The Asian Journal of Horticulture, **Vol. 3 No. 2 : 456-459 (December-2008)**

A Case Study :

Breeding for shoot and fruit borer resistance in brinjal

M. PRABHU, A. RAMESH KUMAR **AND** V. PONNUSWAMI

Accepted : ***November, 2008***

See end of the article for authors' affiliations

Correspondence to:

A. RAMESHKUMAR
Department of Horticulture, Horticultural College and Research Institute, Tamil Nadu Agricultural University, COIMBATORE (T.N.) INDIA

Key words : Brinjal, Shoot borer, Fruit borer

Brinjal or eggplant (*Solanum melongena* L.) is native of India and is extensively grown in all South East Asian countries. It is highly productive and usually finds its place as poor man's vegetable. Several biotic and abiotic factors contribute to losses in production. Among the biotic stress factors that hamper the production of brinjal, the shoot and fruit borer (*Leucinodes orbonalis* Guen.) is the most serious one, which occurs throughout the year at all the stages of crop growth. The loss caused by this deleterious pest was reported to be around 54 to 60 per cent (Krishnaiah, 1980). Chemical control of shoot and fruit borer may reduce the pest attack to a greater extent, but it causes adverse effects on environment and human health. Compared to the productivity of brinjal in other countries (300 t ha^{-1}), Indian level is very low (15.8 t ha^{-1}). The main reason for high yield in other countries is utilization of F_1 hybrids. The hybrid vigour will be the highest in the F_1 hybrids, which serve as a means to increase yield. Combining high yield and resistance to shoot and fruit borer would be a welcome feature. Before initiating any breeding programme, one must have enough information about the ways and means by which the resistance can be exploited.

Incidence of borer in brinjal genotypes:

The marketable yield is one of the important parameters a breeder should take into account while breeding for resistance to biotic and abiotic stresses. This decides the profit to the grower and in brinjal, marketable yield is highly influenced by fruit borer infestation. Lesser the fruit borer incidence better would be the marketable yield. Even if some types may have better yield potential, the marketable yield would come down, if the infestation of fruits by borer is more. At the same time, in certain types even if the total yield is higher, if the borer infestation per cent is lesser and then it will result in increased marketable yield. The genotype PBr 129-5 recorded the lowest borer (23.4 per cent) infestation (Sharma, 1994). Grewal and Singh (1995) reported that the fruit borer infestation was high (61.00 per cent) in Punjab Chamkila and low in SM 17-4 (26.98 per cent). The lowest fruit borer attack of 19.20 per cent was observed in 88006-2, while the highest value of 38.54 per cent was in White Egg Round (Nazir *et al*., 1995). Ghosh and Senapati (2001) evaluated six brinjal cultivars, of which PK 123 and Pant were found to be the least susceptible to the borer. Ananthalakshmi (2001) observed that among the lines, the borer incidence ranged from 35.70 per cent in APAU Bagmathi to 55.00 per cent in EP 65, while among the testers, it varied from 48.90 per cent in Surya to 56.55 per cent in Arka Nidhi. Asati *et al*. (2002) found that the borer infestation ranged from 20.11 to 51.96 per cent in different varieties. The average percentage of infestation for the total pickings ranged from 33.65 to 53.02 per cent among cultivars. Pusa Purple Round showed the lowest infestation of 33.65 per cent.APAU Bagmathi recorded the highest shoot borer infestation (12.57 per cent), while EP 65 had the lowest (7.50 per cent) in the parents. The varieties Arka Kusumakar and SM -10 showed less shoot damage (3.28 to 4.01 per cent), while the varieties Unnati, Daftari, Black Round and Pusa Purple Round had higher shoot damage (8.15 to 12.71 per cent). Varieties Arka Kusumakar, Pant Rituraj, Neelum Long, Pusa Kranti and Pusa Purple Long were less infested (18.33 to 35.47 per cent)

by fruit borer (Jat and Pareek, 2003).

Heterosis breeding for shoot and fruit borer resistance:

Heterosis values should be negative for getting fruit borer tolerant hybrids through heterosis breeding. As far as fruit borer infestation is concerned, the hybrids have to be evaluated ultimately by mean performance. The two parents with lesser incidence resulting in a hybrid with least incidence might be due to complementation of genes for bringing down the incidence of fruit borer. In EP 104 x APAU Bagmathi , the overdominance of APAU Bagmathi work here results in a hybrid with lesser infestation of fruit borer. The cross EP 12 x MDU 1 has the parents with comparatively higher fruit borer incidence, but the hybrid showing very low incidence. The hybrid EP 65 x Pusa Uttam recorded the highest yield of 2.47 kg, followed by EP 12 x MDU 1 (2.19 kg) and EP 104 x APAU Bagmathi (1.92 kg). The hybrids EP 65 x Pusa Uttam and EP 12 x MDU 1 were found to perform well with lower borer infestation and higher yield. The parents involved in these crosses could be considered worthy in varietal improvement programme. The three hybrids namely EP 65 x Pusa Uttam, EP 12 x MDU 1 and EP 104 x APAU Bagmathi exhibited higher mean performance for this trait. The hybrid EP 65 x MDU 1 recorded the least borer infestation of 5.46 per cent. The highest percentage (28.26) was observed in EP 113 and the lowest (17.77) in EP 65. The cross EP 65 x Pusa Uttam recorded the least (14.50) fruit borer infestation per cent and EP 113 x MDU 1 recorded the highest (43.36) among the hybrids.

Association of morphological characters with borer resistance :

The main aim of plant breeder is to achieve higher level of yield, which is a complex trait influenced by a number of component traits, which in turn are governed by definite sub components of these component characters. A negative association of yield with shoot and fruit borer infestation and earliness was observed. Early and higher level of infestation by shoot borer would have made a setback on new growth and prevented the production of new shoots and thereby discouraged the availability of photoassimilates for economic part. The plant height showed negative significant association with earliness, shoot and fruit borer infestation. It indicated that early flowering and fruiting would have inhibited the vegetative growth thus reducing plant height. Similarly shoot borer infestation would have affected the photosynthesis and reduced the photosynthates resulting in reduced plant height. When the fruit borer infestation was more, the plant growth promoting substances would have been converted into defensive substances against fruit borer infestation. This could be attributed to reduction in plant height at the time of severe fruit borer infestation. In brinjal, lesser calyx length was found to be directly related to tolerance to fruit borer. Based on mean performance, the parents EP 104, Surya and EP 65 were regarded as better genotypes for this trait. (Preneetha ,2002).Further infestation by fruit borer would have made a drastic reduction in marketable yield. Negative association of yield with shoot and fruit borer infestation was also reported by Dhankar and Singh (1978), Preneetha (2002) and Thangamani (2003). Choudhary and Kashyap (1993) recorded negative correlation on days taken for shoot infestation in 50 per cent plant with fruit infestation. The shoot borer infestation showed positive association with fruit borer infestation. The results of above studies suggested that yield per plant could be improved by selecting genotypes with higher values for plant height, branches per plant, mean fruit weight, fruit number per plant, length and girth of fruit at vegetable maturity and low shoot and fruit borer infestation and late bearing habit. This would help in improving resistance to borer infestation without compromising marketable yield in brinjal hybrids and their parents.

Biochemical basis of resistance :

The biochemical defense mechanism would certainly be helpful in selection of plants as source of resistance. Many biochemical factors are known to be associated with insect resistance in crop plants. The scientific results clearly showed that the presence of biochemical constituents acted as stimulants of resistance mechanism towards shoot and fruit borer. It is obvious in many cases that the biochemical factors are more important than morphological and physiological factors in conferring non-preference and antibiosis.

Some biochemical constituents may act as feeding stimuli for insects. Occurrence at lower concentration or total absence of such biochemicals leads to insect resistance (Singh, 1983). The development of insects is altered due to the synthesis of chemicals such as plant lectins, a-amylase inhibitor, proteinase inhibitor, chitinase and peroxidase in the plant (Singh *et al*., 2000).The total phenol content indicates the resistance mechanism of the plant to pests such as shoot and fruit borer. The biochemical constituents like glycoalkaloid (solasodine), phenols, phenolic oxidase enzymes *viz.*, polyphenol oxidase and peroxidase are available in brinjal and these biochemical constituents possess insect resistant properties (Kalloo, 1988b).

Biochemical basis of borer resistance in wild species and interspecific hybrids :

The indigenous *S. indicum*. has been recognized as the most potential species since the solasodine content in the berries is comparable to *S. viarum* (Ammal and Vishwannathan, 1974). Maiti *et al*. (1964) were the first to report the presence of solasodine (5.40 per cent) in berries of *S. khasianum*. Khanna and Murthy (1974) screened the *S. viarum* population and found that the solasodine content ranged from 0 to 4 per cent. The range of 0.90 to 2.20 per cent of solasodine in *S. viarum* plants was recorded by Singh *et al*. (1978a). Nandhakumar (1983) recorded the highest content of 2.00 per cent solasodine in *S. incanum* and 2.70 per cent in *S. viarum*. Devarajaiah (1992) however reported that the phenol content was the highest in shoot and fruit of wild relative of brinjal *viz., Solanum macrocarpon*, which exhibited resistance to shoot and fruit borer. Soundararajan and Baskaran (2001) reported that the solanine content was more in the wild accessions, which harbours less insect population. Paturde *et al*. (2002) reported that *S. viarum* "Arka Mahima" contained high amount of solasodine (2.78 per cent). In the interspecific crosses, high peroxidase activity was observed in the shoot and fruit of screened and selected F_6 plant (EP 65 x *S.viarum*). The polyphenol oxidase activity was high in shoot as well in fruit of the same plant in F_6 (EP 65 x *S.viarum*). The total phenol content was high in the shoot (240.15 mg $100g^{-1}$) and fruit (225.14 mg $100g^{-1}$) of selected and screened F_5 plant (EP 65 x *S.viarum*). The highest solasodine (0.065 per cent) was estimated in the fruits of selected and screened plant of BC_3F_1 (EP 65 x *S.viarum*). The susceptible check (CO 2) registered the lowest value for all the biochemical constituents. The highest total phenol content was observed in the screened out F_3 plants which recorded the lowest per cent of shoot and fruit borer infestation in EP 65 x *S. viarum.*

The study on biochemical basis of resistance to shoot and fruit borer showed that among the parents of intervarietal crosses, EP 65 had the highest level of peroxidase, polyphenol oxidase and total phenol content in both shoot and fruit and it also recorded high content of solasodine next to APAU Bagmathi. Among the hybrids, the cross EP 65 x Pusa Uttam had the highest level of peroxidase and polyphenol oxidase activity in both shoot and fruit and high level of total phenols and solasodine content next to EP 104 x APAU Bagmathi. The study revealed that the genotypes with high or moderate level of these biochemical constituents suffered less for shoot and fruit borer infestation. These results indicated that all these biochemical constituents are responsible for conferring resistance to shoot and fruit borer in brinjal (Kosuge, 1969; Preneetha, 2002). The susceptible nature of CO 2 might be due to the low level of the biochemical constituents which may be insufficient to confer resistance to borer attack in shoot and fruit.

For polyphenol oxidase (PPO), the intervarietal hybrids and the variety CO 2 showed single and strong band induction (Plate 10). The PPO-1 was strong in F_6 and BC_3F_3 progenies of interspecific crosses and the CO 2. These results indicated that there is not much difference between the edible genotypes of brinjal. As such obtaining complete borer resistance would be difficult and development of tolerant genotypes could be thought of as was also suggested by Preneetha (2002).

It is, therefore, suggested that while selecting genotypes for shoot and fruit borer resistance, apart from their performance based on *per se*, heterosis and association of morphological characters, due consideration may also be given on the quantity of biochemical constituents and isozyme banding pattern. These results are in conformity with the findings of Panda and Das (1975) for presence of chemical constituents in brinjal and Raju *et al*. (1987) for high total phenol content Jat and Pareek (2003) reported that the biochemical characters such as total sugars, free amino acids and crude protein were positively correlated with fruit borer infestation, while total phenols had negative correlation. Preneetha (2002) studied the biochemical basis of borer resistance and reported that the variety EP 65 had the highest level of peroxidase, polyphenol oxidase and total phenol contents in both shoot and fruit. The cross EP 65 x Pusa Uttam registered the highest level of peroxidase and polyphenol oxidase, while the cross EP 104 x APAU Bagmathi had more of total phenol content.

Cooking quality :

The assessment of cooking quality revealed that the hybrid EP 65 x Pusa Uttam ranked first and obtained high scores for colour and appearance, texture and overall acceptability for poriyal (an edible preparation). This was followed by the hybrid EP 12 x MDU 1. It ranked first for flavour both in *bajji* and *poriyal* and also for taste in *poriyal*. The next best scorer was EP 104 x APAU Bagmathi. The preparations made from the check variety CO 2 got the lowest score for all the characteristics except overall acceptability for poriyal, where it ranked third. The results indicated that these hybrids do not have negative quality such as bitter taste as compared to the standard variety CO 2. This is an added advantage for these hybrids. Similar findings were reported by Preneetha (2002)

Authors' affiliations:
M. PRABHU AND V. PONNUSWAMI, Department of Horticulrure, Horticultural College and Research Institute, Tamil Nadu Agricultural University, COIMBATORE (T.N.) INDIA

REFERENCES

Ammal, J.E.K. and Vishwanathan, T.V. (1974). A high alkaloid containing race of *Solanum incanum* L. collected from the Paniyas of Kerala. *Curr. Sci.,* **43** : 378.

Ananthalakshmi, A. (2001). Genetic studies of yield and quality parameters in eggplant (*Solanum melongena* L.). M.Sc. (Hort.) Thesis, Tamil Nadu Agricultural University, Coimbatore.

Asati, B.S., Sarnaik, D.A., Thakur, B.S. and Guhey, A. (2002). Shoot and fruit borer incidence as influenced by total phenol and total chlorophyll content in round fruited varieties. *Orissa J. Hort.,* **30** (2) : 100-104.

Choudhary, O.P. and Kashyap, R.K. (1993). Influence of some plant growth indices on fruit infestation by *Leucinodes orbonalis* Guen in *Solanum melongena. J. Insect Sci.,* **6** (1) : 139-141.

Devarajaiah (1992). Studies on shoot and fruit borer (*Leucinodes orbonalis* Guen.). resistance in brinjal. M.Sc Thesis, University of Agricultural Sciences, Bangalore.

Dhankar, B.S. and Singh, K. (1978). Correlation and path coefficient analysis for relative susceptibility to shoot and fruit borer (*Leucinodes orbonalis* G). in eggplant. *Haryana J. Hort. Sci.,* **7** (1-2) : 53-57.

Ghosh, S.K. and Senapati, S.K. (2001). Evaluation of brinjal varieties commonly grown in terai region of West Bengal against pest complex. *Crop Res.,* **21** (2) : 157-163.

Grewal, R.S. and Singh, D. (1995). Fruit characters of brinjal in relation to the infestation by *Leucinodes orbonalis* Guen. *Indian J. Ent.,* **57** (4) : 336-343.

Jat, K.L. and Pareek, B.L. (2003). Biophysical and biochemical factors of resistance in brinjal against *Leucinodes orbonalis. Indian J. Ent.,* **65** (2) : 252-258.

Kalloo, G. (1988b). Biochemical basis of insect resistance in vegetables. In: *Vegetable Breeding*. Vol. II. C.R.C. Press. Inc. Boca Raton, Florida. pp 125.

Khanna, K.R. and Murthy, A.S. (1974). Inheritance of solasodine in *Solanum khasianum* Clarke. *Indian J. Genet. Plant Breed.,* **34** : 1200-1203.

Kosuge, T. (1969). The role of phenolics in host response to infection. *Ann. Rev. Phytopath.,* **7** : 195-222.

Krishnaiah, K. (1980). Assessment of crop losses due to pests and diseases (Ed. H.C. Govindu). *U.A.S. Tech. Series,* **33** : 259-267.

Maiti, P.C., Mookerjee, S., Mathew, R. and Henry, A.N. (1964). A rich source of solasodine from *Solanum khasianum* Clarke var. Chatterjeanum Sen Gupta. *Curr. Sci.,* **33** : 730.

Nandhakumar, D. (1983). Intervarietal hybridization in steroid bearing *Solanum viarum* and *S. incanum* and induction of autotetraploidy in *S. viarum*, Ph.D. Thesis. University of Agricultural Sciences, Bangalore.

Nazir, M., Chaudhary, A., Iqbal, M.E. and Sadiqch, M. (1995). Screening of germplasm against insect pests of brinjal crop. *Capsicum Eggplant News Letter,* **14** : 85-86.

Panda, N. and Das, R.C. (1975). Antibiosis factor of resistance in brinjal varieties to shoot and fruit borer *Leucinodes orbonalis* Guen. *South Indian Hort.,* **23** (1/2) : 43-48.

Paturde, J.T., Wankhade, S.T., Khode, P.P. and Khan, A.H. (2002). Performance of Arka Mahima (Tetraploid) against Arka Sanjeevini (Diploid) varieties of wild brinjal (*Solanum viarum* D) under different plant spacings and fertility levels. *Agric. Sci. Digest,* **22** (1) : 67-68.

Preneetha, S. (2002). Breeding for shoot and fruit borer (*Leucinodes orbonalis* G.) resistance in brinjal (*Solanum melongena* L.). Ph.D. (Hort.) Thesis, Tamil Nadu Agricultural University, Coimbatore.

Raju, B., Reddy, G.P.V., Murthy, M.M.K. and Prasad, V.D. (1987). Biochemical factors in varietal resistance of eggplant for the spotted leaf beetle and shoot and fruit borer. *Indian J. Agric. Sci.,* **57** (3) : 142-146.

Sharma, S.S. (1994). Field reaction of promising brinjal cultivars against jassid and shoot and fruit borer. *Haryana J. Hort. Sci.,* **23** (4) : 338-340.

Singh, B., Khanna, K.R. and Murty, A.S. (1978a). A note on genetic variability for glyco alkaloids in *Solanum khasianum* Clarke. *Indian J. Hort.,* **35** : 145.

Singh, B.D. (1983). Breeding for resistance to biotic stresses II. Insect resistance In : *Plant breeding principles and methods*. pp 494

Singh, M., Chakraborty, S., Kumar, S. and Kalloo, G. (2000). Genetic engineering for insect resistance in vegetable crops. *Veg. Sci.,* **27** (2) : 105-116.

Soundararajan, R.P. and Baskaran, P. (2001). Mechanisms of resistance in brinjal (*Solanum melongena* L.) to whitefly (*Bemisia tabaci* Gen.,). *Madras Agric. J.,* **88** (10-12) : 657-659.

Thangamani, C. (2003). Evaluation of F_1 brinjal (*Solanum melongena* L.) for yield and quality. MSc. (Hort.) thesis, Tamil Nadu Agricultural University, Coimbatore.

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