Development of bruchid resistant genotypes in mungbean through introgression of wild genotypes

M Pandiylan, A Krishnaveni, C Sivakumar, M Vaityalingan, P Sivakumar, E Jamuna, V Radhakrishnan and P Senthilkumar

DOI: https://doi.org/10.22271/chemi.2020.v8.i2b.9584

Abstract

Vigna radiata (L.) wilczek, commonly known as greengram or mungbean is the most widely distributed species among the Vigna species cultivated species. Grains are very quickly destroyed by the pulse beetle. Now a days, pulse beetle infestation has started field itself. 100 percent grains loss due to more population of pulse beetle. Climate also desirable for production of pulses beetle. It possessed certain added features compared to other pulses. It is relatively drought tolerant and well adapted to a range of soil conditions including light soils and can thrive even under limited irrigation, moreover, it is suited for crop rotation and crop mixtures (Baldev, 1988 [1] and Sadaphal, 1988) [8]. However, this crop is suffering from the yield due to pulses beetle infestation. Grain quality and germination also affected by pulses beetle’s infestation. In Tamil Nadu it is cultivated nearly 2. Lakhs hectares with a lowest yield due to pulses beetle. Now a days, pulse beetle infestation has started field itself. 100 percent resistance can be utilized for the development of bruchid resistant genotypes in greengram for future greengram improvement breeding programme.

Keywords: Greengram, rice bean, interspecific hybridization, bruchids, resistance

Introduction

Vigna radiata (L.) wilczek, commonly known as greengram or mungbean is the most widely distributed species among the Vigna species cultivated species. Grains are very quickly destroyed by the pulse beetle. Now a days, pulse beetle infestation has started field itself. 100 percent grains loss due to more population of pulse beetle. Climate also desirable for production of pulses beetle. It possessed certain added features compared to other pulses. It is relatively drought tolerant and well adapted to a range of soil conditions including light soils and can thrive even under limited irrigation, moreover, it is suited for crop rotation and crop mixtures (Baldev, 1988 [1] and Sadaphal, 1988) [8]. However, this crop is suffering from the yield due to pulses beetle infestation. Grain quality and germination also affected by pulses beetle’s infestation. In Tamil Nadu it is cultivated nearly 2. Lakhs hectares with a lowest produciton. Besides management factors the prime cause for the low productivity can be ascribed to the inherently low yielding potential of the cultivars coupled with susceptibility to diseases.

The varietal breeding program taken up among the varieties had resulted only with limited success as far as yield improvement is concerned. The basic reason for limited success had been due to the limited variability is high 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 always successfully achieved the targeted genes and also eradicating the problems uncounted with already existing genotypes. Crossing can be done for need based utilizing the primary, secondary and tertiary gene pools of this crop can result in tremendous improvement in yield. Primary gene pool when not in useful then we go for secondary and tertiary gene incorporation into agronomically good genotypes. The Vigna umbellata has durable resistant genes against bruchids. When we use this Vigna species for improvement of greengram to develop bruchids resistant genotypes in greengram.

Selection of parents from the diverse species for hybridization program is likely to generate superior transgressive segregrants. 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.
Materials and Methods
To generate variability through interspecific hybridization involving Vigna radiata with Vigna umbellata, evaluate and characterize interspecific hybrids and studying the segregants for yield and yield components and to assess the pest and disease reaction of the parents, hybrids and selected F1 crosses. For screening for bruchid resistance (Callosobruchus spp.), interspecific crosses between V. radiata with V. umbellata the bruchids ovipositional preferences and non-preferences were studied in the parents and its hybrids. One hundred seeds from these interspecific crosses was placed in cloth bags and 5 pairs of adult bruchids obtained from the maintained culture which were one day old were released into each of the bags. The experiments were replicated twice adopting factorial CRD. Observations were made on the number of eggs laid per seed on 24, 48, 72, 96,120 and 144 hrs after release. The mean number of eggs laid per seed each day was calculated and the number of adults emerged and seeds damaged as per cent were recorded. Data were analyzed using Excel package.

Results
In this cross combination bruchids were laid eggs on the seeds surface. In F1s some of the plants seeds were not damaged. The parent greengram completely damaged by the bruchids and another parent V. umbellata not damaged by the bruchids. In F1s most of the plants seeds showing damaged even full of bruchids released to the container except three plants namely rill no - 158, rill no - 165 and rill no - 169. In these rills, egg laying was not in its seeds. The bruchid damaged in the parental seeds varied from 0.0 percent in V. umbellata and V. radiata 100 .00 percent (Fig 1.). In this cross, 0.0 percent seed damaged to 100 percent seed damage in F1 is presented in the table 1.

Table 1: Screening of bruchids in V. radiata x V. umbellata derivatives in F2 segregants.

| Plant Name | No. of seeds | Number of pairs of insects released | No of eggs laid on the seed | No. of days for counting after bruchids released | No. of seeds damaged | % of seeds damaged |
|------------|--------------|------------------------------------|-----------------------------|-----------------------------------------------|----------------------|------------------|
| P1         | 20           | 2 pairs                            | 58.0                        | 25                                            | 20                   | 100              |
| P2         | 20           | 2 pairs                            | 65.0                        | 25                                            | 20                   | 100              |
| P3         | 20           | 2 pairs                            | 68.0                        | 25                                            | 20                   | 100              |
| P4         | 20           | 2 pairs                            | 80.0                        | 25                                            | 19                   | 95               |
| P5         | 20           | 2 pairs                            | 55.0                        | 25                                            | 18                   | 90               |
| P6         | 20           | 2 pairs                            | 75.0                        | 25                                            | 17                   | 85               |
| P7         | 20           | 2 pairs                            | 48.0                        | 25                                            | 18                   | 90               |
| P8         | 20           | 2 pairs                            | 55.0                        | 25                                            | 18                   | 90               |
| P9         | 20           | 2 pairs                            | 62.0                        | 25                                            | 20                   | 100              |
| P10        | 20           | 2 pairs                            | 64.0                        | 25                                            | 20                   | 100              |
| P11        | 20           | 2 pairs                            | 58.0                        | 25                                            | 20                   | 100              |
| P12        | 20           | 2 pairs                            | 53.0                        | 25                                            | 20                   | 100              |
| P13        | 20           | 2 pairs                            | 75.0                        | 25                                            | 20                   | 100              |
| P14        | 20           | 2 pairs                            | 81.0                        | 25                                            | 20                   | 100              |
| P15        | 20           | 2 pairs                            | 75.0                        | 25                                            | 20                   | 100              |
| P16        | 20           | 2 pairs                            | 63.0                        | 25                                            | 20                   | 100              |
| P17        | 20           | 2 pairs                            | 70.0                        | 25                                            | 20                   | 100              |
| P18        | 20           | 2 pairs                            | 45.0                        | 25                                            | 20                   | 100              |
| P19        | 20           | 2 pairs                            | 49.0                        | 25                                            | 18                   | 90               |
| P20        | 20           | 2 pairs                            | 69.0                        | 25                                            | 18                   | 90               |
| P21        | 20           | 2 pairs                            | 62.0                        | 25                                            | 18                   | 90               |
| P22        | 20           | 2 pairs                            | 48.0                        | 25                                            | 17                   | 85               |
| P23        | 20           | 2 pairs                            | 59.0                        | 25                                            | 19                   | 95               |
| P24        | 20           | 2 pairs                            | 62.0                        | 25                                            | 18                   | 90               |
| P25        | 20           | 2 pairs                            | 80.0                        | 25                                            | 18                   | 90               |
| P26        | 20           | 2 pairs                            | 55.0                        | 25                                            | 19                   | 95               |
| P27        | 20           | 2 pairs                            | 75.0                        | 25                                            | 19                   | 95               |
| P28        | 20           | 2 pairs                            | 48.0                        | 25                                            | 19                   | 95               |
| P29        | 20           | 2 pairs                            | 55.0                        | 25                                            | 18                   | 90               |
| P30        | 20           | 2 pairs                            | 62.0                        | 25                                            | 16                   | 80               |
| P31        | 20           | 2 pairs                            | 64.0                        | 25                                            | 15                   | 75               |
| P32        | 20           | 2 pairs                            | 58.0                        | 25                                            | 18                   | 90               |
| P33        | 20           | 2 pairs                            | 53.0                        | 25                                            | 19                   | 95               |
| P34        | 20           | 2 pairs                            | 75.0                        | 25                                            | 18                   | 90               |
| P35        | 20           | 2 pairs                            | 80.0                        | 25                                            | 18                   | 90               |
| P36        | 20           | 2 pairs                            | 55.0                        | 25                                            | 18                   | 90               |
| P37        | 20           | 2 pairs                            | 75.0                        | 25                                            | 20                   | 100              |
| P38        | 20           | 2 pairs                            | 48.0                        | 25                                            | 20                   | 100              |
| P39        | 20           | 2 pairs                            | 55.0                        | 25                                            | 18                   | 90               |
| P40        | 20           | 2 pairs                            | 62.0                        | 25                                            | 18                   | 90               |
| P41        | 20           | 2 pairs                            | 80.0                        | 25                                            | 18                   | 90               |
| P42        | 20           | 2 pairs                            | 55.0                        | 25                                            | 20                   | 100              |
| P43        | 20           | 2 pairs                            | 75.0                        | 25                                            | 20                   | 100              |
| P44        | 20           | 2 pairs                            | 48.0                        | 25                                            | 18                   | 90               |
| P45        | 20           | 2 pairs                            | 55.0                        | 25                                            | 18                   | 90               |
| P46        | 20           | 2 pairs                            | 62.0                        | 25                                            | 18                   | 90               |
| P47        | 20           | 2 pairs                            | 64.0                        | 25                                            | 20                   | 100              |
| P48        | 20           | 2 pairs                            | 58.0                        | 25                                            | 17                   | 85               |
| P49        | 20           | 2 pairs                            | 53.0                        | 25                                            | 18                   | 90               |
| P50 | 20 | 2 pairs | 75.0 | 25 | 20 | 100 |
| P51 | 20 | 2 pairs | 80.0 | 25 | 20 | 100 |
| P52 | 20 | 2 pairs | 55.0 | 25 | 20 | 100 |
| P53 | 20 | 2 pairs | 75.0 | 25 | 20 | 100 |
| P54 | 20 | 2 pairs | 48.0 | 25 | 20 | 100 |
| P55 | 20 | 2 pairs | 55.0 | 25 | 20 | 100 |
| P56 | 20 | 2 pairs | 62.0 | 25 | 17 | 85 |
| P57 | 20 | 2 pairs | 64.0 | 25 | 18 | 90 |
| P58 | 20 | 2 pairs | 58.0 | 25 | 20 | 100 |
| P59 | 20 | 2 pairs | 53.0 | 25 | 17 | 85 |
| P60 | 20 | 2 pairs | 75.0 | 25 | 18 | 90 |
| P61 | 20 | 2 pairs | 80.0 | 25 | 20 | 100 |
| P62 | 20 | 2 pairs | 55.0 | 25 | 20 | 100 |
| P63 | 20 | 2 pairs | 75.0 | 25 | 20 | 100 |
| P64 | 20 | 2 pairs | 48.0 | 25 | 20 | 100 |
| P65 | 20 | 2 pairs | 55.0 | 25 | 20 | 100 |
| P66 | 20 | 2 pairs | 62.0 | 25 | 20 | 100 |
| P67 | 20 | 2 pairs | 64.0 | 25 | 17 | 85 |
| P68 | 20 | 2 pairs | 58.0 | 25 | 20 | 100 |
| P69 | 20 | 2 pairs | 53.0 | 25 | 20 | 100 |
| P70 | 20 | 2 pairs | 75.0 | 25 | 20 | 100 |
| P71 | 20 | 2 pairs | 80.0 | 25 | 20 | 100 |
| P72 | 20 | 2 pairs | 80.0 | 25 | 20 | 100 |
| P73 | 20 | 2 pairs | 55.0 | 25 | 20 | 100 |
| P74 | 20 | 2 pairs | 75.0 | 25 | 20 | 100 |
| P75 | 20 | 2 pairs | 48.0 | 25 | 20 | 100 |
| P76 | 20 | 2 pairs | 55.0 | 25 | 20 | 100 |
| P77 | 20 | 2 pairs | 62.0 | 25 | 17 | 85 |
| P78 | 20 | 2 pairs | 64.0 | 25 | 20 | 100 |
| P79 | 20 | 2 pairs | 58.0 | 25 | 20 | 100 |
| P80 | 20 | 2 pairs | 53.0 | 25 | 20 | 100 |
| P81 | 20 | 2 pairs | 75.0 | 25 | 20 | 100 |
| P82 | 20 | 2 pairs | 80.0 | 25 | 17 | 85 |
| P83 | 20 | 2 pairs | 55.0 | 25 | 18 | 90 |
| P84 | 20 | 2 pairs | 75.0 | 25 | 20 | 100 |
| P85 | 20 | 2 pairs | 48.0 | 25 | 20 | 100 |
| P86 | 20 | 2 pairs | 55.0 | 25 | 20 | 100 |
| P87 | 20 | 2 pairs | 62.0 | 25 | 20 | 100 |
| P88 | 20 | 2 pairs | 64.0 | 25 | 20 | 100 |
| P89 | 20 | 2 pairs | 58.0 | 25 | 20 | 100 |
| P90 | 20 | 2 pairs | 53.0 | 25 | 17 | 85 |
| P91 | 20 | 2 pairs | 75.0 | 25 | 17 | 85 |
| P92 | 20 | 2 pairs | 80.0 | 25 | 20 | 100 |
| P93 | 20 | 2 pairs | 55.0 | 25 | 20 | 100 |
| P94 | 20 | 2 pairs | 75.0 | 25 | 20 | 100 |
| P95 | 20 | 2 pairs | 48.0 | 25 | 20 | 100 |
| P96 | 20 | 2 pairs | 55.0 | 25 | 20 | 100 |
| P97 | 20 | 2 pairs | 62.0 | 25 | 20 | 100 |
| P98 | 20 | 2 pairs | 64.0 | 25 | 20 | 100 |
| P99 | 20 | 2 pairs | 58.0 | 25 | 17 | 85 |
| P100 | 20 | 2 pairs | 53.0 | 25 | 18 | 90 |
| P101 | 20 | 2 pairs | 75.0 | 25 | 20 | 100 |
| P102 | 20 | 2 pairs | 80.0 | 25 | 20 | 100 |
| P103 | 20 | 2 pairs | 55.0 | 25 | 20 | 100 |
| P104 | 20 | 2 pairs | 75.0 | 25 | 20 | 100 |
| P105 | 20 | 2 pairs | 48.0 | 25 | 20 | 100 |
| P106 | 20 | 2 pairs | 55.0 | 25 | 20 | 100 |
| P107 | 20 | 2 pairs | 62.0 | 25 | 17 | 75 |
| P108 | 20 | 2 pairs | 64.0 | 25 | 17 | 75 |
| P109 | 20 | 2 pairs | 58.0 | 25 | 18 | 90 |
| P110 | 20 | 2 pairs | 53.0 | 25 | 20 | 100 |
| P111 | 20 | 2 pairs | 75.0 | 25 | 20 | 100 |
| P112 | 20 | 2 pairs | 80.0 | 25 | 20 | 100 |
| P113 | 20 | 2 pairs | 55.0 | 25 | 20 | 100 |
| P114 | 20 | 2 pairs | 75.0 | 25 | 20 | 100 |
| P115 | 20 | 2 pairs | 48.0 | 25 | 20 | 100 |
| P116 | 20 | 2 pairs | 55.0 | 25 | 17 | 75 |
| P117 | 20 | 2 pairs | 62.0 | 25 | 17 | 75 |
| P118 | 20 | 2 pairs | 58.0 | 25 | 18 | 90 |
| P119 | 20 | 2 pairs | 58.0 | 25 | 20 | 100 |
| P120 | 20 | 2 pairs | 53.0 | 25 | 20 | 100 |
| P121 | 20 | 2 pairs | 75.0 | 25 | 20 | 100 |
| P122 | 20 | 2 pairs | 80.0 | 25 | 20 | 100 |
as reported by Tomooka et al. (2000) [7], Chakrabarty (2003) [2] and Kalyan and Dadhich (1999) [3]. However, Kashiwaba et al. (2003) [4] had reported that some unidentified compounds contained in the cotyledon of Vigna umbellata has an inhibitory effect on the growth of bruchids. The umbellata having the biochemicals play a major role to avoid the pests.

Discussion

The present investigation was assessed in introgressed genotypes derived from V. radiata x V. umbellata for the bruchids resistance. Bruchids (Callasobruchus macculatus) is a very serious post-harvest pest of greengram. There is no resistant source for this pest across the greengram germplasm for the harvest.
hatching of eggs in the seed surface and hatched larvae enter into inside of the seed but not develop fully and not survive. Among the Vigna species V. umbellata only species having the bio chemicals against bruchids at high level of resistance. Pandiyan et al. (2006) [6]. The hybrids of the cross V. radiata x V. umbellata exhibited certain level of infestation in many of the plants, only three plants showed 100 percent as compared to other hybrids. This result supports the resistant finding of Kashiwaba et al. (2003) [4] that V. umbellata possesses resistance to bruchids. As high level of resistance was observed in the three plants of F1 hybrid of V. radiata x V. umbellata, the screening studies were also continued in the F2 generation of lesser population (Fig-1). The results revealed that the segregants of V. V. radiata x umbellata exhibited more resistance in three plants. According to the recovery of sufficient plant population could be recovered in the F2 generation selection should be postponed to later generations for fixing the resistance by adopting breeding procedure like single seed descent method or bulk method or pedigree or backcross methods. The resistance could be maintained by continuing selection till large number of populations is achieved. Similar attempt for transferring bruchids resistance from V. umbellata into V. radiata has been reported Umamaheshwari (2002) [5] and Tomooka et al. (2000) [7], Tomooka et al. (2000) [7] and Pandiyan et al. (2006) [6] suggested that species level germplasm collection is an efficient means for revealing many new resistance accessions and it may also be effective to explore other types of novel genes.

![Green gram plant with infected pods in the field](image)

**Fig 1:** P1, F1 P2-Larva, Pupa on the seeds of green gram

**Conclusion**

Considering the potential economic importance and genetic erosion of wild species, collection, conservation and evaluation of the wild relatives of crop species deserve greater attention. Even in the smaller population of F2 segregants, there was resistance reaction registered by V. radiata x V. umbellata hence selection for resistance may be employed at later generation when plant population is high.

**References**

1. Baldey B. Cropping patterns. In Pulse Crop (Grain Legumes), Eds Baldev B, Ramanujam S, Jain HK. Oxford & IBH Publishing Co. Pvt. Ltd., 1988, 513-557.
2. Chakraborty S, Gayen P, Senapati SK. Effect of feeding mungbean genotypes on biology of Callosobruchus chinensis L. Environ and Ecol. 2003; 21(1):191-195.
3. Kalyan RK, Dadhich SR. Developmental response of Callosobruchus maculatus to different green gram varieties. Ann agric Bio Research., 1999; 4(2):219-221.
4. Kashiwaba KN, Tomooka A, Kaga O, Han K, Vaughan DA. Characterization of resistance to three bruchid species (Callosocruchus sp. Coleoptera: Bruchidae) in cultivated rice bean (Vigna umbellata). J Econ. Ent. 2003; 96(1):207-213.
5. Uma Maheswari D. Wide hybridization in the genus Vigna. M.Sc. (Ag.) Thesis, TNAU, Coimbatore, 2002.
6. Pandiyan M, Subbulakshmi B, Ganeshram S, Kumar M, Ramanathan SP, Jebaraj S. Bruchid resistance in Vigna species, International Journal of Mendel, 2006; 23(3-4):101-102.
7. Tomooka N, Pandiyan M, Senthil N. Conservation of leguminous crops and their wild relatives in Tamil Nadu. Annu, Rep. Explor. Introduction to Plant Gentic Resour. 2000; 27:111-127.
8. Sadapal MN. Agronomy of pulses. In Pulse Crops (Grain Legumes). Eds Baldev B, Ramanujam S, Jain HK.; Oxford & IBH Publishing Co., Pvt Ltd., 1988, 456-512.