ISSN: 0974-5823 Vol. 7 (Special Issue, Jan.-Feb. 2022)

International Journal of Mechanical Engineering

Breeding for pest resistance in vegetable crops: A Review

Lipsa Dash[1], Barsha Tripathy[2], and Sandeep Rout[3]

[1,2]M. S. Swaminathan School of Agriculture, Centurion University of Technology and Management, Paralakhemundi, Odisha, India

[3]Faculty of Agriculture, Sri Sri University, Cuttack, Odisha

Abstract

Vegetable pests are significant biotic stresses that affect production and productivity. Even if insecticides have somehow successfully managed the pest population, indiscriminate use of these harmful chemicals has been proved to cause deterioration of soil health and environmental pollution, and it also impairs animal health. At the same time, it also leads to the development of resistance and resurgence issues which is now a significant concern among the researchers. Hence, breeding crops to develop biotic resistant cultivars is one of the excellent ways to solve this problem. Genetic bases of pest resistance in vegetable crops and host plant resistance have greatly improved the efficiency of manipulating pest resistance genes in practical breeding programs, which significantly develops high-yielding genetically resistant cultivars. The source of resistance and genetic information is essential for creating resistant lines. Here, attempts have been made to describe resistant sources of different vegetable crops against significant insect pest, their inheritance, genetic manipulations, and biotechnological interventions, which will be helpful in future breeding programs.

Keywords: Host plant resistance, Genetic manipulation, resistance lines

Introduction

One of the significant biotic stresses affecting vegetable production is the heavy incidence of insect pests. Insect pests are responsible for causing a yield loss of up to 40% (Singh *et al.*, 2000). Heavy infestation by insect pests restricts the vegetables from achieving their maximum yield potential. At the same time, indiscriminate use of pesticides has been a significant cause of environmental pollution. Considering the chemical-free vegetables, reduced cost of production, and improved export quality of vegetables, scientists are now focusing on developing 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 economic methods, but such resistance is never stable under all environmental conditions. At the same time, it also leads to the 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 tomatoes has been a neglected area than disease resistance study. However, resistance to

major insect pests of tomato has been detectedin 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 shows resistance to at least 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* (Sughae*t al.*, 2000). In brinjal, shoot and fruit borer is the major pest and several varieties have been developed against this pest. More and Patil reported that DorliJumbliMalayalum and ManjariGota 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 ArkaSanjivans
Jassids	DorliJumblimalayalum and ManjariGota More

Okra

Jassid, fruit borer, whitefly, 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 ones. 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).

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 (*Brevicorynebrassicae*) 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 CaMvcaspid, 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).

Future strategies

Even after developing newer molecules for pest management, the development of tolerant/ resistant varieties has been the best date option. As it is eco-friendly and cost-effective, it is gaining popularity among farmers. There is a need to undertake an intensive research program to make the best use of available germplasm in the country and, above all, utilize wild relatives to

develop pre-bred lines so that as and when resistance sources require these lines can be utilized successfully against certain biotic stresses. Apart from all these, the target should be fixed for multiple pest resistance through gene pyramiding. Due emphasis must be given towards the development of numerous disease and pest resistance. Hence breeders, pathologists and entomologists should work together in this line (Pradhan *et al.* 2021).

Conclusion

Pests are a significant biotic burden on crop yield and productivity. Even though pesticides have been somewhat effective in controlling pest populations, their widespread usage has been shown to undermine soil health, pollute the environment, and impact animal health. It also leads to problems of resistance and recurrence, which are currently key concerns among researchers. Hence, breeding crops to generate biotic resistant cultivars is now one of the main solutions. The ability to manipulate pest resistance genes in practical breeding programmes has substantially increased, allowing for the development of high-yielding genetically resistant cultivars. Resistant sources and genetic information are required to generate resistant lines. The purpose of this paper is to describe resistance sources of various vegetable crops against key insect pests, their inheritance, genetic alterations, and biotechnological interventions for future breeding programmes.

References

1. Babu, R.M., Sajeena, A., Seetharaman, K.(2003). Advances in Genetically Engineered (Transgenic) Plants in Pest Management-An Overview. *Crop Protection*. 22: 1071–1086p.
2. Fischhoff, D.A., Bowdish, K.S., Perlak, F.J.(1987). Insect Tolerant Transgenic Tomato Plants. *Biotechnology*. 5: 807–813p.
3. Hu and Leonard.(2003). Identification of Host Plant Resistance to Pepper Leaf Curl Virus in Chilli (Capsicum *spp.*). *Scentia Hort.* 110: 359–361p.
4. More, D.C., Patil, S.B.(1982). Inheritance of Some Characters in Brinjal Cross SM x Nimbkar Green Round. *J. Maha.Agric. Univ.* 7: 243–244p.
5. Pradhan, K., Rout, S., Tripathy, B., Mishra, U.N., Sahoo, G., Prusty, A.K. and Dash, L.(2021). Role of Biotechnology in Vegetable Breeding. Turkish Online Journal of Qualitative Inquiry (TOJQI) 12(3): 5092-5102
6. Singh, B., Sanwal, S.K., Rai, M.(2009). Sources of Biotic Stress Resistance in Vegetable Crops: A Review. *Veg Sci.* 36(2): 133–146p.
7. Singh, M., Chakraborty, S., Kumar, S.(2000). Genetic Engineering for Insect Resistance in Vegetable Crops. *Veg Sci.* 27(2): 105–16p.
8. Sugha, S.K., Pathania, N.K., Kumar, S.(2002). Evaluation of Brinjal Germplasm against Phomopsis Disease. Capsicum & Eggplant. *Newsl.* 21: 106–109p.