Management of Major Diseases and Pests of Mustard in India

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Mustard (*Brassica juncea*), the major edible oilseed brassica crop in India, is extensively grown traditionally as a pure crop as well as intercrop (or mixed crop) in marginal and sub-marginal soils in the eastern, northern and north western states of India. Cool moist climate of winter months is the major factor for the luxuriant growth and productivity of mustard in these states. In relatively warmer winter climate in the Central and Southern states, mustard is grown only as a mixed crop for seed being used for condiment purposes. Productivity of mustard is highest (1559 kg ha^{-1}) in the state of Haryana and lowest (524 kg ha^{-1}) in Assam with an overall national average being in the range of 900-1150 kg ha^{-1} which is the actually harvested yield and is commonly a fraction of the attainable yield of 2500-3000 kg ha^{-1} because of unmanaged or inadequately managed major diseases and pests at different phenological stages of the crop.

Among several diseases, four diseases *viz*; *Alternaria* blight (*Alternaria brassicae*), white rust + downy mildew complex (*Albugo candida* + *Hyaloperonospora parasitica*), Sclerotinia stem rot (*Sclerotinia sclerotiorum*) and powdery mildew (*Erysiphe cruciferarum*) are of great economic importance, whereas among several insect pests, mustard aphid (*Lipaphis erysimi*) is the key pest and five others *viz*, sawfly (*Athalia lugens proxima*), painted bug (*Bagrada hilaris*), leaf miner (*Chromatomyia horticola*), cabbage butterfly (*Pieris brassicae*) and Bihar hairy caterpillar (*Spilosoma obliqua*) are assumed to be of regional and sporadic importance (Kolte, 1985; Bakhetia *et al.*, 2002).

A. Detection/Diagnosis: Some disease and insect pest problems can be easily diagnosed based on symptoms, signs and syndrome etc. However, quite a few need careful and very close observation before making any recommendation for their control. These are: (a) wilt-like symptoms due to termite damage; (b) virus or phytoplasma – like symptoms due to drift of 2, 4 –D spray on adjacent wheat or in mixed crop of mustard; (c) improper opening of flower buds due to pollen beetle inside the flower bud–abnormal flower buds; and (d) seedling toxicity symptoms due to careless handling of seed treatment agrochemicals.

B. Disease and Pest Management

1. **Host/Varietal resistance or tolerance**

Absolute resistance or very high degree of resistance to *Alternaria* blight (AB) is not available in existing cultivars of desirable maturity type. Among different species, *Brassica juncea* and *B. rapa* are more susceptible than *B. carinata* and *B. napus*. Germplasm lines found tolerant to AB in *B. juncea* are: PHR-2 PAB9511, PAB 9534, EC 399301,EC399299. EC399313, and JMM 915. Early dwarf high yielding mustard strain "DIVYA" possesses the growth and developmental traits associated with high degree of tolerance to AB (Kolte *et al.*, 2000). Sources of resistance to *A. brassicae* have been spotted in wild crucifers such as *Brassica (= Synapis) alba B. desnottesii*, *Camelina sativa. Capsella bursa pestoris. Coincya pseuderucastrum. Diplotaxis berthautii, D. catholica D. cretacea, D. erucoides,Erucastrum gallicum and E. canariense (Bhaskar et al., 2002; Sharma et al., 2002) B campestris ssp. rapifera* is also reported to be resistant to *A. brassicae*. Resistance or tolerance to *Alternaria* is found to be associated with factors like: (a) resistance to deposition or settling of spores, i. e. failure of spore (conidia) retention due to epicuticular wax; (b) resistance to germination of spore and penetration i.e. reduction in rate of conidial germination and germ tube formation due to high phenolic compounds viz, polyphenol oxidase, peroxidase and catalase activities in leaves; and (c) partial or infection rate reducing (race- nonspecific) characteristics of tolerant genotypes. There has been indications that components of partial resistance like small lesion size, low intensity of sporulation, high incubation period, and longer latent period all being significantly correlated with each other leading to lower infection rate and low AUDPC (Saharan and Kadian, 1983; Kumar and Kolte, 2001). Mechanisms of resistance/tolerance, when studied genetically, have been reported to be governed by additive genes or ploygenes with resistance being controlled by genes of partial dominance. From the above, it could be seen that breeding for resistance to *Alternaria* would involve exploitation of horizontal resistance by pyramiding of minor genes which would involve study of heritability of components of resistance, introgression of genes from material found resistant, reciprocal recurrent selection or diallel selective mating.

Resistance to white rust (WR, *Albugo candida*) is known to be of race-specific nature governed by major genes (1 -3 genes). WR-resistant varieties, viz. Bio-902, and JMMWR 914-1-2 have been released. Resistance to WR has been transferred from *B. napus cv* EC

151964 to *B. juncea* cv RLM 198 and a progeny line NRG – 49 has been recovered which is superior to RLM 198 at the PunjabAgricultural University, Ludhiana. Some exotic *B. juncea* genotypes viz EC 399301 and EC 399299 are resistant to WRand varie+tal/genotypic specificity to infection by the same race of *Albugo candida* is also reported in *B. juncea* indicating the scope for development of more and new differential hosts within *B. juncea*, the main crop species in India. It is interesting to note that some genotypes of *B. juncea* viz EC 399301 and 399299 are susceptible at cotyledonary stage but resistant at true leaf stage indicating involvement of two separate genes for reaction to *A. candida* (Mishra *et al., 2009*). *B. napus, B carinata and B. maurorum* show resistance to a predominant isolate of *A. candida* from main mustard-growing region (from north). But *A. candida* isolate from Karnataka is virulent on *B. carinata* and most *B. juncea* varieties (Kolte – Personal observation). Thus *A. candida* Karnataka isolate appears to be highly virulent and distinct race and potentially much more dangerous from what are prevalent in main mustard-growing regions in the north of the county. The WR infection in mustard in India is mostly associated with downy mildew infection caused by *Hyaloperonospora parasitica*. It has been observed that*A. candida* can predispose downy mildew-resistant plant/variety to infection by *H. parasitica* and complicate the procedure for breeding for resistance to downy mildew.

Breeding for resistance to *Sclerotinia* stem not (SRR) appears to be less successful because of wide host range of the pathogen and lack of tissue specificity to infection. However, morphological and developmental traits of mustard plants among available genotypes can be exploited in breeding for early apetalous varieties with stiff stem. Apetalous line (RC 199 of *B. juncea*) is less susceptible to aphid attack (Singh *et al* , 1991) and *Sclerotinia* in comparison to normal petalled lines. Infection is avoided due to depriving of ascospore germination in the absence of petals falling on susceptible sites.

Resistance to mustard aphid is also not available among the germplasm/ varieties released. However, the most tolerant strains in *B. juncea* are: T 6342, RLM 198, RH 7846, Bio – 902, PCR – 7 (Rajat) and DLM 29. No definite pattern of appearance of biotypes in aphid species is known. (Bakhetia *at al.,* 2002)

2. Agronomic manipulations in disease/pest management: cultural control

Considerable experimental evidences are available in Indian literature on the usefulness of cultural and agronomic practices such as timely sowing, sanitation, ploughing, crop rotation, intercropping, spacing and nutrient management in minimizing the losses due to diseases and

pests in mustard. Early October sowing (Kolte, 1985) balanced NPK application – N_{100} P_{40} K_{40} (Sharma and Kolte, 1994) and sanitation are the important top priority practices in management of most major diseases and aphid infestation. The increase in infection rate of AB, WR and SSR diseases and infestation rate of aphid attack is directly proportional to delay in planting of the crop in most mustard-growing areas in the country. The same is true with respect to powdery mildew infection and severity in non-traditional areas in the central and southern states of India. Use of early maturing varieties allowing the diseases escape mechanism (Kolte e*t al.,* 2000), and spray application of micronutrients like boron and zinc (Table 1) are also very useful practices in the control of AB and aphid infestation. Club root disease is important in the State of West Bengal. It can be controlled at Soil pH 7.2 by adding 3t ha^{-1} of lime in the infested soil. Mechanical removal of aphid-infested twigs at 20% plant infestation (9 aphids/central shoot) offers great promise. This practice has been demonstrated to be useful in insecticide-free management of the crop in the Haryana state of India. Economic threshold of the aphid *L. erysimi* under different ecological situations in India is shown in Table 2.

3. Biological Control

Despite a good potential of biological control agents for disease and pest management, their usages in mustard are limited. Antagonists *Trichoderma harzianum, T. viride* (G R isolate), *Streptomyces rochei*, and *Bacillus subtilis* strain (UK-9) are very effective against *Alternaria brassicae*, A *brassicicola* and *Plasmodiophora brassicae.* Predators such as *Coccinella septempunctata* (10 grubs/m^2) are known to be efficient biocontrol agents against mustard aphid infestation (Meena *et al.,* 2004). Evidence of inducing host resistance in the susceptible host variety in reported in *Brassica–A. brassicae* system. Resistance in susceptible mustard against aggressive *A. brassicae* isolate A can be induced using prior inoculation of plants with non-aggressive *A. brassicae* isolate D. (Vishwanath *et al*., 1999). Systemic induction of resistance in susceptible plants of mustard can be obtained by prior inoculation of plant with incompatible isolate of *Albugo candida* (Singh *et al.,* 1999). Considerable number of botanicals and plant-based products are reported to be useful in the management of AB and mustard aphid (Patni *et al.,* 2005). Among these garlic (*Allium sativum*) bulb extract (1% w/v) and leaf extract (1.5 – 2%) of*Azadirachta indica* (*neem*) and *Eucalyptus* species offer great promise (Meena *et al.,* 2004). Water-based neem seed kernel extract (NSKE) @ 10% is found to be very useful in the management of mustard aphid (Bakhetia *et al.,* 2002).

4. Chemical Control

Pre-emergence and post-emergence seedling blight and damping-off diseases caused by *Rhizoctonia solani, Sclerotium rolfsii* and/or *Fusarium* species can be controlled by seed treatment with effective fungicides. Usually a mixture of thiram + carbendarim (2:1) or thiram + carboxin (2:1) @ 0.2% is recommended. In case of downy mildew infection at the seedling stage, the disease is brought under control by treating the seeds with Apron 35 SD (metalaxyl) @ 6 g/kg seed. Sowing time x pesticide (fungicide and insecticide) interaction also becomes an important consideration in disease and insect pest management in later stages of crop growth. If mustard crop is sown late and fertilized excessively with nitrogen, the crop tends to get affected more severely by pests and diseases but can be protected from major diseases and aphid (the key pest) by spraying the cop at flowering-to-early pod formation stage with a mixture of Ridomil MZ 72 WP (a mixture of metalaxyl (8 %) and mancozeb (64%) (Biswas *et al.*,2007; Kolte, 1985). In case powdery mildew becomes severe in central Indian states, Karathane or carbendazim @ 0.05 – 0.1% is reported to be useful.

The above discussion suggests that the disease and pest management in mustard can be best achieved by adopting an integrated approach i.e. use of early maturing and disease / pest tolerant variety, and early October sowing and need-based strategy of insecticide/fungicide use. The compatibility of bio-control agents with resistant/tolerant cultivars, companion crops, cultivation practices followed and botanicals and safer pesticides is to be worked out for sustainability of the disease and pest management practices.

Table 1 : Effect of some chemical nutrient salts on severity of Alternaria blight and yield of Mustard cv. Varuna (Kumar, 2003).

Treatment	Conc(%)	AUDPG	Yield Kg/ha
$CasO_4$	0.50	32.25	1560
	1.50	35.33	1596
K_2SO_4	0.50	45.30	1339
	1.50	42.40	1443
$ZnSO_4$	0.25	45.30	1330
	0.75	46.75	1510
$Na_2B_4O_7$	0.25	46.60	1427
	0.75	45.10	1642
Check		77.95	1355
CD at 5%			213.10

Table 2 : Economic threshold of *L. erysimi* under different agro-ecological situations in India (Bakhetia *et al.,* 2002).

State	Mustard Variety	Economic threshold
Harayana	RL-1359	9 aphids/central shoot or 20%plant infestation.
Uttar Pradesh	Varuna	9-13aphids/15 cm top terminal
Punjab	RLM-198	50-60aphids/10 cm shoot or 40-50% plant infestation of 05-1 cm of aphid colony on central shoot.
Himachal Pradesh	Brown Sarson (Local)	4 mm shoot infestation

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