BREEDING FOR MULTIPLE DISEASE RESISTANCE IN VEGETABLES: A REVIEW

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ABSTRACT

Vegetable crops are attacked by large number of diseases. Control of these diseases through the agronomical measures and chemical control leads to several disadvantages like higher cost of production, environmental pollution, development of vector resistance to the fungicides and some times chemicals has carcinogenic effect to the human being. Hence development of multiple disease resistant variety is only solution to overcome these problems. In the literature different genetic sources having resistance to important diseases of different vegetables have been reported. The inheritance of resistance to different diseases is may be of monogenic or oligogenic or polygenic in nature. When resistance is governed by single dominant gene, it is very easy to exploit it in heterosis breeding programme. The back cross method is generally used to transfer such type of resistance. When resistance is governed by polygenes generally pedigree method is followed to select resistant plants in the segregating generations. For accumulating more number of resistant genes in to a single cultivar, three way or double crosses are followed. The most important multiple disease resistant varieties include Rodade, Florida-11011 of tomato, JP-9 and JP-179 varieties of pea, Arka Manik of water melon, Punjab Lal and CH-1 (F₁) of chilli which has resistance against two or more diseases.

Vegetable crops are highly prone to several diseases. Losses from diseases may be reduced by agronomical, chemical and genetical measures. Agromonical measures reduced the losses to some extent but are not absolute control measures, while the use of pesticides to control the diseases has several disadvantages, particularly the cost of pesticides and their residual effects. Therefore, major emphasis may be given to the development of disease resistant variety in vegetable crops. "A variety having resistance against two or more diseases is known as multiple disease resistant variety". Multiple disease in vegetable crops so far has not been given due attention in the country. Most of vegetables are attacked by more than one disease at a time. The linkage between few diseases have also been seen. Hence, development of multiple disease resistant varieties/hybrids is the best solution to control or avoid spray of pesticides.

The most important diseases which affect the cultivation of vegetables are bacterial wilt, buckeye rot, fusarium wilt, root knot nematode and leaf curl virus in tomato; phomopsis blight, bacterial wilt, little leaf and root knot nematode in brinjal; fruit rot, leaf curl and mosaic in chilli; powdery mildew, downy mildew and anthracnose in watermelon and muskmelon; powdery mildew and fusarium wilt in pea; cabbage yellow and tip burn in cabbage, and black rot and powdry mildew in cauliflower. To develop multiple disease resistant varieties, knowledge on occurrence of disease for a particular season, knowledge on pathogen race specificity, screening techniques, source of resistance, genetics of resistance and appropriate breeding methodology is required.

SOURCE OF RESISTANCE

Tomato: Genotypes BWR-1, BWR-5, L.F.-79, PI 127805A. Saturn Arka Abha, Venus Arka Alok, Pant Bahar, BT-10, BT-1 and Sonali are resistant against bacterial wilt. Lines EC 174023 and EC 174041 (Kohli et al., 1996), SGP8M2 (Fageria, 1994) FT5 x EC 174023, FT4-5 x EC 174041 (Anonymous, 1996) have been reported to be resistant against buckeye fruit rot. Pant Bahar, Marglobe, Pan America, Mangla and Roma were found to be resistant to fusarium wilt. Lines SI 676 (L. hirsutum) and SI 673 (L. pimpinellifolium) were found to be highly resistant to Fusarium wilt (Kesawan and Choudhary, 1977). Resistant varieties to Fusarium wilt race-1, include Manapal, Heing, 1370, Top Red, Mars, Olio WR29 Anahui, Saturn, Menalucie, Nemared, Napoli, Roma VF, and Chico-III (Yang, 1978). Pusa-120, PNR-7, Hisar Lalit, NRT-3, NRT-8, NRT-12, Mangla, TH2312, TH802, are resistant to root-knot nematodes.
Brinjal: Varieties Pusa Bhairav, Pant Samrat are found to be resistant against phomopsis blight. Florida beauty and Florida market were resistant to phomopsis blight (Decker, 1951). Genotype PB-30, BC-1, JC-2, KS-352 were also found to be resistant to Phomopsis blight. Wild sp. of brinjal like S. nigrum, S. xanthocarpum, S. gilo, S. testiculam, S. khasianum and S. torvum have been reported to be resistant against Phomopsis blight (Kalda et al., 1976). The brinjal lines SM1, SM6, SM48, SM56, SM70, SM72, and SM74 and one line of S. texanum were found resistant to bacterial wilt. Solanum melongena var. insanum, S. nigrum, S. xanthocarpum, S. sisymbri folium are reported to be resistant against bacterial wilt. BB-11 and BB-7 (Sharma and Kumar, 1995); Arka Alok, Shakti, Annamali and Arka Nidhi were reported to be resistant to bacterial wilt while varieties PPC, H-8, S.212-1, and S.252-1 were resistant to little leaf. Pusa Purple Round was tolerant to little leaf disease of brinjal (Peter, 1986).

Chilli: Varieties Chinese Giant, Yolo, Hungarian Yellow Wax, Spartan Loral, S-27, S-41-1 are resistant to fruit rot. Capsicum Chinense spp. is resistant to fruit rot whereas Pusa Jwala, Pant C-1 are resistant to leaf curl virus. Varieties Pusa Sadabahar, Pusa Jwala, Punjab Lal, Capsicum chinense (Van den Berkmortel, 1977) and C. chinense P. 159236 are resistant to Tobacco leaf curl virus.

Watermelon: Arka Manik has resistance to powdry mildew, downey mildew and anthracnose whereas varieties Rodas Lov, Black Stone, Sheltran Grey, Kango were found resistant to anthracnose.

Muskmelon: Varieties Arka Rajhans, PMR-45, RM-43, are resistant to powdry mildew. PMR-450 (Bohn and Whitaker 1964), Edisto (Copeland, 1957) were reported resistant to powdry mildew. Resistant to powdry mildew has been reported in P1 164323 and P1 180283 (Kaan, 1973). Line EC 163888 and SNAPmelon collection like SP-1, SP-2, SP-3, KP-7 and KP-9 (Singh et al. 1996) were found to be resistant to downy mildew. WMR-29, MR-1, Punjab Rasila and Cinco were also found resistant to downy mildew.


Cabbage: Varieties AC-238, Spitzkool and EC-93559 are resistant to cabbage yellow. Badger inbred 12 and 13 are resistant to cabbage yellow and tipburn. Variety Globelle is resistant to cabbage yellow and powdry mildew.

Cauliflower: Varieties Pusa Subhra, Pusa Snowball, K-1 and Sel-8 are resistant to black rot. Pusa hybrid-2, BR-2, MGS-2-3, CC-12C, EWAWH are resistant to downy mildew.

Genetics of Disease Resistance

Briffen (1905) was the first who studied genetics of disease resistance. Pearson and Siddhu (1971) reviewed 1000 published papers and concluded that regardless of species, resistance generally segregated in the mendelian ratios. Resistance was dominant over susceptibility. Resistance in vegetable crops have been reported to be governed by mono or oligo or polygenes and effect of genes may be additive or dominant or epistatic. The information on inheritance of various diseases of vegetables is very meagre. However, some workers reported different kinds of nature of inheritance. Resistance to buckeye rot of tomato appeared to be dominant over susceptibility (Obero and Aragabi, 1965). Resistance to buckeye rot was reported to be controlled by single dominant gene (Rattan and Saini, 1979 and Chauhan 1987). Resistance to fusarium wilt of tomato was conditioned by a single dominant gene. Tomato leaf curl virus is transmitted by white fly (Bemisia tabaci) and is most serious problem. According to Som and Chaudhary (1975), resistance to TLCV was incompletely dominant and governed by polygenes. Diseases like leaf mould Rhizoctonia root rot, spotted wilt virus, TMV and root knot nematodes of tomato are controlled by single dominant gene. Bacterial wilt caused by Pseudomonas solanacearum is a serious problem of brinjal in India. Swaminathan and Shreenivasan (1971) reported that a single dominant gene for resistance was found in S. melongena var. insanum. The major dominant gene was found to be resistance to Anthracnose of brinjal or chilli.

Cheema, (1985) has reported that resistance to Anthracnose of chilli was conditioned by recessive, additive, dominant and epistatic gene effects. Resistance to bacterial wilt and TLCV of chilli was governed by dominant gene. According to Galmarni (1975) a dominant gene along with a
modifier may be involved in the control of resistance to *Phytophthora capsici*.

Resistance to most of the diseases in watermelon is controlled by a single dominant gene. Walker (1941) reported resistance to fusarium wilt in watermelon as recessive. Powdery mildew is a major limiting factor in the production of muskmelon in most of the parts of the world. Resistance to *Erysiphe cichoracearum* race-1 and race-2 is monogenic dominant. Resistance to powdery mildew caused by *Sphaerotheca fuliginea*, studied in two resistant varieties campo and PMR-6 indicated that they have the same locus/loci conferring resistance. Genetic studies of resistance to *E. cichoracearum* race-2 had indicated that resistance is partly dominant and controlled by Pm-2 (Bohn and Whitaker, 1964). Resistance to downy mildew (*Pseudoperonospora cubensis*) of muskmelon in PI 124111 is controlled by two independently dominant gene (Cohen et al. 1985). Whereas resistance in PI 124112 was controlled by 2 partially dominant genes (Kenigsbuch and Cohen, 1992). In cauliflower mode of resistance to black rot is polygenic.

**BREEDING METHODOLOGY FOR MULTIPLE DISEASE RESISTANCE**

The breeding procedure for multiple disease resistance are essentially the same as those for other horticultural traits. Following are the certain breeding procedure may be employed for developing multiple disease resistant varieties in vegetables.

Use of appropriate screening techniques to select resistant/tolerant genotype is very important. Williams (1977) advocated simultaneously or sequential screening for more than one disease. Alternatively one can use a line already resistant to one or two diseases and incorporate resistance for other disease in the same line from other sources. Using similar technique Peterson et al. (1982) developed Wisconsin 2757 cucumber which was resistant to as high as nine diseases Grafton et al. (1997) reported Haton pinto bean which was resistant to common mosaic potyvirus and uromycete. Singh (1986) suggested that development of hybrid varieties should be based on parental lines each having a resistance to one or more diseases.

Khush (1977) also suggested that development of single cross F1 hybrid could be crossed with other resistant donors to make double or top crosses to combine resistance to given disease. If more donors are available for single parasite, it is desirable to use good combiners for yield component and plant type etc. Gardner (1985) and Bosch et al. (1990) also advocated to go for three way and four way crosses and then selecting resistant plants in segregating generations for more than one disease. The pedigree method is suitable for handling the segregating populations. Barnes (1961) reported that plants having promising complemental characters in F3 to F5 generations may be crossed for developing multiple resistant cultivars. The entire complex consisted of widely divergent mutagenic characters conferring resistance.

Interspecific hybridization is an another approach, where individuals from two distinct species of the same genus are crossed. The resistance from wild species or genera may be transferred to commercial cultivars. A population was developed among the species of *Cucurbita pepo*, *C. maxima* and *C. lundelliana* possessing resistance to powdery mildew as a bridge species among the interspecific crosses for developing multiple disease resistant varieties to powdery mildew, downy mildew and squash mosaic virus in *C. pepo*. This was called inter breeding gene pool method.

It is important to use back cross method in case of oligogenic resistance whereas in case of polygenic system controlled mating among the resistant progenies in the back cross or F2 or Succeeding generation may be followed. Recurrent or reciprocal recurrent selection methods are often used in simultaneously improving horticultural characters while incorporating disease resistance (Sharma, 1997). Biotechnological techniques have also been used successfully to develop multiple disease resistant genotype viz., Somatic hybrids (*S. breuidens × S. tuberosum*) were resistant to potato leaf roll virus and late blight. Transgenic plants in tomato partially resistant to TMV and tomato mosaic, transgenic line ZW 20 in squash is resistant to Zucchini Mosaic Virus and CMV.

**PROMISING RESISTANT VARIETIES**

Work on multiple disease resistance, where phenomenal success achieved has been reviewed as under. Florida 1011 tomato breeding line was found to be resistant to verticillium wilt, fusarium wilt, grey leaf spot and leaf mould (Volin et al., 1977) “Rotam-4” a multiple disease resistant fresh
market tomato, was resistant to nematodes, bacterial wilt, bacterial canker, fusarium wilt (race-1 and race-2 of pathogen), verticillium wilt and bacterial speck (Bosch et al., 1990). 1-7-1 x Patriot, 7-9-6-1O'and EC 177401 x Sylvestra were resistant to fruit rot and early blight disease of tomato. Variety floramerica of tomato was found to be resistant against fusarium wilt, grey leaf spot, leaf mould Alternaria leaf spot, Verticillium wilt and TMV.

Bosch et al., (1990) reported that variety Rodade was found to resistant against bacterial wilt, fusarium wilt and verticillium wilt of tomato. Variety K-4053 was resistant against late blight and mosaic of tomato (Khrustaleva and Shecherbakov, 1987). F1 hybrid variety Neelima of brinjal was resistant against bacterial wilt and tolerant to Phomopsis blight. In chilli F hybrid CH1 has resistance against fruit rot, dieback, CMV and CLV. In Pea variety JP-179 was found to be resistant against powdry mildew, fusarium wilt, leaf minor, rust and bruchus. JP-9 variety was also found to resistant against powdry mildew and fusarium wilt. In cucumber variety poinsette has been reported to resistant against downy mildew, powdry mildew, anthracnose and angular leaf spot. In water melon variety Arka Manik was resistance against powdry mildew, downy mildew and anthracnose.

REFERENCES


