

shriveled and rotten. The disease is more severe in yellow sarson where it can cause yield loss up to 70 per cent. Moist (>70% RH) and warm weather (12-25°C temp) with intermittent rains favour the development of Alternaria blight.

Management:

Timely sowing of healthy and certified seeds, collecting and burn the diseased plant debris and removing weeds can minimize the spread. Spraying of iprodione or mancozeb (Dithane M-45) @ 2 kg/ha dissolved in 800 litres of water at 15 days interval with a maximum of three sprays, normally at 45, 60 and 75 days after sowing is effective to control the disease.

2. White rust (*Albugo candida*)

The white rust disease is found throughout the rapeseed-mustard growing areas of the country, very often in association with downy mildew disease. Small white or creamy yellow raised pustules, which later coalesce to form patches, are found scattered on the lower surface of the leaves. The part of upper surface corresponding to the lower surface is tan-yellow, which enable recognition of the affected leaves. Rust pustules are also observed on surface of well-developed siliquae. In systemic infection or infection through stem or flower, hypertrophy and hyperplasia are observed, which result in formation of stag heads. Affected flowers become malformed, petals become green like sepals and stamens may be transformed to leaf-like club-shaped sterile structures. Ovules and pollen grains are usually atrophied leading to complete sterility. Whole plant infection at very early stage due to systemic infection of white rust in association with downy mildew results in stunted and thickened plant without any branching. The white rust and downy mildew mixed infection can cause yield loss up to 37 % in Indian mustard. Moist air (> 75% RH), cool weather (5-12°C) and short days (2-6 hours sunshine) favour the disease development.



3. Downy mildew (*Hyaloperonospora parasitica*)

The disease usually appears 10-15 days after sowing as small creamy white spots on the leaves in the seedling stage and at times could be even restricted to these leaves with subsequently emerging leaves not showing any symptom. White downy (cottony) growth of the fungus appear on leaves and spread to stems and stag heads formed by white rust pathogens in the moist (>90% RH) and cool (10-20°C temp) weather. Swollen malformed floral parts usually show mixed infection of downy mildew and white rust.



Management of white rust and downy mildew:

Timely sowing of healthy and certified seeds, collecting and burning the diseased plant debris including stag heads and removing weeds and seed treatment with metalaxyl (Apron 35 SD) @ 6 gm/ kg seed can minimize the spread. Spray the crop (maximum three sprayings) with Ridomil MZ 72 WP or mancozeb (Dithane M-45) @ 2 kg/ha dissolved in 800 litres of water soon after the disease appearance at 15 days interval is effective to control the diseases.

4. Powdery Mildew (*Erysiphe Cruciferarum*)

The dirty white, circular powdery patches develop on leaves, stems and pods. As the disease advances, the whole plant looks to be dusted with powder like white talcum. The severely affected plants remain poor in growth and produce less siliquae. Severely diseased siliquae remain small in size, produce seeds, which are small in size and show shriveling. Such siliquae produce few seeds at the base with twisted sterile tips.



Management:

Spray of 1 kg dinocap or 2 kg wettable sulphur/ha dissolved in 800 liters of water at the incidence of the disease is effective to control the disease.

5. Sclerotinia rot (*Sclerotinia sclerotiorum*)

Sclerotinia rot disease is emerging as one of the important diseases of rapeseed-mustard in the country. Earlier sclerotinia rot was considered as a minor disease in India. Yield losses up to 39 per cent has been observed due to this disease. It is a soil borne disease and mono cropping of rapeseed-mustard favours its development. Based on the symptoms, the disease has also been called as white blight, white rot, stem blight, stalk break, stem canker etc. Symptoms on the stem become visible as elongated water-soaked lesions, which later on are covered by a cottony mycelial growth of the pathogen. When the stem is completely girdled by such lesions, the plant wilts and dries. Sometimes the infection is restricted to a smaller area of pith, which results in stunting of the plant and premature ripening rather than the sudden collapse of the affected plants. Such plants under field conditions can be easily identified because of premature ripening. Premature ripening may also cause additional yield loss due to the shattering. The affected stem tends to shred and numerous grayish-white-to-black, spherical sclerotia appear either on the surface or in the pith of the affected stem. In some infected plants, grain formation does occur. The disease also affects the seed quality adversely. When the crop is at maturation stage, the affected plants tend to lodge, bringing the siliquae in contact with soil. Such plants, though remaining free from stem or aerial infection throughout, show rotting of the siliquae with profuse fungal growth, along with sclerotial bodies just above the soil level. Appearance of the disease in an early stage of crop growth, results in damping-off or the death of whole plant. Root rot symptoms are also seen due to the disease.



Management:

Deep ploughing during summer, seed treatment with *Trichoderma* 10 gm/kg seed, collecting and burning of the diseased plants along with sclerotia, follow crop rotation with non-host crops like wheat, barley and maize, sowing of healthy seeds free from the sclerotial bodies and spray of carbendazim @ 2g mor tebuconazole @ 1ml/litre of water at twice at 50 and 70 DAS will reduce its infestation. No irrigation during 25th December to 15th January also help in minimizing the disease.

6. Phyllody (*Mycoplasma like organism*)

The disease has been observed particularly on toria and yellow sarson and is transmitted through insect vector like leafhopper. Up to 90 % yield losses have been reported on the individual plants and losses in yield could be substantial under field conditions, if the percentage of the diseased plants is high. The symptoms include, transformation of floral parts into leafy structures, green and sepaloid petals, indehiscent stamens, ovary without ovules and leafy structures on false septum. Plant parts are malformed into numerous shoots as bushy or broom shaped.



Management:

Sowing of toria should be done by mid September. Rouging of the affected plants at early stage. Spray oxydemeton methyl 25 EC or dimethoate 30 EC @ 800 ml dissolved in 800 litre of water/ha at appearance of the disease.

Author: **Drs. Ashok Kumar Sharma, Pankaj Sharma and P. K. Rai**

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To more information contact us:

Director, ICAR-Directorate of Rapeseed-Mustard Research
Sewar, Bharatpur-321 303 (Rajasthan), India
Phone: + 91-5644-260379,260495 Fax: +91-5644-260565
e-mail: director.drmr@gmail.com Web: <http://www.drmr.res.in>

Premier # 9783855551



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ICAR-DIRECTORATE OF RAPESEED-MUSTARD RESEARCH



(Indian Council of Agricultural Research)

Sewar, Bharatpur 321 303 (Rajasthan) India

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Integrated Disease and Insect Management in Rapeseed-Mustard

Insect Management

Among the major insect in rapeseed-mustard, mustard aphid (*Lipaphis erysimi*), saw fly (*Athalia lugens proxima*), painted bug (*Bagrada hilaris*), pea leaf miner (*Chromatomyia horticola*) and bihar hairy caterpillar (*Diacrisia obliqua*) are the important insect commonly seen in Assam. In the absence of any true resistant variety of rapeseed-mustard for these insects, chemical control has been recommended for their management. However, an integrated approach including various cultural practices is recommended for effective management of insect to prevent the build-up of insect resistance to various commonly used insecticides and to reduce the environmental pollution resulting from use of pesticides.

1. Mustard aphid (*Lipaphis erysimi*)

The insect is also known as “Chainpa, Mahoo, Moyala, Lahi, Tela etc.,” in local languages. The mustard aphid is a small, globular, pear shaped and delicate insect, which mostly appears at the end of December and remains active up to March. The pest lives in colonies and has a high rate of multiplication. Low temperature (8-18°C), high RH (60-80 %), and cloudy weather favour the rapid multiplication of aphids. Mustard aphid (both nymph and adult) feeds on different parts of the plants (inflorescence, leaf, stem, twig and pods) by sucking the cell sap. In cases of heavy infestation, the entire plant can dry up and lead to seed yield losses up to 80 per cent. The infestation of mustard aphid also results in reduction oil yield and such reduction has been recorded up to 10 per cent. The aphid also secretes honeydew, which is responsible to the growth of black fungus called “sooty mould” which hinders the photosynthesis in the plant.

Management:

Early sowing of the crop, using the recommended fertilizer dose, plucking and destroying infested twigs 2-3 times at 10 days interval can help the crop to avoid the infestation by mustard aphid. Use predators such as coccinellids, syrphid and lacewing, etc to minimise the incidence. Chemical control is done by spraying oxydemeton methyl 25 EC or dimethoate 30 EC @ 1.0 litre dissolved in 800-1000 litres of water/ha. Repeat the spray at 15 days interval, if the aphid population builds up again.

2. Painted bug (*Bagrada cruciferarum*)

Painted bug is a polyphagous insect, which also infest the rapeseed-mustard crops in India. The other names of the insect are “Chitkabra, Sunder, Jhanga, Dagila, etc. Adult bugs are sub ovate, grey to dark brown or black in colour having many orange/ brownish spots on the dorsal side of the body. The painted bug attacks the crop in warmer months when moderate temperature (20-40°C) and low humidity persists during September-November and March-April. The insect is more serious in early stages of the crop. Both adults and nymphs suck the cell sap from the leaves, shoot and pods and can cause up to 30 per cent loss of seed yield. The infestation in the two-leaf and vegetative stage results in whitening of leaves then wilting leading to complete drying of the tender shoot/plant. In such cases, re-sowing becomes necessary leading to a delayed crop which is more susceptible to pest and diseases. The cost of cultivation also increases due to the additional cost involved in re-sowing. The infestation at maturity results in curling of pods and shrivelling of grains.

Management:

Deep ploughing of the field in summer, clean cultivation by weeding, hoeing and destroying of debris in and around the field, seed treatment with imidacloprid 70WS @5g/kg seed, conserving bio-control agents such as *Alophorasp*, applying first irrigation 3-4 weeks after sowing of the crop helps in reducing the population of insect.



Chemical control is done by spraying malathion 50 EC @ 500 ml in 500 litres of water/ha in case of severe infestation during early stages.

3. Mustard sawfly (*Athalia proxima*)

This insect is also commonly known as “Ara makhi” in Hindi. Adult sawfly happens to be orange yellow in colour with black head and legs and its ovipositor is serrated and saw like hence called sawfly. The larvae are yellowish green to dark green with five lateral longitudinal stripes. The pest attacks the crop at seedling stage. Usually the infestation occurs on three to four week old crop during the months of October and November. Moderate temperature (20-30°C) and low humidity (favour) its development. The larvae make irregular holes in the leaves. Grown up larva feed from the margin of leaf and in severe infestation the crop looks as grazed by animals. It can cause loss up to 35 per cent. The pest survives on the alternate host (radish) and shift to toria crop in September from where they migrate to the germinating crops of rapeseed and mustard in October.

Management:

Same as foliar control measures as recommended for painted bug.



4. Bihar hairy caterpillar (*Spilosoma obliqua*)

The insect is a highly polyphagous and sporadic in nature and is reported throughout rapeseed-mustard growing areas of the country. The pest is also known as “Katra, Kamla, Kambal-keera, Balon wali sundi, Bhabhu kutta” in India. Adult moth is dull yellow in colour with orange tiny wings having black spots. The body of full-grown larva is covered with tuft of thick long hairs. The insect attacks the crop in vegetative stage during September-October. A temperature range of 20-30°C with medium humidity is suitable for this pest. The Bihar hairy caterpillar infestation is more severe on toria crop. They feed on chlorophyll content from the margin of leaves and make them almost transparent and gradually defoliate the entire plant. In case of severe attack, re-sowing has to be done. Grown up larvae migrate to other plants in the field and even to other plants in adjoining fields.

Management:

At the initial stages destroy the insect through hand collection. Collect the infested leaves and dip them in kerosene or insecticide treated solution. Dust the border of field with malathion 5% dust to check the spread of larvae to new fields. Dust the crop with malathion 5% @ 25-30 kg/ha against young caterpillars. Spray the crop with malathion 50 EC @ 1.0 litre in 500 litre of water/ha.



5. Pea leaf miner (*Chromatomyia horticola*)

The pea leaf miner is a highly polyphagous insect and found in all the mustard growing areas of the country. It is called as “Patti ka surangi keet” in Hindi. The adult is a black coloured fly with yellow head and resembles a housefly but smaller in size. Young maggot is dirty white in colour with smoky brown mouthparts, while full-grown maggot is greenish yellow with thickest region in middle and tapering at both ends. The adult makes feeding puncture and feeds on the sap that oozes out from the puncture. The maggots mine the leaf and a larger number of silvery zig-zag mines appear due to the feeding on the parenchyma tissues. Maggot remains inside the mine and pupates therein. The pest population increases at the temperature ranging from 20-30°C during February-March. The heavily infested leaves become yellow and fall down affecting the yield adversely. Its damage is more conspicuous on the older leaves. Yield losses up to 15 per cent has been observed due to pea leaf miner infestation.



Management:

Pluck the infested leaves and bury them to kill the maggots and pupae resting inside. Foliar spray of systemic insecticide such as oxydemeton methyl 25 EC or dimethoate 30 EC @ 1.0 litre in 600-800 litre of water/ ha controls the pest effectively.

6. Diamond back moth (*Plutella xylostella*)

This is a sporadic insect of late sown rapeseed-mustard crop and is found all over the country. The adult moth is gray or brown in colour with light brown anterior wings having three yellow spots and the forewing having white triangular spot, which look like a row of diamonds and hence the name given as diamond back moth. The insect makes tunnel and holes in the leaves and feed on the mesophyll. A moderate temperature is conducive to the insect development and the insect remains active throughout the year except December-January.

Management:

Collect and destroy pest infested leaves. In cases of severe infestation, spray the crop with malathion 50 EC @ 1.0 litre in 600-800 litre of water.



7. Termite or white ant (*Odontotermus obesus*)

Termites attack the *Brassica* crops very severely all over the country, especially under rainfed conditions. Termites are highly polyphagous in nature and remain active throughout the year on crop debris and stubbles. The insect is small, soft, creamy in colour and wingless with biting and chewing type of mouthparts. Infested plants initially turns yellow and finally dries due to extensive root damage.

Management:

Destroy of plant debris in and around the fields. Deep summer ploughing. Use only well decomposed farmyard manure. Frequent irrigation helps in reduction of termite infestation. Entomopathogenic fungi like *Beauveria bassiana* 1 kg multiplied in 50 kg FYM/compost can effectively control the termites. Application of chlorpyrifos 20 EC @ 4 litre/ ha during last ploughing and properly mixing in soil minimizes termite infestation.



Disease Management

Diseases to a large extent are responsible for low and unstable production of rapeseed-mustard and cause the yield losses up to 90 per cent. More than 22 diseases have been reported to affect rapeseed-mustard group of oilseed crops in India. Among these the important diseases affecting the production and productivity of rapeseed-mustard in Assam are Alternaria blight, white rust, downy mildew, powdery mildew and Sclerotinia stem rot and Phyllody.

1. Alternaria blight or leaf spot (*Alternaria brassicae*)

Alternaria blight or leaf spot disease is found throughout the rapeseed-mustard growing areas of the country. The disease is characterized by the formation of prominent, light brown to black round spots with concentric rings of various sizes on leaves, stem and siliquae leading to subsequently blighting and defoliation. The disease appears on leaves after one month of sowing and progress from lower leaves with small sized spots and later covers almost the entire leaf. Later at maturity, round to linear black spots appear on siliquae and stem of toria, yellow and brown sarson and brownish black spots with a distinct gray centre on mustard silique, which later elongate. The seeds in the silique may become small,

