HOST PLANT RESISTANCE TO INSECT PESTS OF GRAIN LEGUMES - A REVIEW

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ABSTRACT

Grain legumes are important source of dietary protein in tropical region and insect pests cause considerable damage to these crops. Development of resistant varieties in legume crops is an important component in integrated pest management strategies. Though insecticides are effective against sucking pests and pod borer complex, development of insecticide resistance, residues in short duration crops produces and environment hazards demand alternative eco safe method of management. The chapter reviews the development and studies on host plant resistance in major grain legumes against pod borer complex 

Maruca vitrata, Helicoverpa armigera, etc. and major sucking pests. The mechanisms of resistance, factors responsible for the resistance are discussed in this paper.

Key words: Antibiosis, Antixenosis, Host plant resistance, Pod borer complex, Screening, Sucking pests.

Grain legumes have rich source of protein and are damaged by a number of insects, both in field and storage. Amongst many insect pests damaging pulse crops, legume pod borer Maruca vitrata (Geyer), gram pod borer, Helicoverpa armigera (Hubner), aphids (Aphis craccivora Koch, whitefly Bemisia tabaci Genn., tobacco caterpillar Spodoptera spp., leaf hopper Empoasca spp. and thrips, Megaleurothrips distalis Karny and Caliothrips indicus Bag. cause extensive damage to grain legumes under field conditions while bruchids Callobruchus spp. damage the grain in storage. On an average 2-2.1 million tone of pulses with a monetary value of nearly Rs.6,000 crore are lost annually due to ravages of insect pest complex (Reddy, 2009).

The data on primary yield loss due to sucking pests in urdbean and mungbean is though scarce, the sucking pests which act as vector of major diseases viz., yellow mosaic virus (YMV) and leaf crinkle and more studies were made on disease-vector and yield loss. The whitefly which acts as major vector of YMV causes 30-70 per cent yield loss (Marimuthu et al., 1981). The seed yield and avoidable loss in mungbean was estimated by Nitharwal et al. (2009) and results showed that the treated plots had increased yield of 112.03 per cent over non treated plots and avoidable loss is 52.95 per cent due to sucking pests only. Saxena (1983) reported that urdbean yielded 874 kg/ha when protected against pest complex in comparison to only 259 kg/ha without protection. Avoidable losses due to pod borer complex have been estimated to 27 per cent in urdbean, 48 per cent in mungbean and 41 per cent in cowpea (Hameed and Durbey, 1983). In the untreated blackgram plots the cumulative pod damage caused by different borers Maruca vitrata, Helicoverpa armigera, Lampides boeticus and pod bugs were 27.15 per cent during 2008 and 34.33 per cent during 2009 (Soundararajan and Chitra, 2011).

Status of host plant resistance studies in major legume crops: Elaborative studies on host plant resistance to insect pest in pulse crops are restricted to few important pulse crops only viz., pigeonpea, cowpea, chickpea and soybean only. A few attempts have been made in mungbean and urdbean. Resistance breeding programmes are in progress for only a few pests because of the difficulties involved in screening and selection of the test material under
uniform insect infestation across seasons and locations. In addition, it is difficult to rear and multiply some of the insect pests on artificial diets to ensure screening and selection of the test material under optimum levels of insect infestation. Because of the ease with which insects can be controlled with help of insecticides, there has been an insufficient focus on developing cultivars with resistance to insect pests. However, with the development of insect resistance to insecticides, insecticide residues in food products, adverse effects on natural enemies and other non target organisms and environmental hazards of pesticides use, there has been a renewed emphasis on the development of alternative approaches to pest control. Host plant resistance can play a pivotal role in pest management in grain legumes and resistance to insect pests should be one of the major criteria in the development and release of new crop cultivars, in order to ensure prolonged cultivar life and cost effective production (Sharma and Crouch, 2004). Varieties with resistance to the target insect pests have been developed and released for pigeonpea, cowpea, soyabean and field pea. However, the cultivars found with less damage or incidence was reported in various co-ordinated programmes on cowpea, mungbean and urdbean (Table 1). The level of resistance in most of the varieties released for cultivation were low to moderate while high levels of resistance have been reported in the wild relatives of several crops (Sharma et al., 2003). Resistance from the wild relative needs to be transferred into high yielding varieties with acceptable agronomic backgrounds.

**Host plant resistance to pod borers of tropical legume crops:** The pod borer complex damaging urdbean, mungbean and cowpea *viz.*, legume pod borer *M. vitrata*, gram pod borer, *H. armigera* and pod bugs (*Riptortus* spp.). The incidence of blue butterfly, *Lamedes boeticus*, also noticed in some region in India. Recently, the pink pod borer, *Cydia ptychora* (Meyrick) on urdbean was also noticed in some of the regions in Gujarat (Dawoodi et al., 2009)

| Table 1: List of promising cultivars reported as less susceptible to various pest species under All India Co-ordinated Pulses Improvement Project (Lal, 1990). |
|-----------------|-----------------|-----------------|-----------------|
| **Crop**       | **Location**    | **Pest species**| **Cultivars found promising** |
| Mungbean       | Durgapura       | Pod borer       | J1, LM 11, P 526, P336, S 9, ML 4, ML 6, B1, Jawahar 45, ML 24, ML 73, Mi 12, Mi 69, PIMS 3, PIMS 4, Gujarat 1, R 12-16-3 |
|                 | Badnapur        | Galeruidd beetle| S 9, ML 4, ML 6, B1, Jawahar 45, ML 24, ML 73, Mi 12, Mi 69, PIMS 3, PIMS 4, Gujarat 1, R 12-16-3 |
|                 | Kanpur          | Galeruidd beetle| Jawahar 45, 122 S 8, T44, ML 8, ML 5 |
|                 | Coimbatore      | Thrips, stemfly, Pod borer | Co 3 |
| Urdbean         | Badnapur        | Galeruidd beetle | Pusa 1, KG 3, Krishna, T 9, T 27 |
|                 |                 | Pod borer       | S 9, ML 4, ML 6, B1, Jawahar 45, ML 24, ML 73, Mi 12, Mi 69, PIMS 3, PIMS 4, Gujarat 1, R 12-16-3 |
|                 | Kanpur          | Galeruidd beetle | Jawahar 45, 122 S 8, T44, ML 8, ML 5 |
|                 | Coimbatore      | Thrips, stemfly, Pod borer | Co 3, Co 4, Co 5 |
|                 |                 | Stemfly         | Karaikal, Killikulum, 338/3, P 58 No.55 |
| Cowpea          | Durgapura       | Pod borer       | Banswara, G 20, C 55, CR 2-55, P 1461 |
|                 | Badnapur        | Jassid          | JG 10-72, NS 19-4-1, 3-779 |
|                 | Kanpur          | Galeruidd beetle | P 1473, P 1476 |
|                 | Coimbatore      | Aphid           | 5269 |
|                 |                 | G 7             | MS 9369 |
Among ten varieties screened for resistance to pink pod borer, SKNU-03-03 was found least susceptible as it recorded minimum larval population (0.42 larva/plant), minimum damage to pods (1.98%) and grains (1.97%) (Dawoodi et al., 2010). Twenty four entries were screened for their resistance to pod borers, tur plume moth and pod fly and found that pod damage by the lepidopteran borers ranged from 7.35 to 28.71 per cent with the mean pod damage of 11.72 per cent (Chavan et al., 2009). The lowest incidence was recorded in the entry TT 401. All the entries were found to be significantly less susceptible than check UPAS 120. The entry ASJ 106, TT 401, HDM 04-1, PWA 2006-2, PA 322 and Vipula were found to be tolerant against pod borers. However, the studies on host plant resistance are restricted to *M. vitrata* and *H. armigera* in case of cowpea, mungbean and urdbean. The pod borer complex damage was low in some of the mungbean entries screened during rabi 2008-09. The pod damage was low (1.5 %) in CGG 08-007 and CGG 08-028 with Pest Score Index (PSI) of 1. In the susceptible check ML 5 the damage was 9.7 per cent. In urdbean minimum damage (1.0%) was recorded in CBG 08-011 and PLU 54 with PSI 1 (Soundararajan et al., 2010).

The three mechanisms: antixenosis, antibiosis and tolerance contribute resistance to few insect pests of pulse crops. Several physio-chemical characteristics contribute to insect resistance in grain legumes (Clement et al., 1994). Presence of dense covering of hairs or trichomes on the leaves/pods confers resistance to many insect species. Allomones such as arcelins, L-canavanine, polyhydroxy alkaloids and saponins have been reported to confer resistance to insect pests in grain legumes (Dilawari and Dhaliwal, 1993).

I. Host plant resistance studies on legume pod borer, *M. vitrata*: The legume pod borer, *M. vitrata* is one of major pests of grain legumes in the tropics and sub-tropics because of its extensive host range, destructiveness and distribution. *M. vitrata* larvae feed on flowers, buds and pods by webbing them. This typical feeding habit protects the larvae from natural enemies and other adverse factors, including insecticides. Moths prefer to oviposit at the flower bud stage. Larvae move from one flower to another and each may consume 4-6 flowers before larval development is completed. Third-to fifth instar larvae are capable of boring into the pods and occasionally into peduncle and stems (Taylor, 1967). Losses in grain yield have been estimated to range from 20 to 60 per cent (Singh and Allen, 1980). In Bangladesh, pod borer damage in cowpea was 54.4 per cent during harvest but yield loss was estimated to be < 20 per cent (Ohno and Alam, 1989). Dreyer et al. (1994) observed low seed damage despite heavy flower infestation. Seasonal variation in yield losses was shown in Nigeria, where cowpea yield loss was 72 per cent in 1985 and 48 per cent in 1986. A threshold of 40 per cent larval infestation in flowers has been established (Ogunwolu, 1990). The incidence of *M. vitrata* commenced from August 2nd week and remained up to October first week. The peak population of 3.84 larvae/plant was observed in Junagadh region of India (Sonune et al., 2010).

(A) Screening for resistance

Field screening: The resistance screening programme for pod borers can be carried out during March-April and August-September when pod borer intensity is usually high. Planting infester rows 2 weeks earlier than the test cultivars and uprooting the infester rows running parallel to the test material after 6 weeks (Jackai, 1982), spraying experimental plots at the flower bud stage to suppress thrips and hemipterans and keeping the greenhouse or the field plots moist (Singh and Jackai, 1988) helps to improve the efficiency of screening for resistance to the pod borer. An infestation level of two larvae per plant was enough to detect differences in flower and pod damage and grain yield between infested and uninfested plants (Echendu and Akingbohungbe, 1989). Flower, pod and seed damage (Jackai, 1982; Valdez, 1989), larval population in flowers and ratio of grain yield under protected and unprotected condition (Wooley and Evans, 1979), and pod evaluation index (ratio of pod load to pod damage) (Oghiakhe et al., 1992a) have all been suggested as criteria to select for resistance to legume pod borer.

Laboratory techniques: Field screening has several disadvantages and often difficult due to low or unknown levels of insect infestation. Artificial infestation of the test plants under field/greenhouse conditions can be used to overcome this problem. Expression of cowpea resistance to *Maruca* is affected by plant stages (Dabrowski et al., 1983).
Plants with five to seven shoots are most suitable for resistance screening prior to flowering. Using five eggs per plant at this stage, it was possible to differentiate between the resistant and susceptible lines, but 10 eggs per plant is optimum. Echendu and Akinbohungbe (1989) using free and no choice techniques, confirmed the results obtained under field conditions. Jackai (1991) used a dual choice arena test (DCAT) for 72 h and calculated the relative resistance of cowpea test line compared with either the susceptible or resistant check using a feeding index. In the second assay a no choice test was conducted in a screen house for 2 weeks. Using this test, conclusive information on seed damage could be obtained after 72 h feeding exposure. In this test, TVNu 72 showed resistance similar to that determined by the DCAT. The two assays are complementary and provide useful information on antixenosis and antibiosis components of resistance in cowpea.

A large number of accessions belonging to selected wild Vigna species namely V. unguiculata subspecies dekindtiana, V. oblongifolia and V. vexillata were evaluated using choice (DCAT) and non choice (NCFT) laboratory feeding bioassays to determine their resistance to the legume pod borer. The most resistant accessions belonging to V. vexillata followed by V. oblongifolia with a few outstanding exceptions from V. unguiculata. More eggs were laid on the abaxial surface than on the adaxial surfaces of leaves for all tests conducted, except for the TVNu 72 in no choice test. Significant negative correlation was found between mean number of eggs and length and density of non glandular trichomes. There was a significant negative correlation between larval velocity and length of non glandular trichomes on pod surface (Jackai et al., 1996).

(B) Mechanisms of resistance: In cowpea several genotypes showing moderate to high levels of resistance to Maruca damage have been identified. TVNu 946 showing high levels of resistance across seasons and locations (Jackai, 1981). Oghiakhe and Odulaja (1993) used principal components analysis to study the variation patterns in 18 cowpea cultivars developed for resistance to M. vitrata based on seven developmental parameters of the pest on floral buds, flower and sliced pods. Percentage puation, adult emergence and growth index were important for the grouping of the cultivars. Growth index had the highest factor score. Using cluster analysis, Oghiakhe and Odulaja (1993) found that MR x 6-84F has wider adaptability in the presence of Maruca infestation. TVNu 946 performed best, and was in a single cluster. Mokwa, MR x 2-84F, MR x 5-84F, MR x 6-84F, MR x 54-84F, MR x 8-84F, MR x 49-84F and MR x 50-84F were grouped together. Expression of resistance to the pod borer was influenced by variety and environment (Suh and Simbi, 1983) and intercropping (Gethi et al., 1993). Accessions belonging to Vigna vexillata (TVNu 72 and TVNu 73) wild relatives of cowpea have shown high levels of resistance to M. vitrata (Jackai and Oghiakhe, 1989).

Antixenosis: The female moths prefer oviposition on cowpea and pigeonpea plants 4 days after mating. Cowpea cultivar TVNu 946 exhibits non preference for oviposition compared to Ife Brown and VITA 1 cultivars (Macfoy et al., 1983). In contrast to this, Valdez (1989) indicated that there is no oviposition antixenosis in cowpea to the pod borer. Non preference to M. testualis larval feeding has been reported in cowpea (Echendu and Akinbohungbe, 1989). Attraction and arrest-stay of first instar larvae contribute to the resistance in TVNu 946 and VITA 5 varieties of cowpea to the pod borer (Okech and Saxena, 1990). Free choice arena test conducted in urdbean varieties revealed that highest larval orientation of M. vitrata was observed in LBG 17 (susceptible) both in pods (19%) and flowers (14%) than the tolerant cultivar LBG 611 (Jayadeep and Srinivasan, 2007). Trichome density and length were found associated with resistance in short duration pigeonpea genotypes. Trichome density on upper and lower surfaces of the leaf (390 and 452/9 mm²) and length (3.5 mm), and trichome density (442.9 mm²) and length (5.9 mm) on pods were found positively correlated with the resistant genotype ICPL 98003 (Sunitha et al., 2008).

Antibiosis: The larval survival was low on TVNu 946 and it was due to the nutritional and antibiotic factors (Macfoy et al., 1983). Valdez (1989) observed only a slight effect of the host on larval survival. The M. vitrata larvae reared successfully on floral buds, flowers and sliced pods but not on stems, terminal shoots and intact pods. Sliced pods were most
suitable for growth and development followed by flowers and flower buds (Oghiakhe et al., 1993). Okech and Saxena (1990) indicated that antibiosis was a component of resistance in TVNu 946 and VITA 5 stems and pods. Highest larval weight gain was recorded on TVu 3 and least in CES 15-27. Consumption index was higher on TVu 1248 and TVu 1 compared to CES 15-27, TVu 161-2, TVu 461, TVu 946, TVu 1016-1 and TVu 1499-1.

On pigeonpea, the third instar larvae consumed 27.0 to 47.2 mg food on the flowers and had growth rates of 114.7 (ICPL 88020) to 207.3 per cent (ICPL 85010). Approximate digestibility was lower on ICPL 85010 than on ICPL 90011. Efficiency of conversion (ECI) of ingested food into body matter was lower on ICPL 90011 compared to ICPL 85010 and ICPL 88007. The fifth-instar larvae consumed 52.3 to 80.6 mg of food on pods and showed growth rates of 30.1 to 41.8 per cent (Sharma, 1998). Pigeonpea ICPL 88034 and MPG 679 showing low *Maruca* damage (10-25%) (Saxena et al., 1996). Sugars, phenols and proteins were associated with resistant in pigeonpea. High sugar content in flower (22%) and pods (10.6%) was responsible for the susceptibility of ICPL 88034, while high phenol concentration in flowers (6.5%) and pods (9.3%) in ICPL 98003 was responsible for resistance. Protein content in pods was significantly higher (25.5%) in susceptible ICPL 88034 when compared with resistant ICPL 98003 (16.5%) (Sunitha et al., 2008).

**C) Factors associated with resistance**

**Morphological parameters:** The length of the peduncle and angle of pods have significant contribution for resistance towards *M. vitrata* in cowpea. The resistance of cowpea varieties TVu 946 and TVu 4557 is due to long peduncles, pods held over the plant canopy and at a wider angle than the normal (Singh, 1978). The pod damage and larval infestation by *M. vitrata* in flowers of cowpea were positively correlated with RH and negatively with temperature (Oghiakhe et al., 1991). Cowpea genotypes with bunched pods suffer greater damage by legume pod borer (Usua and Singh, 1979). Oghiakhe et al. (1992b) observed negative relationship of pod angle with pod and seed damage index in two cowpea cultivars. Pods with wide angles (>89°) were damaged on one side and rarely on both sides by *M. vitrata* larvae. Erect and profuse flowering contributed to the resistance of TVu 946 to *M. vitrata* (Oghiakhe et al., 1992c). Open canopy, long peduncles, erect pods with wide angle, profuse flowering, pod size and rate of pod growth can be used to select for resistance to *M. vitrata*. Pubescence in wild and cultivated cowpea *Vigna vexillata* and *V. unguiculata* adversely affected oviposition, mobility, food consumption and utilization by the legume pod borer in tests conducted with TVNu 729 wild, highly resistant and highly pubescent), TVNu 946 (semi wild, moderately resistant and pubescent) and IT 82D-716 (cultivated, highly susceptible and pubescent) (Oghiakhe, 1995).

Determinate lines with clustered inflorescence of pigeonpea cultivars were more susceptible than the indeterminate types (Saxena et al., 1996). Fifty six per cent of indeterminate lines had <50 per cent damage in contrast to 15 per cent of the determinate lines (Lateef and Reed, 1981).

**Correlation studies of Dolichus bean against pod borer complex including *M. vitrata* revealed that foliar colour, days to 50 per cent flowering, flower colour, pod colour, pod texture and fragrance have shown significant relationship with larval boring. When the above characters subjected to stepwise regression analysis only pod texture and fragrance showed significant relationship with larval boring (Mallikarjuna et al., 2009).**

**Biochemical factors:** The biochemical components sugars, proteins and phenols had significant influence on biology of the *M. vitrata* larvae. Sugar content in the pod wall of TVNu 72 is greater than in IT 82D-716 and phenol content is lower in the pod wall of TVNu 752 in cowpea, but the reverse is true for fresh and dry seeds (Oghiakhe et al., 1993). Neither sugars nor phenols seem to be involved in the resistance of TVNu 72 to *M. vitrata*. Phenol concentration varies significantly between different plant parts and generally decreases with an increase in plant age. Otieno et al (1985) indicated that ethyl-acetate soluble fraction of methanol extracts of stems of TVNu 946 showed greater feeding inhibition than the extract from ICG 1.

The biochemical basis for resistance to *M. vitrata* in urdbean was estimated by Jayadeep and Srinivasan (2007) and results revealed that phenols were highest (21.72 mg/g) in resistant cultivar LBG
The effects of some fractions of the n-hexane extract of green pods were analysed in three Vigna species namely V. vexillata, V. oblongifolia and V. unguiculata on the growth, development and fecundity of M. vitrata. The fractions when incorporated in the artificial diet, the phenolic and basic fractions had no significant effect on larval growth and development. However, the neutral fraction from the three Vigna species showed antibiosis by significantly reducing larval weight, percentage pupation and adult emergence. There was no pupation on diet with V. vexillata neutral reaction (Ojiangbe et al., 2006).

II. Mechanisms of resistance to gram pod borer, H. armigera: Several morphological and phenological traits such as pod shape, pod wall and thickness, foliage colour and crop duration seems to influence the H. armigera on crops like chickpea and mungbean (Ujagir and Khare, 1988). There is a large variation in larval survival, larval and pupal weight, egg viability, adult longevity and growth index of H. armigera (Srivastava and Srivastava, 1990). Larval weight contributed maximum to the variation, followed by larval period, pupal weight and pupal period.

Factors contributing resistance to H. armigera
The components viz., high crude fibre and non reducing sugars with low percentage of starch have also been found to be associated with resistance to H. armigera in GL 645 of cowpea. High percentage of cellulose, hemi celluloses and lignin in the pod wall inhibits pod damage by H. armigera (Chhabra et al., 1990). Low acidity in the leaf extracts is associated with susceptibility to H. armigera (Srivastava and Srivastava, 1989; Bhagwat et al., 1995). However, resistance expressed by PDE 2-3, PDE 7-3 and ICC 506 of chickpea have been attributed to factors other than acidity while that of PDE 7-2 is due to high acidity (Patnaik and Senapati, 1995). Chickpea exudates have malate and oxalate as the main components and there are characteristic differences depending on the variety, diurnal cycles and growth stage. Varieties with highest amount of malic acid had the highest resistance to H. armigera (Rembold, 1981; Rembold et al., 1990). Malic acid acts as deterrents to the H. armigera larva and pod borer resistant lines have more amount of malic acid than the susceptible lines (Bhagwat et al., 1995). Oxalic acid inhibits the growth of H. armigera larvae when incorporated in artificial diet, while malic acid shows no growth inhibition (Yoshida et al., 1995). The chickpea flavonoids judicin 7-O-glucoside, 2 methoxy judaicin, judaicin and maakain have shown antifeedant activity towards the larvae of H.armigera (Simmonds and Stevenson, 2001). There is considerable variation in H.armigera gut protease inhibitory activity in developing seeds of chickpea (Pantankar et al., 1999) and that proteinase inhibitor from the non-host plants are more efficient in inhibiting the gut proteinase of H. armigera larvae than those from its favoured host plant chickpea, pigeonpea and cotton (Harsulkar et al., 1999). In chickpea, accessions belonging to Cicer bijugum, C. judaicum, C. cuneatum and C. microphyllum have also been identified with high levels of resistance of H. armigera (Sharma et al., 2002b).

In pigeonpea, wild relatives of Cajanus cajan have better resistance than the cultivated species. Larval and pupal weight and developmental period are all adversely when fed on the flowers of wild species such as C. cajanifolius, C. reticulatus and C. sericeus (Dodia et al., 1996). The wild relatives C. scarabaeoides, C. sericeus, C. acutifolius and Rhynchosia aurea have shown high levels of resistance to H.armigera under field conditions (Sharma et al., 2001). Resistance of C. scarabaeoides to H.armigera has been attributed to high density of non-glandular trichomes on pods (Romeis et al., 1999). There is positive correlation between pod length and basal girth of stem with pod borer damage (Nanda et al., 1996). Varieties with brown seeds and green pods having streaks have been reported to be least susceptible to pod borer damage (Tripathi and Purohit, 1983). Total soluble sugars in the pod wall have a significant and negative correlation with pod damage. Acetone extracts of C. cajan and C. platycarpus pods had a significant feeding stimulant effect on H. armigera larvae whereas extracts from C. scarabaeoides pod showed no such effects (Shanower et al., 1997), while water
extract from *C. cajan* and *C. platycarpus* pods had so such effect. Wild *Cajanus* species have been effectively exploited in developing cytoplasmic male sterility (CMS) systems. CMS systems have been developed from *C. scarabaeoides*, *C. cajanifolius*, *C. acutifolius* and *C. platycarpus*. These have helped in developing commercial hybrids in pigeonpea. Resistance to *H. armigera* has been introgressed from *C. acutifolius* and *C. scarabaeoides* (Gaur et al., 2009).

Quercetin, quercetin-3-methyl ether and quercetin play an important role in food selection behavior of *H. armigera* larvae in pigeonpea. Stilbene-a phytoalexin, occurs at high concentration in pigeonpea cultivars with resistance to *H. armigera* (Green et al., 2002a,b). Amylase and protease inhibitors in pigeonpea have been shown to have adverse effects on larval growth and development of *H. armigera* (Giri and Kochole, 1998).

**III. Host plant resistance studies on sucking pests and defoliators in legume crops:** The major sucking pests in the short duration legume crops viz., urdbean and mungbean are whitefly *Bemisia tabaci*, leaf hopper *Empoasca kerri*, aphid *Aphis craccivora* and flea beetle *Madurasia obscurella* (Soundararajan et al., 2009). The host plant resistance studies are very limited to the sucking pest. However, there was much importance given for the resistance studies on *B. tabaci* in relation to Mungbean Yellow Mosaic Virus (MYMV). Whitefly act as important vector for the dreaded viral disease and resistance breeding programme for MYMV is progressively attended by various developing countries. MYMV incidence is as high as 100 per cent in farmers fields is common in the Indian Subcontinent often resulting in considerable yield losses. Despite nearly 25 years of resistance breeding efforts and the release of tolerant lines, the disease still poses a major problem to economic production of this crop in the Indian subcontinent (Varma et al., 1992).

Among fifty seven mungbean genotypes screened for four years two genotypes were found promising against whitefly and MYMV (Kooner and Harpeet, 2006). The genotypes ML 1265 and ML 1229 were identified as resistant donors against *B. tabaci* and the virus against the standard checks ML 5, ML 267, ML 613 and SML 668 and are being used for breeding programme. Antibiosis mechanisms of resistance in some mungbean genotypes against whitefly and yellow mosaic virus disease was studied during rainy and summer seasons (Singh et al., 2009). The antibiosis mechanisms of resistance in three promising genotypes viz., ML 325, PDM 76, PDM 84-143 on the basis of life cycle of whitefly recording their population growth and duration, pupal and adult numbers and adult longevity in one generation was studied. The genotypes ML 325 and PDM 76 exhibited that whitefly took longer time to complete a life cycle and adult longevity were found lowest. These parameters remained reverse in case of Pusa Baisakhi and T 44. Similarly, the size of whitefly was also smallest in above three genotypes that remaining two susceptible genotypes. The genotypes PDM 84-143 proved to be intermediary but remained free from the infection of YMV incidence. Mungbean varieties, NM-92 and NM-98 showed significantly low mean whitefly population/leaf as compared to the other three tested varieties. Similar trend was also found among the varieties against jassids and thrips; however, the mean population/leaf of jassids and thrips in NM-98 and NM-121-125 were statistically similar. Yield production of NM-92 and NM-98 was significantly higher than the other tested varieties due to low infestation by sucking insect pests (Masood Khan Khattak et al., 2004). Naqvi et al. (1995) observed that none of the 10 mungbean varieties tested were immune to *B. tabaci* and yellow mosaic virus however M-8-20, M-20-21 and M-10-30 were comparatively more resistant than others and resulted in greater yield. Chhabra and Kooner (1993) found that after testing 39 accessions of mungbean that genotypes M-537 and M-370 had high degree of resistance and were designated as donors for use in breeding program. In field trials Chhabra and Kooner (1994) also found that out of 26 tested genotypes ML 395, ML 505 and ML 543 were resistant to the mungbean insect pests and the virus. Out of ten mungbean varieties, Pant U 30 was tolerant to whitefly and yellow mosaic disease (Sahoo and Hota, 1991).

Feeding preference or nutritional antibiosis is the major components of resistance in soybean to the beetle *Epilachna varivestris* (Kogan, 1982). A significant reduction in fecundity has also been
observed when the larva is reared on the resistant varieties. Pubescent varieties of soybean are highly resistant to *Empoasca fabae* Harris (Kogan, 1982). As a result of insect damage there is increased production of certain flavonoids in soybean (Sharma and Norris, 1991). Non preference for oviposition is one of the components in *H. zea* in PI 2227687 soybean (Horber, 1978). Trichomes on the pods *Vigna vaxillata* a wild relative of cowpea are partly responsible for resistance to *Clavigralla tomentosicollis* Stal. (Chiang and Singh, 1988). Durairaj et al. (2009) reported that most of the wild relatives are found susceptible to aphids and some sucking pests. Both antixenosis and antibiotic type of resistance has been observed against *E. fabae*, *E. varivestis* and *Bruchus pisorum* L. (Clement et al., 1994). Pea varieties deficient in certain amino acids are also resistant to the pea aphid *Acyrthosiphum pisum* (Harris). Both antixenosis and antibiotic types of resistance have been observed against *Callosobruchus chinensis* L. in chickpea and faba bean (Clement et al., 1994). In chickpea, accessions belonging to *Cicer bijugum*, *C. judaicum*, *C. cuneatum* and *C. microphyllum* have been identified as an important source of resistance to the leaf miner *Liriomyza ciceri* Rondani and bruchid *Callosobruchus chinensis* L. (Singh and Ocampo, 1997). The wild types of mungbean and urdbean *Vigna umbellata*, *V. sublobata*, *V. glaberescens* and *V. vexillata* had the pest spectrum of *A. craccivora*, red spider mite *Tetranychus urticae*, hoppers *Empoasca* and the pod bug *Riptartus*. However, the damage by *T. urticae* and *A. craccivora* was found to be severe (60 - 70%) and moderate (20 -30%), respectively (Durairaj et al., 2009).

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