Integrated Pest Management on Mustard Crop

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Indian vegetable oil economy is the world's fourth largest after United States, China and Brazil. India is third largest rapeseed- mustard producer in the world after China and Canada with 12 per cent of world total production. Rapeseed-mustard ranks second after soybean among edible oilseeds in production and contributes to more than 30% of edible oil production in India. Rapeseed-mustard group pf crops comprise mustard / raya, toria, brown Sarson, Yellow Sarson, Gobhi Sarson, black mustard and taramira. The crops occupy an area of 6.01 million hectare, yield 8.04 million tons with average productivity of 1339kg/ha (AICRPRM, 2018). Mustard is mainly cultivated in India, which contribute about 90 per cent of the total rapeseed-mustard production. It is predominately grown in *Rabi* season in wheat belt of northern (Haryana, Punjab and Jammu and Kashmir) India. The important factors causing low and fluctuating production of mustard in India are low or non-adoption of package of improved production technology, susceptibility of mustard varieties to pest and diseases and non-adoption of pest and diseases management practices. The major insect-pest of mustard include Aphid (*Lipaphis erysimi)* and Painted bug (*Bagrada hilaris),* threatening the crop right from sowing until end of crop season. Among diseases white rust (*Albugo candida), Sclerotinia* rot (*Sclerotinia sclerotiorum), Alternaria* blight (*Alternaria brassicae)* and powdery mildew (*Erysiphe cruciferum)* are the major diseases, which reduced the yield potential of rapeseed mustard substantially (Chattopadhyay *et al.,* 2015). The loss in yield may depend upon the nature of the pest and severity of attack. In India, mustard is predominately grown in which integrated pest management (IPM) is urgently required. ICAR-National Research Centre for Integrated Pest Management (NCIPM) has been working on synthesis and validation of IPM in mustard over two decades. Extensive surveys of mustard growing areas revealed that excessive and injudicious use of chemical pesticides and fertilizers have aggravated the pest menace, secondary pest outbreaks and caused environmental degradation. Recently a holoparasitic weed Broomrape (*Orobanche aegyptica)* has emerged as a serious pest in mustard.

Key Pests of Mustard

Mustard Aphid (*Lipaphis erysimi)*: This is a major pest of mustard. It causes loss to the crop from December to March. This insect can cause loss from 25 to 40 per cent. Both nymphs and adults suck cell sap from leaves, stems, inflorescence and developing pods, as a result plants remain stunted, reduced pod and grain number, pod shrivel up and seed do not develop. Economic threshold level of this pest is when

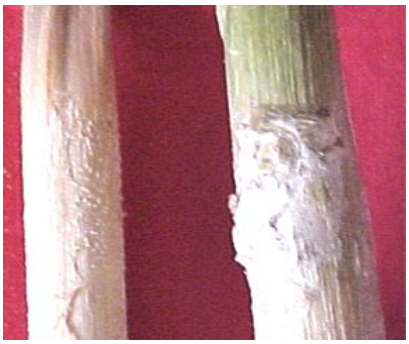
pest population reaches 20-25 aphids/ plant and when 30 per cent plants are infested.

Painted Bug {(*Bagrada hilaris (cruciferarum*)}: This pest attacks the crop at two stages in the season i.e. at initial stage in October-November and crop maturity stage in March-April. The nymphs and adults suck cell sap from leaves and pods, which eventually wilt and dry up. This insect also reduced the oil quantity by sucking pods, pods shrivel up and seed do not develop.

Alternaria blight: In mustard crops, this disease is mainly caused by *Alternaria brassicae*. However, other species of Alternaria that is, *A. brassicicola*, *A. raphani* and *A. alternata* have also been reported parasitizing these crops in India. This is widely distributed, more destructive and most damaging disease under epiphytotic conditions, causing yield loss up to 70 per cent. Heavy losses in yield occurs if favourable conditions like an average temperature of 18^{o}C with relative humidity 80 percent or above and stormy weather prevail especially during flowering and pod development stages. The shrivelled and discoloured seeds fetch lower market price. The disease is characterized by formation of brown colour concentric rings on leaves, stems, siliquae and pods. *Alternaria brassicae* survives on diseased plant debris in the soil and many alternate cruciferous hosts like, cauliflower, cabbage, turnip, radish etc.

White rust: This is a common disease of mustard caused by fungus *Albugo candida* and attacks all the plant parts except roots. The disease appears as prominent white creamy scattered raised and roundish pustules on the under surface of lower leaves. Many pustules coalesce and form large patches which cover entire lower surface of the leaf. This disease when appears on stag head phase distorts inflorescence, where it causes hypertrophy and hyperplasia causing 17-34 per cent loss in yield. White and creamy pustules also appear on the hypertrophied parts.

Sclerotinia rot: *Sclerotinia* rot caused by fungus *Sclerotinia sclerotiorum* is the major pest in mustard. Its infection at early stages of plant growth results in complete failure of the crop whereas late infection lowers the yield quantity and quality as well. Disease increases with mono-cropping of mustard. In individual affected plants some time no grain is formed. In recent years, Sclerotinia rot has emerged as major pest in



mustard in North India. The extent of damage is 40 - 80 per cent in Haryana and Punjab. The disease appears as elongated, buff to light brown water soaked lesions, which later rot and are covered with white, cottony mycelial growth of the fungus. All the affected parts of the plants rot in cool and wet weather. The affected plants show stunting and premature ripening, shredding of stem, wilting and drying. A large number of black sclerotia appear in fungal growth around the rotted stem. The sclerotia survive in the soil for longer period.

Powdery mildew caused by *Erysiphe cruciferarum* is a disease of warmer and drier tracts, where mustard is grown. The disease is gradually becoming common with shortening of winter and climate change. The disease usually arrives in later part of crop. However, it is also observed during vegetative stage, whereby the pathogen could cause significant loss to the crop.

Broomrape (*Orobanche aegyptica***)**: Mustard crop in Haryana over large area has been severely infested with holoparasitic weed broom rape, which has threatened the cultivation in these areas. This parasitic weed grows on the roots of mustard plants in response to germination stimulants secreted by its roots and looks like a beautiful plant. As infestation of this weed starts after 7-10 days of sowing of oilseeds Brassica. So control measures in early stages of crop growth should be applied.

IPM Interventions in mustard at different growth stages of the crop

IPM is a systems approach that combines a wide array of crop production and protection measures to minimize the economic losses caused by pest. Hence, use of low or judicious dose of pesticides, integrated with other means like growing pest tolerant cultivars, sanitation, crop rotation, use of bio-agents and plant extracts seems to be best method of pest management without environmental pollution. ICAR-National Research Centre for Integrated Pest Management, New Delhi conducted multilocational field trials of IPM technology of mustard in farmers' participatory mode in Haryana and Rajasthan. Based on which IPM interventions at different growth stages of the mustard crop were developed which are as follows:

Pre-sowing stage

- Deep summer ploughing the soil to expose the soil-borne pathogens and to destroy egg of painted bug in order to reduce the primary source of inoculum
- Preparation of level and well drained field to ensure proper drainage of water
- Follow appropriate crop rotation and balanced dose of fertilizers as per location specific recommendation

- *Sesbania* green manuring along with soil incorporation of mustard waste @ 2.5 ton/ha in *Kharif* season
- Removal of pest debris and residue of previous crop to reduce the soil-borne inoculum of diseases. Painted bug also thrives on crop residues and weed

Sowing Stage

- Soil incorporation of *Trichoderma* based product @ 2.5 kg/ha pre-incubated in 50 kg of well rotten farm yard manure to reduce soil-borne inoculum of diseases
- Sowing at proper time (01-31 October). It escapes the attack of aphid, painted bug and white rust
- Use of disease resistant hybrids and varieties recommended for the region
- Seed treatment with freshly prepared aqueous garlic bulb extract (1% w/v) or *Trichoderma* based product @10 g/kg
- In case of downy mildew infection, the disease is brought under control by treating the seeds with metalaxyl-M 31.8% ES @ 6 ml/kg seed
- Avoid narrow spacing/ heavy seed rate

Seedling and Vegetative stage

- Maintain recommended spacing of plants by thinning of crop
- Irrigation of crop at seeding stage to protect against painted bug
- Maintenance of weed free crop by clean cultivation
- Regular monitoring of crop and destroying of pest infested/ infected plants
- Spray application of micronutrients like boron and zinc are also very useful practice in pest management
- Judicious use of irrigation depending on soil type and rain fall. Irrigation after vegetative stage should preferably be avoided.
- Hand picking of aphid-infested twigs in the initial attack
- Conservation of natural enemies of Aphids namely *Coccinella septempunctata, Chrysoperla carnea*, Syrphid fly, etc.
- Application of two drops of soybean oil per young shoot of Orobanche reduced the infestation
- Removal of heavily diseased plants from the field and apply need based spray of freshly prepared aqueous garlic bulb extract (2% w/v)

Flowering and Pod formation stage

- Regular monitoring of crop field
- Foliar spray of freshly prepared aqueous garlic bulb extract @ 1% (w/v) at early bloom
- If mustard crop is sown late and fertilized excessively with nitrogen, the crop tends to get affected more severely by diseases but can be protected from major diseases by spraying the crop at flowering-to-early pod formation stage with a mixture of metalaxyl 4 % and mancozeb 68%

ECONOMIC ANALYSIS

Crop stage based implementation of IPM mustard module was undertaken in 100 ha in farmers' participatory mode on farmers' fields in districts of Mahindergarh, Haryana and Alwar, Rajasthan in collaboration with *KVK* Mahindergarh, *KVK*, Jhajjar and *KVK*, Navgaon, Alwar during 2014-2019.

The key determinants of cost and returns in crop production were compared across the IPM technology and farmers' practice, which provided 10% advantages to IPM. Each additional rupee invested in the adoption of IPM technology gave Rs.5.1 in return, thus giving a good economic logic for adoption of the technology. Studies on prioritizing components of package of integrated pest management in Indian mustard (*Brassica juncea*) in India for better economic benefit were conducted during 2014-2017 (Yadav *et al*., 2019). The studies highlights the impact of input costs, which allows growers to decide inputs based on the prevalence of biotic stress (es), the decision on intervention based on the importance of the same with an idea about the resultant quantifiable and monetary impact.

VALIDATION OF IPM IN MUSTARD IN FARMERS' PARTICIPATORY MODE: A SUCCESS STORY

ICAR-National Research Centre for Integrated Pest Management (NCIPM) has been working for synthesis and validation of IPM in mustard for more than decade. The technology has been successfully demonstrated at village level in Haryana and Rajasthan in farmers' participatory mode (Yadav *et al*. 2012). As IPM is location specific and dynamic, therefore, need regular updating because of changes in pest scenario due to introduction of new hybrids and monoculturing in large tract of irrigated and water logged soil, where close spacing and heavy fertilization was practised. In 2010, after introduction of high yielding hybrids by ICAR-AICRP on rapeseed-mustard, *Sclerotinia* rot disease (*Sclerotinia sclerotiorum*) emerged as a serious problem in mustard because few hybrids are highly susceptible to this disease. Desperate mustard growing farmer of Siyali Khurd village (District Alwar of Rajasthan) approached NCIPM because of severe incidence of *Sclerotinia* rot. Siyali Khurd Village (latitude N27^{o} 54' 23.2'' longitude E 76^{o} 36' 27.7'') is about 150 km away from IARI Campus, Pusa, New Delhi in flood prone eastern plain zone III b of Rajasthan. Baseline information of village indicated that the farmers of the area, prior to IPM implementation were taking monoculture of mustard without crop rotation & deep summer ploughing and no

seed treatment with *Trichoderma* was undertaken. In addition to this recommended dose of fertilizer along with gypsum @250 kg/ha and Potash @40 kg/ha, soil incorporation of *Trichoderma* @ 2.5kg/ha pre-incubated in 50 kg well rotten FYM and seed treatment with *Trichoderma* @ 10g/kg seed were followed. By destroying the previous crop residue in IPM, crop was avoided from painted bug infestation and loss due to disease causing soil-borne pathogens. In IPM practices appropriate seed rate of 4 kg/ha was followed along with regional specific optimum sowing time which escape the incidence of aphids, *Alternaria* blight, white rust and *Sclerotinia* rot. Farmers were not aware of IPM concept and were not able to identify insect-pests, diseases and beneficial. Based on baseline information collected at Siyali Khurd in 2011, the IPM module was fine-tuned and implemented in 40 ha in 2011-12 in Haryana and Rajasthan, which was subsequently implemented in 40 ha during 2012-13 and 2013-14, as more and more farmers become part of IPM programme. Implementation of IPM resulted in significant reduction in the severity of *Sclerotinia* rot with higher yield as well as benefit cost ratio in IPM as compared to farmers' practices. After 2014, need based regular updating of IPM mustard are undertaken and crop stage based IPM interventions are validated in 20 ha in farmers' participatory mode on farmers' field in district of Alwar (Rajasthan), Mahindergarh-Jhajjar (Haryana) and Morena- Bhind in Madhya Pradesh in collaboration of *Krishi Vigyan Kendra*, Navgaon, Alwar of Sri Karan Narendra Agriculture University, Jobner, Rajasthan and *Krishi Vigyan Kendra* Mahindergarh and Jhajjar of Chaudhary Charan Singh Haryana Agricultural University, Hisar, Haryana and Zonal agricultural Research Station, Morena of Rajmata Vijayraje Scindia Krishi Vishwa Vidyalaya, Gwalior, Madhya Pradesh.

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