traits when compared to their parents. Developing hybrids and segregating populations are useful genetic resources and provides interspecific hybridization to enlarge the gene pool of Daincha species.

Keywords: Crossability, *Sesbania aculeata*, *Sesbania bispinosa*, *Sesbania rostrata*

Introduction

Significant constraints affecting rice production are high production costs and low crop productivity. Although direct seeding of rice in the lowlands is a cost-effective and labour-saving method of crop improvement. Excessive weed growth is a major constraint leading to high production costs and low nitrogen use efficiency. Scarcity and high cost of organic manures also constrain wetland rice productivity in India. *In situ* green manuring offers an effective method of providing organic manures and has considerable potential for weed suppression. Although many green manure crops are available, the N₂ fixing leguminous crops are important. Green manure crops supply organic manure and enrich the nitrogen status of the soil. Among leguminous green manuring crops, Daincha (*Sesbania aculeata*) is one of the most important crops, and its incorporation in the soil adds about 60-80 kgs of nitrogen/ha. *Sesbania* green manure, after decomposition, increases humus and available nitrogen and lowers the C:N ratio of soil. Though daincha is a potential green manure crop, the genetic variability of the species is very low. It is necessary to create genetic variability through various breeding programme. Hence the present breeding programme was formulated to study the crossability of three *Sesbania* species.

Materials and Methods

The three *Sesbania* species (*Sesbania aculeata*, *Sesbanica bispinosa*, and *Sesbania rostrata*) were grown during Kharif 2020 in the Experimental Farm of the Department of Plant Breeding and Genetics, Agricultural College and Research Institute, Tiruchirappalli. The staggered sowing was done in all three species for the continuous availability of the flower buds for the hybridization program. The interspecific crosses and their reciprocals were attempted in *Sesbania* species by 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. The F_1 hybrids were raised and evaluated during Rabi 2020-21 along with their parents and observations were recorded.

Results and Discussion

In the present crossing program, the crossability of *Sesbania* species ranged from 0-3.26% (Table 1) and inferred that the crossing is possible among the three species (*Sesbania aculeata*, *Sesbania bispinosa*, and *Sesbania rostrata*). The difference in pod setting percentage indicates the presence of reproductive barriers that render introgression difficult among the crosses. The *Sesbania aculeata* X *Sesbanica bispinosa* combination exhibited a higher pod setting percentage. It was recorded that the pod setting was observed only when *Sesbania aculeata* was used as a female parent as compared to the other two species. The crossed pods differ from selfed pods by showing their ill filled appearance. Moreover the crossed pods developed normal and wrinkled seeds on maturity.

The F_1 showed a very low seed germination percentage, ranging from 10 to 45.2 percent. The germination percentage was higher in the *Sesbania aculeata* x *Sesbania bispinosa* cross when compared to the *Sesbania aculeata* X *Sesbanica rostrata* cross. No pod setting due to the abscission of crossed flowers 4 days after pollination was observed in the reciprocal crosses. These reciprocal differences in the crossability of *Sesbania* species were noticed when *Sesbania bispinosa* or *Sesbania rostrata* was used as a female parent. These results clearly exhibited the presence of unfavorable interaction between the genetic and cytoplasmic factors (Stebbins, 1958). This unfavorable interaction may be due to cross incompatibility barriers, viz., delayed pollen germination and penetration of stigma, style and ovule (Gopinathan *et al.*, 1986) and

slow pollen tube growth (Thiyagu *et al.*, 2008) unable to release male gametes to the ovule, failure to unite with the egg, and embryo abortion reported in various pulse crops. No external factors are involved in hybridizing these species because they have the same anthesis time, pollen/ ovule maturity period, and pollen dispersal time.

In interspecific crosses, the endosperm development is affected by the absence or delayed endosperm nuclear division leads to abortion of endosperm and subsequent drying of young pods. The observation of shrivelled seeds was noticed in *Sesbania aculeata* x *Sesbania bispinosa* and *Sesbania aculeata* x *Sesbania rostrata* crosses, is probably related to the failure of endosperm to reach maturity; similar findings were reported by various authors in *Vigna* species (Bharathi *et al.*, 2008). In distant hybridization, the low frequency of the pod set indicates the presence of prefertilization barriers, and reduced germination percentage and sterility of F1 progenies confirmed the presence of post-fertilization barriers. The low hybrid pod recovery and varying levels of sterility in F₁'s, hybrid inviability, lethality, and hybrid sterility (Nishant Banu *et al.*, 2018) are explained by various workers in Pulse crops (Rashid *et al.*, 2013; Dhiman *et al.*, 2013).

In the present hybridization programme, the hybrid showed morphological variation in intermediate leaf let size observed in *Sesbania aculeata* X *Sesbania rostrata* cross. Whereas in the *Sesbania aculeata* X *Sesbania bispinosa* cross, the hybrids were morphologically similar to the female parent. Hence, further confirmation by molecular marker is required to fix the true hybrids in this cross combination. The present study requires variability created through hybridization and further generation advancement to get desirable genotypes. Using alternative methods like mutation breeding, embryo rescue ovule culture, and chromosome doubling offers the development of new cultivars with desirable genes from related species.

Table 1. Crossability of *Sesbania* species

S.No.	Particulars	<i>Sesbania aculeata</i> X <i>Sesbania bispinosa</i>	<i>Sesbania aculeata</i> X <i>Sesbania rostrata</i>
1.	Number of flowers crossed	460	570
2.	Number of crossed pods	15	15

	obtained		
3.	Pod setting percentage (%)	3.26	2.63
4.	Number of crossed seeds obtained	105	102
5.	Seed setting percentage	22.82	17.89
6.	No. of seeds germinated	40	24.5
7.	Number of hybrid plants	15	10

References

- Bharathi, A., K.S. Vijay Selvraj, P. Veerabadhiran, Subba Lakshami, B. 2006. Crossability barriers in mungbean (*Vigna radiata* L. Wilczek) with its wild relatives. Ind J Crop Sci.1:120-124.
- Dhiman, R., Mittal, R.K., Chaudhary H.K., Yadav, A.K.(2013). Crossability relationship between blackgram (*Vigna mungo*) and ricebean (*V. umbellata*) for successful blackgram x ricebean hybridization programme. Indian J. of Agric. Sci. 83:907-911.
- Gopinathan, M.C., Babu, C.R. and Shivanna, K.R. (1986). Interspecific hybridization between rice bean (*Vigna umbellata*) and its wild relative (*V.minima*): Fertility sterility relationships: Euphytica. 35:1017-1022.
- Nishant Bhanu, A. Singh, M.N. and Srivastava, K. (2018). Crossability studies of interspecific hybridization among *Vigna* species. Biomed J. Sci Tech Res.
- Rashid, K., Daran, A.B.M., Nezhadahmadi, mA., Yusof, M.F.B.M., Azhar, S., Efzueni, S.(2013). Interspecific crosses and morphological studies of two cultivars of *Vigna radiata* through in vitro and in vivo techniques. Life Sci. J. 10:2549-2555.
- Stebbins, G. L. (1958). The inviability weakness and sterility of interspecific hybrids. Adv. Genet. 9:147-215.
- Thiyagu, K., Jayamani, P. and Nadarajan, N. (2008). Pollen pistil interaction in interspecific crosses of *Vigna* sp. Cytologia, 73:251-257.