Insects and Diseases of Brinjal and Breeding for Resistance

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INSECTS

Insect pest infestation is one of the most limiting factors in increasing the yield potential of brinjal or eggplant. The crop is prone to damage by various insects, although there is wide variability in their degree of infestation. Some of the important insect pests of brinjal are described in this paper.

Shoot and Fruit Borer (*Leucinodes orbonalis*)

This insect limits the successful cultivation of eggplant, particularly under high temperature and humidity. Alone, it has been reported to cause yield loss of up to 70%. The short pinkish larva of the pest initially attacks the terminal shoots, bores inside and, as a result, the shoots wither and dry. In advanced stages, it also bores into the young fruit, feeds inside, causes rotting and makes the fruit unfit for human consumption.

As continuous cropping of brinjal is conducive to infestation, crop rotation is suggested. As soon as the insect is detected, the affected parts should be clipped along with the insect and destroyed. Fruits showing any boring should be picked and destroyed. As it is difficult to control the borer after it has entered the shoot or fruit, the control measure should be taken at the appropriate time, just after the larvae are hatched from the eggs.

Good control of shoot and fruit borer can be obtained with fortnightly application of Sevin or 50% W.P. at 28 or 56 g/4.54 liters. Mote (1976) observed that Carbaryl at 0.2% was the most promising and gave significantly higher yield of brinjal than the other insecticides tested. Carbaryl (0.2%) was sprayed three times at an interval of two weeks. First spraying was done 75 days after transplanting, at the fruit-setting stage.

The development of resistant cultivars to control the insect seems to be the only solution to reduce the hazards caused by the use of toxic chemicals. Kashyap and Kallo (1983) have reviewed different works on insect resistance in vegetable crops. Several accessions of *Solanum melongena* have been screened against this insect pest and the following have been reported to be tolerant to resistant in character: Pusa Purple Long (Singh and Sikka 1955; Gill and Chadha 1979); H-128 and H-129 (Srinivasan and Basheer 1961); Aushey (Dhankhar et al. 1977); Thorn Pendy, Black Pendy, H-165 and H-107; SM 202, Sel. 519, Sel. 520, Sel. 521 and Solan-11 (Lal et al. 1976); PPC-2 (Dhankhar et al. 1977); Dorley; Long Purple; PPC-17-4; and PVR-195 (Singh 1981).

Epilachna Beetle (*Epilachna vigintioctopunctata*)

This beetle is a polyphagous insect that feeds on the leaves of potato, brinjal, tomato, etc. by scraping in a characteristic manner leaving the veins intact. The grubs are yellowish and stout with stiff hairs on their bodies. The beetle is bronze to red, small and spherical, and mottled with black spots. In brinjal, the adult and the grub feed voraciously on the leaves and tender parts of the plant and often cause serious damage when in large number. As a result of the feeding by both the grubs and adults on the green chlorophyll, characteristic skeletonized patches which are lace-like in appearance are developed on the leaves. The leaves later dry.

Handpicking and destroying grubs, adults and eggs along with infested leaves during the early stages are suggested to reduce the infestation.

Sandhu (1973) evaluated the efficacy of 14 insecticides on the control of *E. vigintioctopunctata* in brinjal plants and reported that all of them gave over 90% control of the pest; for both safety and effectiveness, Carbaryl, Dichlorovos, Endosulfan and Malathion (all as 0.1% sprays) are recommended.

Crops may be dusted with 5% BHC at the rate of 20 kg/ha or sprayed with 0.05% Malathion (50 E.C.) for the control of this insect pest.

Use of resistant cultivars like Arka Shirish, Hissar Sel. 14 and Shankar Vijay were found effective against this insect.

Jassids [*Amrasca biguttula biguttula, Cestius (Hishimonus) phycitis*]

Both nymphs and adults suck the sap from the lower surface of the leaves. The infested leaves curl upwards along the margins which may turn yellowish and show burnt patches. They also transmit mycoplasma disease-like little leaf, and virus disease like mosaic. Fruit-setting is adversely affected by the infestation.

Nath (1976) suggested the spraying of 0.1% Ekatox at three-week interval before fruiting. During the fruiting stages, the crop should be sprayed with Malathion (0.15%) at one-week intervals. The fruits should be picked before spraying and should not be harvested for a few days after spraying.

Mote (1978) recorded the lowest number of jassid nymph incidence per 30 leaves in the following brinjal cultivars: H-4, Round Green, Dorley, Aushey, Jumbli Mulayam and Long Purple. This indicates that these cultivars are moderately resistant to jassids. It was also observed that various morphological characteristics contributed to resistance, including long hairs and a high density of hairs on the midrib and lamina, and more erect hairs on the midrib and thin leaf lamina.

Red Spider Mite (*Tetranychus neocaledonicus, Tetranychus cinnabarinus, Paratetranychus indicus*)

These are small, polyphagous insects found in large colonies on the underside of leaves covered with fine silky webs. The protonymph stage is the most active feeding stage. As a result of their feeding, white specks appear on the leaves. Ultimately, the entire affected leaf becomes discolored and withers. The damage is more pronounced during warm and dry season. In severe cases, it may be found all over the leaf surface. Due to the removal of plant sap with chlorophyll and other plant pigments during feeding, characteristic blotching of leaves is observed.

Dusting with fine sulphur at the rate of 20-25 kg/ha or spraying with sulphur is effective in controlling this mite (Narayanan 1959). Singh (1970) has cautioned that after Thiometon spraying, the fruits should not be harvested for four weeks. He also recommended 0.1% Mevinphos, which is comparatively safe.

Leaf Roller (*Eublemma olivacea*)

Caterpillars roll leaves and feed on chlorophyll while remaining inside the folds and, thus, leading a concealed life. As a result, the folded leaves wither and dry. The caterpillars may also bore into the plant to wither.

Collecting and destroying infested leaves along with insects in the initial stages help minimize the infestation. Spraying of 0.1% Carbaryl, and 0.05% Malathion or Dichlorovos (DDVP) is also effective.

Stem Borer (*Euzophera perticella*)

Pale white caterpillars attack stems and often kill the young plants. Due to the attack on the older plants, the infested plants wither; growth is stunted and fruit yield is adversely affected.

Removal and destruction of the affected plant or plant parts help reduce the infestation. The crop may be sprayed with 0.03% Diazinon, 0.1% Lindane or 0.1% Carbaryl. The fruits should be picked before spraying. After spraying, the fruits should be harvested for the next six to seven days.

Mealy Bug (*Centrococcus insolinus*)

The nymphs and adult females remain in large number on the undersurface of leaves; they suck the sap from the plants making them pale and weak. As a result, the plants wilt and dry. The insect is abundant during the rainy season.

Spraying of any systemic insecticide may provide some control. In the field condition, 0.1% Basudin gave 68.9% control; more than one application was needed to get adequate control.

Brinjal Lace Wing Bug (*Urentius echinus, Urentius sentis*)

This is a specific pest of brinjal. Nymphs and dark brown bugs with lace-like wings suck the sap from leaves which turn yellowish and are covered with insect excreta. Affected leaves ultimately dry. The summer crop suffers comparatively more.

As soon as the pest appeared, spraying with DDT (W.P.) at 0.025-0.05% effectively controlled both nymphs and adults but the residual toxicity lasted for more than two weeks. Phosphamidon 0.03% and Endrine 0.02% were superior to Lindane 0.02%, Malathion 0.05% and BHC 10% dust for the control of *Urentius echinus*.

Termites (*Trinervitermes biformis, Microtermes* spp.)

Termites or white ants are cosmopolitan pests with a very vast range of host plants, one of which is brinjal. Termites are abundant in sandy soil and do not thrive in heavy soil. Infestations start soon after germination and may continue until harvest of the crop. The pest, being subterranean, lives at the roots and stem below the ground level and from there, tunnels upwards. The affected plants turn pale, wither and dry.

Soil application with 5% Chlordane or Heptachlor at the rate of 22 kg/ha is very effective in minimizing the attack of termites. In sandy or termite-infested soils, the growing of crop should be avoided. Soil application of Aldrin is also very effective in controlling the termites.

NEMATODES

Root-knot Nematodes (*Meloidogyne* spp.)

Brinjal is highly susceptible to nematode. Nematodes stunt the plants and leaves show chlorotic symptoms. Fruiting is adversely affected.

In a study conducted by Alam (1975), pot-grown brinjal plants were inoculated with 0-5000 *Meloidogyne incognita* larvae; after 45 days, they were uprooted, washed and placed in flasks containing water for six hours per day. It was reported that the water uptake by the plants was reduced by the infection. The reduction in the water uptake was attributed to the decrease in root weight.

Proper crop rotation with crops resistant to the root-knot nematode, like marigold, will help in the reduction of the nematode population (Choudhury 1967). Different cropping sequences of brinjal with other crops, including capsicum, garlic, beetroot and turnip, affect the nematode population in the soil. *Meloidogyne incognita* population rises with all cropping sequences, especially when preceeded by capsicum. When brinjal is followed by beetroot, nematodes increase, but when followed by garlic, they are greatly reduced.

The most effective treatments against *Meloidogyne incognita* in decreasing order of effectiveness are DD (dichloropropane-dichloropropene) mixture at 280.82 liters, DBCP (dibromochloropropane) at 26.92 liters, Phorate at 4.92 kg, DD mixture at 224.66 liters and DBCP at 20.19 liters/ha.

Soil injection of 249 liters/ha of ethylene dibromide one month before transplanting controlled root-knot nematode and increased yield. Other soil fumigants like DD and Di-Trapex (DD + methyl isothiocyanate) and the granular nematicides Aldicarb, Carbofuran, DBCP and Fenamiphos applied 14-60 days before transplanting were found less effective.

Sel. 96-2, Sel. 119, Pol Baigan and the species *Solanum sisymbrifolium* and *S. elaegnifolium* are highly tolerant to *Meloidogyne* spp. under field and laboratory conditions. According to Yadav et al. (1975), Vijaya and Black Beauty cultivars are tolerant to *M. incognita*.

Black Beauty, T-2 (U. P.) Vijaya and Banaras Giant cultivars have relatively low numbers of nematode egg/root system. The number of eggs per root systems was considered to be a more reliable criterion for determining the extent of infection than the number of galls per gram root.

The cultivars reported so far as tolerant to *Meloidogyne* spp. may be used in controlling the nematodes as well as in future breeding programs to evolve a resistant cultivar.

DISEASES

Brinjal is attacked by many diseases that affect the roots, leaves, stems and fruits. Severity of disease infestation depends on the season and the region in which the crop is grown. Many of the diseases cause damage only in certain years. But a few are prevalent in many areas each year and at varying levels of damage. Only the most common diseases are mentioned here with their possible control measures.

Damping Off (*Pythium* spp; *Phytophthora* spp; *Rhizoctonia* spp.)

The fungus attack usually starts on the germinating seed and spreads to the hypocotyl, basal stem and developing tap root. The affected seedlings turn pale green and brownish lesions appear at the basal portion of the stem. The lesion girdles the stem, later extending upwards and downwards. The affected tissue rots and the seedling collapses. The disease is very severe in the nursery. The fungus is soil-borne.

The disease may be controlled if the nursery soil is sterilized and the seeds are treated with Ceresin before sowing. Hot water treatment (at 51.7°C for 30 min) of seeds has also been effective in controlling the disease (Nath 1976).

Phomopsis Blight (*Phomopsis vexans*)

This is a serious disease of brinjal. In seedling infection, it causes damping-off symptoms. The foliage is attacked any time during the season. When the leaves are infected, small circular spots appear which become gray to brown and the center, light-colored with irregular blackish margins. The affected leaves may turn yellow and die. Lesions may also develop on petiole and stem, causing blighting of affected portions of the plant. The fungus penetrates into the soil and lives on affected host tissues. It is specific to brinjal and once the seeds are sown or the seedlings are transplanted to the infested soil, the organism becomes active. The causal organism of the disease remains viable for about 14 months in soil debris; the seeds from infected fruits poorly germinate.

Kalda et al. (1976) studied the resistance to *Phomopsis vexans* from 300 entries, including *Solanum* spp., brinjal cultivars and interspecific F_1 hybrids. *Solanum xanthocarpum, S. indicum, S. gilo, S. khasianum, S. nigrum* and *S. sisymbrifolium* were highly resistant; *S. melongena* lines 11a and 264 were resistant. The reactions of the F_1 hybrids varied. It was further observed that resistance to phomopsis blight was recessive and governed by polygene. Dominant gene effects were more pronounced than the additive in most of the crosses (Kalda et al. 1977). Decker (1951) released two cultivars by hybridization, namely, Florida Market and Florida Beauty, that are resistant to this blight.

The control measures suggested by different researchers are: (a) use of seeds obtained from disease-free plants; (b) seed treatment by 0.1% mercuric chloride or with other organomercurial fungicides; (c) adaptation of suitable sanitary measures; (d) growing of resistant cultivars; (e) hot water treatments of seeds at 50°C for 30 minutes; (f) spraying at regular intervals in the nursery and in the main field with 1% Bordeaux mixture or other chemicals; and (g) a suitable crop rotation.

Leaf Spots (*Alternaria* spp., *Cercospora* spp.)

Rangaswami (1979) reported four different types of leaf spots in brinjal caused by *Alternaria melongenae* Rang. and Samb., *Alternaria solani* (Ell. and Mart.) Jones and Grout., *Cercospora solani-melongenae* Chupp. and *Cercospora solani* de Thumen. Both species of alternaria produce the characteristic leaf spots with concentric rings. The spots are mostly irregular, 4-8 mm in diameter and may increase covering a large area of the leaf blade. The leaves may drop off due to severe infection. *Alternaria melongenae* infects the fruits causing large deep-seated spots. The infected fruits turn yellow and drop prematurely.

Cercospora leaf spots are characteristically chlorotic lesions, angular to irregular in shape, later turning grayish brown with profuse sporulation at the center of the spot. Severely infected leaves drop off prematurely resulting in the reduction of fruit yield.

The disease may be primarily controlled by maintaining proper field sanitation and by burning diseased leaves. However, this can be controlled by spraying Dithan Z-78, Fytolan and Blitox.

The moderately resistant cultivars to *Cercospora egenulae* available are: Manjari Gota, Black Round, Junagadh Sel. II (long), P 8, Pusa Purple Cluster and H-4.

Wilt

This disease is becoming a limiting factor in successful brinjal cultivation. A number of pathogens associated with this disease include *Verticillium dahliae* Kelp, *Fusarium salani* (Mart.) App. and Wollenw., *Sclerotium rolfsii* Sacc. and *Macrophomina phaseolina* (Tassi) Goid.

The characteristic symptoms of infection by *Verticillium* spp. are found in stems and roots. The infected plants become stunted in growth and, generally, do not flower and set fruit. If the infection takes place after the flowering or fruit-setting, the flowers and fruits become deformed and flaccid, and finally drop off. Cutting the affected stem length-wise would show dark color inside the vascular tissue. The first symptoms appear on the lower leaves. The affected leaves turn yellow and then brown between the veins followed by wilting. Wilting proceeds from one margin to the other, until the leaves completely drop off. The pathogen is soilborne and the primary inoculum usually comes from the soil.

Weeds can be controlled by increasing the soil temperature with plastic mulch prior to sowing. Enhanced plant development decrease wilt (*Verticillium dahliae*) incidence by 60-90% and increase crop yield by 300%.

Soil fumigation is also effective in controlling this disease. Soaking seed in 0.05% hydroquinine, 0.5% methylene blue, 0.01% para-nitrophenol or 0.01% orthonitrophenol prevents the occurrence of both Verticillium and Fusarium wilt. As the pathogen is soilborne, soil treatments with different chemicals are found to be very effective. Good control can be obtained when the soil is treated with Benlate (benomyl), Topsinmethyl (thiophanatemethyl) and Bavistin each at 0.05 or 0.1% at an interval of 25-30 days. Rangaswami (1979) reported that foliar application as well as soil application of 0.1% Benlate was effective in controlling the disease in India.

Use of resistant cultivars, however, controls the disease permanently. Brinjal cvs. Black Beauty (USA), Pusa Purple Long (India) and K-2282 (USSR) are less affected by *Verticillium* species.

Bacterial Wilt (*Pseudomonas solanacearum* E. F. Sm.)

Bacterial wilt disease causes severe problem in brinjal cultivation. The characteristic symptoms of the disease are wilting, stunting and yellowing of the foliage followed by collapse of the entire plant.

Proper crop rotation reduces the disease infestation. In a two-year trial with brinjal cv. Pusa Purple Long which is susceptible to *Pseudomonas solanacearum*, the following rotations were found to reduce the pathogen incidence: maize-okra-radish; maize-Vigna sp-maize; okra-Vigna sp.-maize; wilt resistant cv. Pusa Purple Cluster-*Phaseolus vulgaris*.

Resistant genes may be found in brinjal cultivars or wild species. The first is preferred as there is less chance of unusual combination and occurrence of infertility or any undesirable wild character. The wild brinjal *S. melongena* var. *insanum* was reported to be resistant to bacterial wilt (*P. solanacearum*) and highly compatible with solanaceous crops.

VIRAL AND MYCOPLASMAL DISEASES

Little Leaf

In the early times, this disease was attributed to virus but has been confirmed to be caused by mycoplasma. Plant affected by little leaf is generally shorter in stature but possesses larger number of branches, roots and leaves than the healthy ones. The leaves are malformed into tiny chlorotic structures. The petioles get shorter considerably; many buds appear on the axil of leaves and internodes are stunted, giving the plants a bushy appearance. Flower parts are deformed, making the plants sterile. Infected plants do not bear any fruit and if fruiting occurs, the fruits harden. The mycoplasma is transmitted by leaf hopper *Cestius* (*Hishimonus*) *phycitis* Dist. and *Amrasca biguttula biguttula* Ishida. Affected plants have stunted growth with numerous malformed leaves; the leaf chlorophyll content and total carbohydrate percentage decrease while total nitrogen percentage increases.

Roguing out of the diseased plants in the earlier stage of infestation and spraying with Ekatox or Folidol until fruit-set may help check the spread of the disease (Nath 1976). Root dipping at the time of transplanting with 1000 ppm tetracycline followed by three sprays at weekly interval for four to five weeks after transplanting also check the disease. Temporary suppression of the disease has been recorded by the application of tetracycline hydrochloride at the rate of up to 500 ppm. Besides tetracycline, diseased plants also respond to GA application at 50 ppm.

The best disease control and the highest yield can be obtained when Phorate at a rate of 1 kg/ha is applied to the seed bed followed by dipping the seedling in aqueous solution of 0.05% tetracycline along with 0.05% Monocrotophos.

From the study on the reaction of brinjal lines and cultivars to little leaf disease under natural conditions, cvs. Pusa Purple Cluster and Kartain were found resistant to the disease under field conditions. Chakravarty and Choudhury (1975) obtained only two lines, Sel. 212-1 and Sel. 252-1-1, which were free from little leaf from among 164 cultivars tested.

Mosaic

This is a virus disease. Plants infected with the virus are stunted in growth and show mosaic symptoms of leaves.

Five distinct viruses were isolated from brinjal plants infected by a widespread sap-transmissible mosaic disease. The isolates are: isolate LL (a distinct strain of TMV) called brinjal mild mosaic; isolate 4 (a distinct strain of CMV) known as common brinjal mosaic; isolate SS known as severe brinjal mosaic; isolate 6 known as brinjal ring mosaic; and isolate 17 known as brinjal crinkle mosaic. With the exception of *Solanum indicum* IW 599, which is resistant to isolates SS and 4, the 12 *Solanum* species tested were susceptible to the above five viruses.

The removal of all the virus-affected plants as soon as they are identified proved to be an effective control. Proper sanitary measures may be beneficial in controlling the disease. The viral activity of brinjal seed is entirely lost after seven months of storage at room temperature without any appreciable reduction in germination.

Use of resistant or tolerant cultivars can be adopted as control. From screening tests, only one, Pusa Purple Cluster, among several cultivars was found tolerant to brinjal mosaic virus.

The methodology for breeding for resistance to diseases is wide and varied. It will naturally depend on the source of resistance and its nature. In diseases like little leaf in brinjal, resistance is available in *Solanum gilo* and *S. integrifolium* which are not crossable with the cultivated *melongena* (Chakrabarti and Choudhury 1975).

The type of inheritance is dependent on the source, since there can be more than one type of resistance such as monogenic, and polygenic as in bacterial wilt.

The inheritance of bacterial wilt was reported to be under the control of a single dominant gene (Swaminathan and Srinivas 1972; Vijayagopal and Sethumadhanwan 1973). The knowledge of the mode of inheritance and mechanisms of resistance to bacterial wilt would be useful in setting up efficient brinjal improvement program. Physiological and biochemical characters like dry matter of leaves, bark to wood ratio and total phenols could be used as selection indices in the screening program at the seedling stage against the bacterial wilt. West coast Green Round 112-8 (WCGR 128-8), was isolated and purified from a local variety of Karnataka State for resistance to bacterial wilt (Gopinath and Madalageri 1986).

Little leaf disease of brinjal is the crop's most serious disease, causing 40-80% crop damage in the field. The wild species *Solanum viarum* showed no infection and was immune, whereas, the species *S. incanum* and *S. sisymbrifolium* (both 8.33%) were found to be resistant to little leaf disease by Anjaneyulu and Ramkrishnan (1968) and by Chakrabarti and Choudhury (1974). In the case of cultivated types of *Solanum melongena*, Pusa Purple Cluster was the only variety observed to be resistant (5.55%)

to the disease while Nurki (13.88%), Bourad Local No. 4 and Chikhalgaon Local No. 1 (both 19.44%) were moderately resistant to the disease.

Kale et al. (1986) revealed that the wild species *S. viarum* was immune, while *S. incanum, S. sisymbrifolium* and cv. Pusa Purple Cluster were resistant. Nurki, Bourad Local No. 4 and Chikhalgaon Local No. 1 were moderately resistant to the disease. At Hisar, vars. Hisar Shyamal and H10 were found tolerant under field conditions (Kalloo et al. 1990).

The study revealed that the immune varieties are the wild type and will be of little use in resistance breeding because of difficulties in interspecific hybridization. Meanwhile, the resistance in the cultivated varieties can be used in hybridization program. Practical assessment integration of plant protection measures and inherent resistance in varieties can lead to increased production. Kalda et al. (1976) found that *S. xanthocarpum, S. indicum, S. gilo, S. khasianum, S. nigrum* and *S. sisymbrifolium* were highly resistant to phomopsis blight while *S. melongena* lines 11a and 264 were resistant. Resistance was recessive and polygenically inherited (Kalda et al. 1977). It was further observed that dominant gene effects are more pronounced than the additive gene effects in most of the crosses studied.

Vijaya and Black Beauty cvs. were reported to be tolerant to root-knot nematode (Yadav et al. 1975). Shelty and Reddy (1985) studied four species of *Solanum* , namely, *S. torvum, S. incanum, S. seaforthianum* and *S. mammosum* and 10 strains of *S. khasianum* against *M. incognita* under greenhouse conditions. *S. torvum* and *S. seaforthianum* gave resistant reaction. A very small number of larvae invaded roots of *S. torvum* (2.2 larvae) and *S. seaforthianum* (3.3 larvae). Chadha (1988) reported that *Solanum torvum* Sw. was resistant to root-knot nematodes. It was used as a rootstock for tongue-grating a number of chosen cultivars of brinjal (*S. melongena* Linn.). The grafted hybrids behave as perennials and yield three to four times more.

The breeding methods to incorporate resistance in cultivated varieties will have to be manipulated in answer to the needs. With root-knot nematode or Fusarium wilt resistance which are governed by a single dominant gene, backcross method of breeding has been adopted. But there are several cases of resistance of complex mechanism, like phomopsis blight in brinjal (Kalda et al. 1976) where the breeder has to contend with polygenic systems. He may have to devise modification, such as controlled mating (among the resistant progeny) in the backcross or F_2 or succeeding generations. Sometimes, it may even be necessary to go into a second crossing with the resistant (donor) parent to bring in more resistant genes, than has been possible in a single dose. Recurrent or reciprocal recurrent selection methods are often used in improving horticultural characters simultaneously with incorporating disease resistance. Usually, resistance screening is done under controlled conditions in glasshouse and the resistant selections are done in the field, allowing mass selection to improve the horticultural characters under field conditions. This alternate selection for resistance and horticultural characters would be useful in cases where two crops can be raised in a year.

Heterosis breeding can be integrated with resistance breeding. In the absence of stable resistance, only tolerant varieties should be bred, which may remain for a short time only. Under these circumstances, F_1 hybrids produced with resistant parents would show better or high disease resistance and the hybrid seed production should be simplified to reduce the seed cost. In these cases, disease resistance has to be governed by dominant genes with high level of expression in F_1 population.

Stability of resistance in the evolved varieties has often baffled the breeders. By experience, greater care in breeding is necessary when the source of resistance is one of tolerance. The seed multiplication of such tolerant varieties should be undertaken under near-epiphytotic conditions; otherwise, susceptible population will multiply.

Multiple disease resistance, in case of brinjal phomopsis blight affecting the seed crop, should be combined with resistance to disease affecting vegetable crop.

The development of a program for insect resistance will depend on the character of the crop, insect pest involved and the information available from the beginning. The following steps, in general, may be followed:

- Survey for possible sources of insect resistance of varieties and strains locally available and a separation of resistance and pseudoresistance;
- Search for new germplasm that may carry resistance (a) in new selections out of the older varieties, (b) in foreign plant introductions, and (c) in varieties of related species of plants, if necessary;
- Determination of some of the basic properties of the plants responsible for resistance;
- Hybridization to combine gene for resistance with desirable horticultural characters;
- Study of genetics of plant resistance to the insect;
- Study of resistance in advanced generation hybrids; and
- Study of resistance of released varieties in plots to evaluate resistance as an insect control method.

Brinjal shoot and fruit borer (*Leucinodes orbonalis* Guen) and Jassid (*Amrasca biguttula biguttula* Ishida) are very serious pests. The wild species *Solanum sisymbrifolium* (Dhankhar et al. 1980), *S. integrifolium*, *S. xanthocarpum*, *S. nigrum* and *S. khasianum* have earlier been found free from the damage of this insect, while *S. incanum* showed an infestation of 8.6% (Lal et al.1976).

From the screening of varieties, it can be concluded that long, narrow-fruited brinjal varieties were less infested than the spherical-fruited ones. Preference for egg laying was lower in resistant varieties than susceptible ones which may be one of the mechanisms for resistance. Larvae bore more successfully in round fruits than in long fruits. Varieties S-34 and S-258 showed resistance to both jassid and fruit borer under natural field conditions.

Kale et al. (1986) reported in their study on the shoot infestation (both on number and weight basis) of *S. incanum, S. xanthocarpum, S. khasianum* and *S. sisymbrifolium* that these varieties are immune as they showed no infestation. The cvs. Tambalwadi Local (4.78%), Gopuri (5.42%), Pusa Purple Round (3.50%), Jalgaon Local (5.89%), Hingana Dorla (7.28%), Baramasi (9.06%), Punjab Bahar (9.49%) and Junagadh Bhattu (10.40%) were highly resistant to shoot infestation, while other varieties were grouped as fairly resistant (11-20%), tolerant (21-30%), susceptible (31-40%) and highly susceptible (above 41%). However, varieties Nurki, Pusa Purple Cluster and Gulabi Dorla were highly resistant to fruit infestation, both in number (7.25- 10.33%) and weight basis (6.65-10.52%). In addition to these, Arka Shirish, Selection-1 and Tambalwadi Local also showed high resistance on fruit weight basis (9.45-10.57%). All these varieties were highly resistant or fairly resistant to shoot infestation except Nurki and Pusa Purple Cluster which were susceptible and highly susceptible, respectively, to shoot infestation.

Bajaj et al. (1989) reported that the variety SM-17-4 which is relatively field resistant to shoot and fruit borer (*Leucinodes orbonalis* Guen.) has higher glycoalkaloid content, peroxidase and polyphenol oxidase activity than the susceptible Punjab Chamkila. However, higher anthocyanin content was found in the susceptible variety. It was suggested that glycoalkaloids in association with phenolic compounds could confer resistance on eggplant fruits to pest.

For jassids, Mote (1978, 1982) reported that varieties Dorle Jumbli Malayalum and Manjri Gota were resistant. Resistance of brinjal varieties to jassid reported by early workers was due to more density and length of the hair on the leaves. Hairiness of leaves was the main cause of resistance.

There should be continued search for resistant strains of plants until all available germplasm has been carefully surveyed. It has been observed that the chance of finding resistant types is proportional to the number and multiformity of the plants studied. If satisfactory resistance is not available within the plant species, the search has to be diverted towards the related plant species, but the transfer of the gene concerned becomes more difficult and takes a relatively long time. The ease of incorporating genes for resistance into a commercial crop depends partly on the available knowledge of genetics in the crop and partly on the possibility of maintaining an insect population with which resistance may be tested.

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