

## Integrated Pest Management in Mustard crop through Farmers Participatory mode

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India is world's fourth largest edible oil economy after United States, China and Brazil. Although, India is the Largest cultivator of oilseed crops (28.52 m ha), yet it is also a major importer of edible oils (11.0 metric tons). 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 among the edible oilseeds in production and contributes to more than 30% of edible oil production in India. Major species of oilseed Brassicas in India are *Brassica juncea* (90% area); *B. napus* (canola) and *B. rapa*. Mustard oil contains high amount of essential fatty acids and is the richest source of essential fats-Omega-3 alpha-Linolenic acid (ALA). The crops occupy an area of 6.01 million hectare, yield 8.04 million tons with average productivity of 1339 kg/ha (AICRPRM,2018). Indian mustard is mainly cultivated in India, which contribute about 90 per cent of the total rapeseed-mustard production. These crops are predominately grown in *Rabi* (post rainy) season in India. The important factors causing low and fluctuating production of these crops in India are low or non-adoption of package of improved production and protection technology and susceptibility of mustard varieties to pest and diseases. The loss in yield may depend upon the nature of the pest and severity of attack. Considerable advancement in research has led to an increase in the productivity of the rapeseed-mustard, particularly in China and India. The earlier studies, in general were based on rapeseed which is widely grown in U.S., Germany and Canada but in India Indian 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 excessive and injudicious use of chemical pesticides and fertilizers that aggravated the pest menace, secondary pest outbreaks and caused environmental degradation. The major insect-pests of mustard includes Aphid (*Lipaphis erysimi*), Painted bug (*Bagrada hilaris*) and Leaf miner (*Chromatomyia horticola*) threatening 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) Recently a holoparasitic weed Broomrape (*Orobanche aegyptica*) has emerged as a serious pest in rapeseed mustard.

**Brief description of key pest are as follows:**

**Mustard Aphid (*Lipaphis erysimi*):** This is a major pest of rapeseed-mustard. It causes loss to the crop from December to March. This insect can cause loss from 25-40 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 (ETL) of this pest is when pest population reaches 20-25 aphids/plant and when 30 per cent plants are infested.



**Painted Bug (*Bagrada hilaris*):** 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 rapeseed-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. The shrivelled and discoloured seeds fetch lower market price. The disease is characterized by formation of small light brown round spots on lower leaves. Later on these spots develop into big circular dark coloured with concentric rings clearly visible in these spots. Pods may show sunken, dark brown to black circular lesions. Deep lesions on the pods cause infection in the seed. *Alternaria brassicae* survives on diseased plant debris in the soil and many alternate cruciferous hosts like, cauliflower, cabbage, turnip, radish, etc.



**White rust:** It is 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 heavy 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 monocropping of mustard. In individual affected plants some time no grain is formed. 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.



**Powdery mildew:** It is caused by *Erysiphe cruciferarum* which is a pathogen of warmer and drier tracts, where mustard is grown. The disease is gradually becoming quite severe in Haryana, Rajasthan, Madhya Pradesh, Uttar Pradesh and Gujarat with shortening of winter and climate change resulting in considerable loss in yield. The disease usually arrives in later part of crop. However, it is also observed during vegetative stage, whereby the pathogen appeared, could cause significant loss to the crop.



**Broomrape (*Orobanche aegyptica*):** 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 mustard. Therefore, control measures in early stages of crop growth should be applied. The seed of the parasite survives in soil or as seed contaminants along with mustard seed and serve as source of inoculum. It survives many years in the soil.



## IPM Strategy

An inter-disciplinary and inter-institutional team to address these problems through holistic tactics has synthesized IPM strategies. Validations of IPM in farmers' participatory mode on farmers' fields were done along with demonstrations. The validated interventions of IPM for mustard across locations over seasons are furnished. 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. On the basis of which IPM interventions at different growth stages of the mustard crop were developed which are as follows:

### Pre-sowing stage

- Deep summer ploughing to kill fungal spores and residual population of pests
- Ensure proper drainage of water, Preparation of level and well drained field
- Crop rotation and balanced quantity of seed and fertilizers as per location specific recommendation of the region
- Apply 15 kg of Zinc sulphate + sulphur per hectare as per location specific recommendation
- *Sesbenia* green manuring along with soil incorporation of mustard waste @ 2.5 t/ha in *Kharif* season
- Removal of pest debris and residue of previous crop to avoid painted bug infestation and disease causing pathogens

### Sowing Stage

- Sowing at proper time (01-31 October) which escape the incidence of aphids and diseases
- Use of disease resistant hybrids and varieties recommended for the region.
- Soil incorporation of *Trichoderma* based product @ 2.5 kg/ha pre-incubated in 50 kg of well rotten farm yard manure for management of soil borne pathogens
- Seed treatment with freshly prepared aqueous garlic bulb extract (2% w/v) or *Trichoderma* based product @ 10 g/kg or metalaxyl-M 31.8% ES @ 6 ml/kg seed for the management of seed-borne pathogens.
- Avoid narrow spacing/heavy seed rate for the management of *Sclerotinia* rot.

### Seedling and Vegetative stage

- Maintain recommended spacing of plants or optimum plant population by thinning
- Irrigation of crop at seeding stage to protect against painted bug
- Maintenance of weed free crop by clean cultivation which act as collateral hosts for pathogens
- 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 to reduce *Sclerotinia* rot.
- Hand picking of aphid-infested twigs in the initial attack.
- Conservation of natural enemies of Aphids namely *Coccinella septempunctata*, *Chrysoperla carnea*, Syrphid fly, etc.
- Panicle initiation of *Orobanche* starts early so post-emergence application of glyphosate at 25-50 g/ha at 30 and 50 days after sowing holds some promise with 60-80% control of broomrape.
- Release *Chrysoperla* for control of aphid
- Rogueing/thinning of crop

- Destroy the pest infected/infested plants
- Spray of freshly prepared aqueous garlic bulb extract @ 2% (w/v) or *Trichoderma* based product @ 0.2% for management at early bloom stage

### **Flowering and Pod formation stage**

- Regular monitoring of field for pest monitoring
- For environment friendly management of mustard aphid, spray of dimethoate 30 EC @ 1 ml/l of water followed by release of 5000 adult/ha of *Coccinella septempunctata*
- If mustard crop is sown late and fertilized excessively with nitrogen, the crop tends to get affected more severely by white rust 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%.
- In case powdery mildew becomes severe, spraying the crop with Karathane or carbendazim @ 0.05-0.1%.
- Follow spray schedule in standing crop when pest attack is more than tolerance limit.

### **Harvest and Post-harvest stage**

- Harvest at the right stage of maturity
- For drying seed, resort to sun drying. Moisture in the dried pods should be brought down to less than 10% to avoid microbial activity.
- Grading with winnower is to be done to remove defective and discoloured pods.

### **Economic Analysis**

Crop stage based implementation of IPM module was undertaken in 60 ha in farmers' participatory mode on farmers' fields in state of Haryana and Rajasthan of India in collaboration with adopted *Krishi Vigyan Kendra (KVK)* during 2014-17. The key determinants of cost and returns in crop were compared across the IPM technology and farmers' practice, which provided 10% advantage to IPM. Each additional rupee invested in the adoption of IPM technology gave 5.1 in return, thus giving 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° 54' 23.2" longitude E 76° 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. Recently in 2017-19, need based regular updating of IPM mustard was undertaken and crop stage based IPM interventions are being validated in 20 ha in farmers' participatory mode on farmers' field in district of Alwar (Rajasthan) and Jhajjar (Haryana) in collaboration of *Krishi Vigyan Kendra*, Navgaon, Alwar of Sri Karan Narendra Agriculture University, Jobner, Rajasthan and *Krishi Vigyan Kendra* Jhajjar of Chaudhary Charan Singh Haryana Agricultural University, Hisar, Haryana, India.

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