

INTERSPECIFIC HYBRIDIZATION IN BOTH DIRECTION OF VIGNA RADIATA X VIGNA RADIATA VAR. SUBLOBATA

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Abstract:

An objective to develop superior segregants for yield components coupled with pest and disease resistance, the interspecific hybridization was attempted between mungbean (*V. radiata*) and *V. radiata* var. *sublobata*. In direct and reciprocal crosses the pod set percentages were recorded 28.71 and 16.88 respectively. The observation for parents and both direct and reciprocal cross combinations were recorded. The germination percentage of 98 was recorded in parent *Vigna radiata* and 85 percentage in *Vigna radiata* var. *sublobata*. The direct and reciprocal cross *V.radiata* x *V.radiata* var *sublobata* and *V.radiata* var *sublobata* x *V.radiata* were recorded 64 and 44 respectively. The hybrid lethality percentage of 81.25 recorded in *V.radiata* x *V.radiata* var *sublobata* where as *V.radiata* var *sublobata* x *V.radiata* was 68.18.

The hybrid break down percentage was 18.74 recorded in *V.radiata* x *V.radiata* var *sublobata* while in reciprocal cross of 31.82 percent recorded in the cross *V.radiata* var *sublobata* x *V.radiata*. The Number of seedlings attained maturity in the parents 65 in *V.radiata* and 46 in *V. radiata* var. *sublobata* and the same character for the both direct and reciprocal crosses of 25 and 15 percent in *V.radiata* x *V.radiata* var. *sublobata* and *V. radiata* var. *sublobata* x *v. radiata* respectively. The pollen fertility percentage of parent *V. radiata* was 90.55 and 91.26 percent in *V. radiata* var. *sublobata* and F1 hybrids of interspecific crosses for *V. radiata* x *V. radiata* var. *sublobata* was 78.26 and *V. radiata* var. *sublobata* x *V. radiata* recorded 65.26 percent.

Parents	PHT	NOB	BRL	DFP	NCB	NOC	NPP	POL	NSP	HSW	SPY	DMP	DFM
<i>V.radiata</i>	48.5	3.0	35.5	35.0	4.0	10.0	46.0	8.80	10.0	3.2	5.25	23.5	65.0
<i>V.radiata</i> var <i>sublobata</i>	28.8	3.0	26.0	32.0	4.0	10.0	48.0	5.27	6.0	2.2	3.8	15.5	60.0
<i>V.radiata</i> x <i>V.radiata</i> var. <i>sublobata</i>	44.0	3.0	32.0	35.0	3.0	10.0	50.0	8.5	10.0	2.9	5.9	28.7	65.0
<i>V.radiata</i> var. <i>sublobata</i> x <i>V.radiata</i>	28.3	3.0	28.5	33.0	3.0	8.0	35.0	6.5	8.2	2.5	3.5	25.0	62.0

For quantitative traits the mean performance for almost all the traits like plant height, number of branches per plant, days to fifty percent flowering, length of branch, number of clusters per branch, number of clusters per plant, number of pods per plant, pod length, number of seeds per pod, hundred seed weight, dry matter production and seed yield exhibited high *per se* performance in the direct cross *V. radiata* x *V. radiata* var *sublobata* like parent *Vigna radiata* except days to full maturity. For all the traits in the cross of *Vigna radiata* x *Vigna radiata* var *sublobata* the skewness was positive indicating that predominance of dominant alleles.

Introduction:

Vigna radiata (L.) wilczek, commonly known as green gram or mungbean is the most widely distributed species among the six Asiatic *Wild Vigna* accessions. It is one of the predominant sources of protein and certain essential amino acids like lysine and tryptophan in vegetarian diets. The basic reason for limited success had been due to the limited variability prevailed among the parents used for hybridization in most of the studies. There had been always possibility of improving the crop by incorporating wild genes to the cultivated species. Stepwise utilization of primary, secondary and tertiary gene pools of this crop can result in tremendous improvement in yield. It is essential to attempt interspecific crosses and to develop viable hybrids. These hybrids need to be critically evaluated as such and in the segregating generations for improvement in yield and yield components.

The introgressed materials developed through wide crosses can also contribute as genetic reservoirs for novel genes apart from contributing to the improvement of yield and yield components. With a view to evaluate for attempting interspecific hybridization to generate segregants for better yield, this study was taken up keeping the objectives in mind such as to generate variability through interspecific

hybridization involving *Vigna radiata* with species in secondary and tertiary gene pools and to compare the variability created for yield and yield components among segregants generated through interspecific hybridization.

Key Words: Interspecific hybridization, *Vigna radiata*, *Vigna radiata* var. *sublobata*, Crossability, Seeds germination, Hybrid lethality (%), % of hybrid break down, Pollen fertility, F₁ and F₂ generations.

Materials and Methods:

The genotype of greengram *Vigna radiata* (VRMG(g)1) and *Vigna radiata* var *sublobata* (IC. 276990), The mungbean was used as female and male parents is *Vigna radiata* var *sublobata* and vice versa.

Vigna radiata and *Vigna radiata* var *sublobata* were raised during Rabi 2023-2024 in a crossing block. The direct and reciprocal crosses were effected at Dr.M.S.Swaminathan Agricultural College & Research Institute, Tamil Nadu Agricultural University, Eachankottai, Thanjavur, Tamil Nadu- 614 902 for following the method suggested by Boling *et al.* (1961) for hybridization. The number of plants survived over germinated seeds were taken to assess the lethality of F₁ hybrids.

$$\text{Hybrid lethality} = \frac{\text{No. of plants died}}{\text{No. of seeds germinated}} \times 100$$

The set seeds from the above mentioned crosses were sown in 2 rows along with one row of male and female parents with a spacing of 45 x 30 cm during rabi season.

The following quantitative traits were studied for all F₁ hybrids. Plant height (cm), Number of branches per plant, Length of branches (cm), Days to 50 per cent flowering, Number of clusters per branch, Number of clusters per plant, Number of pods per plant, Pod length (cm), Number of seeds per pod, Hundred seed weight (g), Grain yield per plant (g), Dry matter production and Days to maturity.

The pollen fertility analysis was carried out in the parents and their hybrids by acetocarmine staining technique

$$\text{Pollen fertility} = \frac{\text{No. of viable pollen}}{\text{Total no. of pollen observed}} \times 100$$

The seeds from individual F₁ plants were collected separately and were sown as progeny rows during kharif 2013. Observation for all the quantitative traits as that of F₁ generation except the traits 50 per cent flowering and days to full maturity were recorded. The descriptive parameters such as mean, range, SE, SD, skewness and kurtosis were computed. The frequency distribution of the F₂ segregants for seven traits that are significantly correlated with single plant yield namely, number of branches per plant, length of branch, number of clusters per branch, number of clusters per plant, number of pods per plant and hundred seed weight.

Results:

The result of this parental crosses pertaining to crushability related characters, pollen fertility, mean performance of F_{1s} and F₂ morphology characters studies were carried out and revealed. The successful direct and reciprocal crosses between *V. radiata* and *V. radiata* var. *sublobata* species and the results were obtained for the following observations namely number of flower emasculated, number of flower crossed, pod set and crossability percentage presented in Table 1. In this direct cross 258 flowers were emasculated and 202 flowered crossed from which 58 numbers of pods obtained and 28.71 pod set percentage was recorded. In this reciprocal cross 250 flowers were emasculated and 225 flowered were crossed from which 38 numbers of pods obtained and 16.88 pod set percentage was recorded.

In Table 2, In this cross, the parents and both direct and reciprocal cross combinations, some of the following observations namely number of seeds germinated, hybrid lethality percentage, percentage of hybrid break down, percentage of germination and number of seedlings attained maturity were recorded. 100 seeds from each parent, 50 seeds from both direct and reciprocal crosses namely *V.radiata* x *V.radiata* var *sublobata* and *V.radiata* var *sublobata* x *V.radiata* were used for test respectively. In the parents and crosses, seeds were used, the germinated seeds of 98 in parent of *V.radiata* while 85 seeds germinated in *V.radiata* var.*sublobata*. In direct cross 32 seeds germinated while reciprocal cross recorded 22 seeds germinated. The hybrid lethality percentage of 81.25 recorded in *V.radiata* x *V.radiata* var *sublobata* where as *V.radiata* var *sublobata* x *V.radiata* was 68.18.

In the direct cross the hybrid break down percentage was 18.74 recorded in *V.radiata* x *V.radiata* var *sublobata* while in reciprocal cross of 31.82 percent recorded in the cross *V.radiata* var *sublobata* x *V.radiata*. The germination percentage of 98 and 85 was recorded in *V. radiata* and *V. radiata* var. *sublobata* parents respectively. In the direct cross of *V.radiata* x *V.radiata* var *sublobata* was 64 and 44 percent of germination observed in the reciprocal cross *V.radiata* var. *sublobata* x *V.radiata*. The Number of seedlings attained maturity in parents 65 and 46 in *V.radiata* and *V. radiata* var. *sublobata* respectively and the same character for the both direct and reciprocal crosses of 25 and 15 percent in *V.radiata* x *V.radiata* var. *sublobata* and *V. radiata* var. *sublobata* x *v. radiata* respectively

The pollen fertility percentage of parent *V. radiata* was 90.55 and 91.26 percent in *V. radiata* var. *sublobata* and F₁ hybrids of interspecific crosses for *V. radiata* x *V. radiata* var. *sublobata* was 78.26 and *V. radiata* var. *sublobata* x *V. radiata* recorded 65.26 percent.(Table 3)

The Mean performance of parents and hybrids both direct and reciprocal crosses of *V. radiata* and *V. radiata* var. *sublobata* and cross *V. radiata* var. *sublobata* x *V. radiata* and *V. radiata* var. *sublobata* x *V. radiata*. For various 13 characters like PHT- Plant height (cm), BRL- Branch length (cm), DFF- Days to fifty percent flowering, NCB- Number of cluster per branch, NOC- Number of cluster per plant, NPP- Number of pods per plant, POL- Pod length, HSW- Hundred grain weight, SPY- Single plant yield, DMP- Dry matter production and DFM- Days to full maturity were recorded (Table 4).

In Plant height (cm), *V. radiata* registered highest value of 48.5 while the *V. radiata* var. *sublobata* (28.8). In the direct crosses, the hybrid plant of *V. radiata* x *V. radiata* var. *sublobata* was found to be taller (44.00). In the reciprocal crosses the *V. radiata* var. *sublobata* x *V. radiata* registered the value of 28.3.

Number of branches per plant, in the parental species *V. radiata* possessed more number of branches (4.0) while *Vigna radiata* var. *sublobata* recorded (3.0). The hybrid of the direct cross *V. radiata* x *V. radiata* var. *sublobata* registered (4.0). The hybrid of the cross *V. radiata* var. *sublobata* x *V. radiata* registered branches per plant (3.0) in the reciprocal cross.

Length of branch (cm), *V. radiata* possessed lengthiest branch (35.0) while branch length 26.0 was recorded by the parent *V. radiata* var. *sublobata*. The hybrids of the cross *V. radiata* registered the maximum branch length of 35.0 as compared to reciprocal crosses *V. radiata* var. *sublobata* x *V. radiata* recorded 28.5 cm.

Days to 50 per cent flowering, the parental species *V. radiata* was the earliest to flower with 35 days closely followed by *V. radiata* var. *sublobata* with 32 days. The direct cross *V. radiata* x *V. radiata* var. *sublobata* registered early flowering (35.0 days) followed by *V. radiata* var. *sublobata* x *V. radiata* (33.0 days).

Number of clusters per branch, *V. radiata* registered the highest value of 4.0 for number of clusters per branch. Other parent *V. radiata* var. *sublobata* recorded (4.0). In the cross *V. radiata* x *V. radiata* var. *sublobata* possessed highest number of clusters per branch (3.0) while *V. radiata* var. *sublobata* x *V. radiata*, registered highest value of 3.00 clusters per branch in the reciprocal crosses.

Number of cluster per plant, the numbers of clusters per plant was observed in the parent *V. radiata* was 10 while other parent *V. radiata* var. *sublobata* was also 10 number of cluster per plant. The cross *V. radiata* x *V. radiata* var. *sublobata* recorded the value of 10.0 for this trait in the direct crosses. The reciprocal cross hybrid registered the highest value of 8.00 for this trait by the *V. radiata* var. *sublobata* x *V. radiata*.

Number of pods per plant, For this trait, *V. radiata* recorded in the highest value of 46.0 followed by *V. radiata* var. *sublobata* 48.0. In the direct cross *V. radiata* x *V. radiata* var. *sublobata* registered more number of pods 50.00, in case of reciprocal crosses highest value of 35.00 was observed in the hybrid *V. radiata* var. *sublobata* x *V. radiata*.

Length of pod (cm), the parent *V. radiata* recorded 8.80 other parent *V. radiata* var. *sublobata* for length of pods was 5.27. In the direct cross *V. radiata* x *V. radiata* var. *sublobata* has recorded 8.50 cm and reciprocal cross *V. radiata* var. *sublobata* x *V. radiata* registered the highest value (6.50)

Number of seeds per pod, the highest value of 10.0 seeds was observed in the parental species *V. radiata* while *V. radiata* var. *sublobata* recorded 6.0 seeds per pod. The hybrid of the cross *V. radiata* x *V. radiata* var. *sublobata* recorded (10.0) while the reciprocal hybrid *V. radiata* var. *sublobata* x *V. radiata* exhibited the value of 8.2 for this trait.

Hundred seed weight (g), *V. radiata* the parental species registering 3.2 for trait hundred seed weight. *V. radiata* var. *sublobata* recorded the value of 2.20 for this trait. In the direct cross hybrid *V. radiata* x *V. radiata* var. *sublobata* recorded 2.90 when *V. radiata* var. *sublobata* x *V. radiata* exhibited the value of 2.5 g for this trait.

Single plant yield (g) for this trait the value of 5.25 registered by *V. radiata* and other parent *V. radiata* var. *sublobata* registered 3.80. In the direct cross, the value of 5.90 recorded by the hybrid *V. radiata* x *V. radiata* var. *sublobata*. In the reciprocal *V. radiata* var. *sublobata* x *V. radiata* registered the value of 3.5(g)

Dry matter production (g) for dry matter production *V. radiata* (23.5) registered the highest value and *Vigna radiata* var. *sublobata* registered (15.5) in the parents. In the direct crosses the value of 28.7 recorded by the hybrids *V. radiata* x *V. radiata* var. *sublobata* was highest value of 28.7. In the reciprocal crosses *V. radiata* var. *sublobata* x *V. radiata* revealed highest value of 25.0.

Days to full maturity, *V. radiata* was the parent to mature earliest at 65 days followed by *V. radiata* var. *sublobata* in 60.00 days. The hybrid of the cross *V. radiata* x *V. radiata* var. *sublobata* was shortest in duration with 65 days similar to female parent. The hybrid of the reciprocal cross *V. radiata* var. *sublobata* x *V. radiata* was earliest with 62 days.

Mean performance of different yield contributing characters of *Vigna radiata* and *Vigna radiata* var. *sublobata* cross in F₂ segregants of both direct and reciprocal crosses (Table .5). The number of branches per plant ranged from 1.55 (*V. radiata* var. *sublobata* x *V. radiata*) to 1.82 (*V. radiata* x *V. radiata* var. *sublobata*). Length of branch, the mean value for the length of branches per plant varied from 16.22 to 25.37 with over all mean of 20.79 for F₂ segregants. The cross combination *V. radiata* x *V. radiata* var.

sublobata was exhibited mean value of 16.22 in the direct and reciprocal cross combination was 25.37 respectively.

Number of clusters per branch, the number of clusters per branch ranged from 1.70 (*V.radiata* x *V.radiata* var. *sublobata*) to 2.27 (*V.radiata* var *sublobata*) with the overall mean of 1.98

Number of clusters per plant, the number of clusters per plant ranged from 4.20 (*V.radiata* var *sublobata* x *V. radiata*) to 4.86 (*V.radiata* x *V. radiata* var. *sublobata*) with over all mean of 4.53 among the crosses.

Number of pods per plant, the range was found to be between 15.25 (*V. radiata* var. *sublobata* x *V.radiata*) to 17.68 (*V.radiata* x *V. radiata* var. *sublobata*) with the over all mean value of 16.46. Hundred seed weight(g) , the hundred seed weight ranged from 2.40 (*V. radiata* var. *sublobata* x *V.radiata*) to 2.68 g (*V.radiata* x *V. radiata* var. *sublobata*) with the over all mean of 2.54 g for F₂ segregants. Single plant yield, the seed yield ranged from 2.13g (*V. radiata* var. *sublobata* x *V.radiata*) to 2.81 g (*V.radiata* x *V. radiata* var. *sublobata*) with a overall mean of 2.47g for F₂ segregants.

For most of the direct as well as reciprocal crosses, the F₂ progenies revealed high *per se* performance and also exhibited high variability for seven yield contributing traits. For all the traits in majority of the crosses, the skewness was positive indicating that predominance of dominant alleles (Table 6)

Discussion:

In the present investigation with an objective to transfer useful traits from the *Vigna.radiata* var *sublobata* (wild) and to into *Vigna .radiata* (greengram), the interspecific hybridization was attempted. The extent of crossability, fertility of hybrids and possibility of obtaining superior recombinants in the F₂ generation through recombination of genomes were studied. The wild relatives of greengram possess desirable genes for many yield components coupled with resistance to bruchids and MYMV. Transferring of these genes into cultivated species, could result in development of high yielding resistant types. The use of wild greengram in greengram improvement breeding programme has been difficult because of problems encountered in obtaining successful F₁ hybrids due to crossability barriers. In spite of these difficulties, wide hybridization between *V. radiata* and its wild relative was successfully accomplished by many workers Renganayaki (1985), Pandae *et al.* (1990), Ganeshram (1993) and Subramanian and Muthiah. (2000). Pandiyan *et al.* (2005, 2006, 2006, 2006, 2006, 2008, 2010, 2010, 2012, 2012, 2012, 2012, 2013, 2018) Kathikeyan *et al* 2008, 2012, 2013, Sudha *et al.*, (2013, 2013, 2015), Devina Serum *et al.* (2016, 2019), Premkumar *et al.* (2007), Mariyammal *et al.* (2019, 2019) and Umamaheshwari (2002). Crossability is a pre-requisite for gene transfer in wide hybridization. An understanding of crossability relationship among the species had been helpful not only in choosing methods for producing F₁ hybrids, but also in tracing phylogenetic relationship among species..

In the present study, successful pod set was observed in interspecific crosses with *Vigna radiata* either as ovule or pollen parent. This result is in agreement with the reports of Ahuja and Singh (1977), Parida and Singh (1985), Gopinathan *et al.* (1986), Egawa *et al.* (1990), Mendioro and Ramirez (1994), James *et al.* (1999). Pandiyan *et al.* (2005, 2006, 2006, 2006, 2006, 2006, 2008, 2010, 2010, 2012, 2012, 2012, 2012, 2013, 2018) Kathikeyan *et al* 2008, 2012, 2013, Sudha *et al.*, (2013, 2013, 2015), Devina Serum *et al.* (2016, 2019), Premkumar *et al.* (2007), Mariyammal *et al.* (2019, 2019) and Umamaheshwari (2002).

The pollen fertility percentage of parent *V. radiata* was 90.55 and 91.26 percent in *V. radiata* var. *sublobata* and F₁ hybrids of interspecific crosses for *V. radiata* x *V. radiata* var. *sublobata* was 78.26 and *V. radiata* var. *sublobata* x *V. radiata* recorded 65.26 percent.(Table 3)

In the direct cross the hybrid break down percentage was 18.74 recorded in *V.radiaa* x *V.radiata* var *sublobata* while in reciprocal cross of 31.82 percent recorded in the cross *V.radiata* var *sublobata* x *V.radiata*. Similar observations on hybrid lethality and inviability were noticed in interspecific crosses involving different *Wild Vigna accessions* by AL- Yasiri and Corijne (1966), Chen *et al.*(1989), Chen *et al.* (1982), Adinarayanamurthy *et al.* (1993), Pandiyan *et al.* (2005, 2006, 2008, 2010, 2010, 2012, 2012, 2012, 2013, 2018) Kathikeyan *et al* 2008, 2012, 2013, Sudha *et al.*, (2013, 2013, 2015), Premkumar *et al.* (2007), Mariyammal *et al.* (2019, 2019). Umamaheshwari (2002), Ganeshram (1993) and Renganayaki (1985). Stebbins (1958) had attributed the hybrid weakness, inviability, lethality and sterility as mechanisms of nature for maintaining the integrity of related species.

In general, the pollen fertility in the direct crosses was higher as compared to their corresponding reciprocal crosses which indicated that the approach using the cultivated species as a female parent is likely to generate better hybrids and segregants . Similar result was reported by various authors for differential pollen fertility among interspecific crosses of *Wild Vigna accessions* (Pandae *et al.*, 1990, Mendioro and Ramirez, 1994, Ravi *et al.*, 1987, Anandabaskaran and Rangasamy, 1996, Subramanian and Muthiah 2001, Monika *et al.*, 2001. Pandiyan *et al.* (2005, 2006, 2008, 2010, 2010, 2012, 2012, 2012, 2013, 2018) Kathikeyan *et al* 2008, 2012, 2013, Sudha *et al.*, (2013, 2013, 2015), Premkumar *et al.* (2007), Mariyammal *et al.* (2019, 2019). Umamaheshwari, 2002 and Sidhu and Satija, 2003). Among the crosses the pollen fertility was highest in the cross *V. radiata* x *V. radiata* var. *sublobata* and this observation support the view of Pandae *et al.*(1990), Pandiyan *et al.* (2005, 2006, 2008, 2010, 2010, 2012,

2012, 2012, 2013, 2018), Mendioro and Ramirez (1994) that *V. radiata* var. *sublobata* is the probable progenitor for *V. radiata*

The range of pollen fertility observed in direct and reciprocal crosses was high enough to obtain sufficient viable F₂ segregants.

The primary criterion used for the evaluation of hybrids was the *per se* performance for different traits. In the present study, in this cross combination in the direct cross exhibited high mean value for important traits *viz.*, plant height, number of branches per plant, length of branch, number of clusters per branch, number of clusters per plant, number of pods per plant, pod length, number seeds per pod, hundred seed weight, single plant yield and dry matter production

The reciprocal cross exhibited less value mean performance which is good value for day to fully maturity traits.

The hybrid of the direct cross *V. radiata* x *V. radiata* var. *sublobata* recorded high *per se* performance for the characters almost all the characters. Hence the segregants that could be recovered from these promising lines might serve as better breeding base for improvement of yield and yield components. Such promising interspecific hybrids were also reported by Umamaheswari (2000), Subramanian and Muthiah (2001) and Ganeshram (1993). Pandiyan *et al.* (2005, 2006, 2008, 2010, 2010, 2012, 2012, 2012, 2013, 2018)

For most of the direct as well as reciprocal crosses, the F₂ progenies revealed high *per se* performance and also exhibited high variability for seven yield contributing traits. For all the traits in majority of the crosses, the skewness was positive indicating that predominance of dominant alleles as opined by Fisher *et al.* (1967) and Darbeshwar Roy (2000) Pandiyan *et al.* (2005, 2006, 2008, 2010, 2010, 2012, 2012, 2012, 2013, 2018). In this situation selection for traits in the early generation will not be fixable hence selections in later generations or by adopting modified breeding procedures such as intermating the segregants followed by recurrent selection may shift the gene action towards additive effects. Since sterility factors will gradually reduce over generations in case of interspecific crosses and more recombined populations will be available for selection, the effecting selection in the later generation will be more effective.

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Table 1: The crosses, pod set and crossability percentage of *V. radiata* and *V. radiata* var. *sublobata* crosses

Parents	No. of flowers emasculated	No. of flowers crossed	No. of crossed pods obtained (Pod set)	%
<i>V.radiata</i> x <i>V. radiata</i> var. <i>sublobata</i>	258	202	58	28.71
<i>V. radiata</i> var. <i>sublobata</i> x <i>V. radiata</i>	250.0	225	38	16.88

Table 2: Germination percentage of parents and F₁ hybrids for direct and reciprocal crosses

Parents and Crosses	No. of crossed seeds taken for analysis	No. of seeds germinated	Hybrid lethality (%)	% of hybrid break down	% of germination	No. of seedlings attained maturity
<i>V.radiata</i>	100	98	33.67	66.33	98	65.00
<i>V.radiata</i> var <i>sublobata</i>	100	85	54.11	45.89	85	46.00
<i>V.radiata</i> x <i>V.radiata</i> var <i>sublobata</i>	50	32	81.25	18.74	64	25.00
<i>V.radiata</i> var <i>sublobata</i> x <i>V.radiata</i>	50	22	68.18	31.82	44	15.00

Table 3: Pollen fertility percentage of parents and F₁ hybrids of interspecific crosses *V. radiata* and *V. sublobata*

Parents and Hybrids	Pollen fertility (%)
<i>V. radiata</i>	90.55
<i>V. radiata</i> var. <i>sublobata</i>	91.26
<i>V.radiata</i> x <i>V. radiata</i> <i>sublobata</i>	78.23
<i>V.radiata</i> var. <i>sublobata</i> x <i>V.radiata</i>	65.26

Table 4: Mean performance of parents and hybrids both direct and reciprocal crosses

Parents	PHT	NOB	BRL	DFP	NCB	NOC	NPP	POL	NSP	HSW	SPY	DMP	DFM
<i>V.radiata</i>	48.5	3.0	35.5	35.0	4.0	10.0	46.0	8.80	10.0	3.2	5.25	23.5	65.0
<i>V.radiata</i> var <i>sublobata</i>	28.8	3.0	26.0	32.0	4.0	10.0	48.0	5.27	6.0	2.2	3.8	15.5	60.0
<i>V.radiata</i> x	44.0	3.0	32.0	35.0	3.0	10.0	50.0	8.5	10.0	2.9	5.9	28.7	65.0

V.radiata var. sublobata													
V.radiata var. sublobata x V.radiata	28.3	3.0	28.5	33.0	3.0	8.0	35.0	6.5	8.2	2.5	3.5	25.0	62.0

PHT- Plant height (cm), BRL- Branch length (cm), DFF- Days to fifty percent flowering, NCB- Number of cluster per branch, NOC- Number of cluster per plant, NPP- Number of pods per plant, POL- Pod length, HSW- Hundred grain weight, SPY-Single plant yield, DMP- Dry matter production, DFM- Days to full maturity.

Table 5: Mean performance of the yield contributing characters among F2 families of interspecific crosses

Crosses	NOB	BRL	NCB	NOC	NPP	HSW	SPY
<i>V.radiata</i> x <i>V. radiata</i> var. <i>sublobata</i>	1.82	16.22	1.70	4.86	17.68	2.68	2.81
<i>V. radiata</i> var. <i>sublobata</i> x <i>V.radiata</i>	1.55	25.37	2.27	4.20	15.25	2.40	2.13
Mean	2.59	20.79	1.98	4.53	16.46	2.54	2.47

Table 6: Skewness and Kurtosis of yield contributing characters among F2 families of interspecific crosses

Crosses	NOB		BRL		NCB		NOC		NPP		HSW		SPY	
	Skewness	Kurtosis	Skewness	Kurtosis	Skewness	Kurtosis	Skewness	Kurtosis	Skewness	Kurtosis	Skewness	Kurtosis	Skewness	Kurtosis
<i>V.radiata</i> x <i>V. radiata</i> var. <i>sublobata</i>	0.1	1.06	0.72	1.76	0.56	0.83	1.40	2.22	1.12	2.54	2.13	7.53	1.75	5.12
<i>V. radiata</i> var. <i>sublobata</i> x <i>V.radiata</i>	0.40	-0.22	0.42	-1.02	0.45	0.40	0.45	-0.88	-0.75	1.25	-0.35	0.18	-0.56	0.33
Mean	0.25	0.42	0.57	0.74	0.50	0.61	0.92	0.67	0.18	1.89	0.97	3.85	0.59	2.72