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Sources of pest resistance in vegetable crops: A review

Lipsa Dash, Deepayan Padhy, Manish Kumar Yadav, V Ramalakshmi
Assistant Professor, Centurion University of Technology and Management, Paralakhemundi, Odisha, India

Abstract
Vegetable pests are one of the major biotic stresses that affect the production and productivity. Even if application of insecticides have been some how successful in managing the pest population, indiscriminate use of these harmful chemicals have been proved to cause deterioration of soil health, environment pollution and it also impairs animal health. At the same time, it also leads to development of resistance and resurgence issues which is now a major concern among the researchers. Hence at this point, breeding of crops to develop biotic resistant cultivars is one of the major ways to solve this problem. Genetic bases of pest resistance in vegetable crops and host plant resistance has greatly improved the efficiency of manipulating pest resistance genes in practical breeding programs which plays a great role to develop high-yielding genetically resistant cultivars. To develop resistant lines, source of resistance along with the genetic information is the basic essential part. Here, attempts have been made to provide a description on resistant sources of different vegetable crops against major insect pest, their inheritance, genetic manipulations, biotechnological interventions which will be useful in future breeding programme.

Keywords: host plant resistance, genetic manipulation, resistance lines

Introduction
One of the major biotic stresses that is affecting the vegetable production is the heavy incidence of insect pest. Insect pests are responsible for causing a yield loss up to 40% (Singh *et al.*, 2000) [7]. Heavy infestation by insect pests restricts the vegetables achieving its maximum yield potential. At the sametime, indiscriminate use of pesticide has been a major cause of environment pollution. Keeping in view the chemical free vegetables, reduced cost of production and improved export quality of vegetables, scientists are now focusing on development of pest resistant varieties. Hence, trials have been made regularly to breed insect-pests resistant cultivars in vegetables. However, Host plant resistance (HPR) is one of the the economical methods but such resistance is never stable under all types of environment conditions. At the same time it also leads to development of biotypes.

Table 1: Major insect pests attacking vegetable crops

Crop	Major insect pests
Tomato	Fruit borer, white fly, aphid
Brinjal	Shoot and fruit borer, spider mite, jassid, hadda beetle
Chilli	Thrip, mite, aphid, white fly
Okra	Jassid, spotted bollworm, spider mite
Onion	Thrip, onion maggot
Cucumber	Red pumpkin beetle, aphid, fruit fly, leaf miner, mite
Musk melon	Red pumpkin beetle, aphid fruit fly, leaf miner, mite
Water melon	Red pumpkin beetle, aphid fruit fly, leaf miner, mite
Cabbage	Diamond-back moth, tobacco caterpillar
Cauliflower	Diamond-back moth, tobacco caterpillar, Aphid
Cowpea	Jassid, aphid, pod borer or blue butterfly
Pea	Thrip, leaf miner, stem fly

Tomato
Tomato is attacked by numerous pests including mites, white flies, tomato fruit borer, Colorado potato beetle, thrips, cutworms etc. However, insect resistance study in tomato has been a neglected area than disease resistance study.
However, resistance to major insect pests of tomato has been detected in the related wild species, in particular *S. habrochaites* and *S. pennellii*. *S. pennellii* has been showing resistance to atleast nine pest species including white fly, spider mite and potato aphid. Similarly, *S. habrochaites* is showing resistance to atleast 16 pest species.

Table 2: Insect pests and their source of resistance in tomato

Insect pests	Source of resistance
Fruit borer	*L. hirsutum f. glabratum*
White fly	*L. hirsutum*

Brinjal

Resistance has been recorded in wild species of *Solanum*, e.g., *S. torvum, S. xanthocarpum, S. nigrum*, and *S. sisymbriifolium* (Sugha *et al.*, 2000). In brinjal, shoot and fruit borer is the major pest and a number of varieties have been developed against this pest. More and Patil reported that Dorli Jumbli Malayalum and Manjari Gota varieties were resistant against jassids (1982).

Table 3: Insect pests and their source of resistance in brinjal

Insect pests	Source of resistance
Shoot and fruit borer	*Solanum sisymbrifolium, S. integrifolium, S. xanthoranpum, S. nigrum, S. khasianum*, Pusa Purple Long, H-128, H-129, Azcabey, Thorn Pendy, Black Pendy, Banaras Long Purple, Arka Mahima and Arka Sanjivans
Jassids	Dorli Jumbli malayalum and Manjari Gota More

Okra

Jassid, fruit borer, white fly, aphid and spider mite are important pests attacking okra. Out of the above pests attacking okra, jassid and spotted fruit borer are the most important one. Resistance to jassid was reported in indigenous accessions IIHR-21, AE-15, AE-30, hairy lines IC-7194 and IC-8899; Crimson Smooth Long, IC-7194, IC-8899, *A manihot* ssp. *manihot*, *A. moschatus* (I.W. 1502) and *A. tuberculatus* etc. Hairiness of *A. esculantus* provides its resistance against jassids. Resistance/tolerance to fruit and shoot borer, *Earias sp*., was reported in Red I, Red II, Red Wonder I, Red Wonder II, AE-22, AE-52, AE-79, AE-72, AE-57, AE-3, AE-75 (Singh *et al.*, 2009) [3].

Table 4: Insect pests and their source of resistance in okra

Insect pests	Source of resistance
Fruit borer	*A. tuberculatus, A. moschatus*
Mite	EC-305656, EC-305664, EC-305696, *A. angulosus*
Jassid	*A. moschatus, A. crinitus*, EC-305656, EC-305694, EC-305695, EC-305714, EC-306731

Cabbage

Red type cabbage is resistant to caterpillars (*Pieris brasssicae*) but susceptible to aphids (*Brevicoryne brassicae*) and its vice-versa is true in case of green/white cabbage. The hybrid KCH-5 is tolerant to both aphids and caterpillars.

Biotechnological intervention

Marker assisted breeding is quite helpful in incorporating desired genes from wild relatives to cultivated varieties. Rather than traditional varieties, molecular markers can specifically identify the portion signifying the gene of interest, which help the breeders to narrow their search for desirable genes. Genetic engineering has been successful for developing plants resistant to various biotic stresses such as viruses, bacteria, fungus and insect pests.

Marker assisted selected has been successfully implemented in cauliflower for production of doubled haploids, and research for disease/insect pest resistant varieties. Economically potential useful target genes, such as trypsin inhibitors CaMv caspid, antisense CaMv gene VI and anther specific BcP1 genes were also explored in transforming the cauliflower crop (Hu and Leonard, 2003). Bt okra has been successfully developed by incorporating Cry IAc gene. Similar is the case for mustard and tomato (Fischhoff *et al.*, 1987; Babu *et al.*, 2003) [1, 2].

Future strategies

Even after development of newer molecules for pest management, still development of tolerant/ resistant varieties has been the best option till date. As it is ecofriendly and cost effective, it is gaining popularity among the farmers.

There is a need to undertake intensive research programme to make best use of available germplasm in the country and above all to utilize wild relatives for development of pre bred lines so that as and when resistance source require these lines can be utilize successfully against certain biotic stresses. Apart from all these, target should be fixed for multiple pest resistance through gene pyramiding. Due emphasis must be given towards development of multiple disease and pest resistance. Hence breeders, pathologists and entomologists should work together in this line.

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