

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.

Management: Same foliar control measures as recommended for painted bug.

4. Bihar hairy caterpillar (*Spilosoma obliqua*): The insect is also known as “Katra, Kamla, Kambal-keera, Balon wali sundi, Bhabhu kutta” in different localities 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 October-November. 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.

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 insect is also known 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 heavily infested leaves become yellow and fall down

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.



Mustard sawfly Painted bug Leaf miner Aphid Bihar hairy caterpillar

Major diseases and their 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.

1. Alternaria blight or leaf spot (*Alternaria brassicae*): 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 siliqua, which later elongate. The seeds in the siliqua may become small, shriveled and rotten.

Management: Timely sowing of healthy and certified seeds, collecting and burning 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 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 stagheads. 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.

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. 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 g/ 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. Sclerotinia rot (*Sclerotinia sclerotiorum*): 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. 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.

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 @ 2gm or tebuconazole @ 1ml/litre of water at 60-70 DAS twice at 50 and 70 DAS will reduce its infestation.

5. 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.



Alternaria blight White rust Downy mildew Sclerotinia rot Powdery Mildew

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Scientific Technology of Rapeseed-Mustard for Assam



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Scientific Technology of Rapeseed-Mustard for Assam

In India, rapeseed-mustard is grown in diverse agro-climatic conditions ranging from North-east to North-west and northern India to the south with wide acceptability as an edible oil. The crop is grown as sole or in mixed cropping under both rainfed as well as irrigated conditions. Rapeseed-mustard crop has high production potential, where the cultivation is supported with technology and knowledge inputs. Rapeseed-mustard is one of the important sources of edible oil in the country which has made a significant contribution to domestic edible oil availability over the last few decades. In India, eight cultivable crops are grown namely toria, brown sarson, yellow sarson, gobhi sarson, and taramira under rapeseed and raya or Indian mustard, karan rai and black mustard under mustard group. Rapeseed-mustard is predominantly cultivated in Rajasthan, Uttar Pradesh, Madhya Pradesh, Haryana, Gujarat, West Bengal, Assam, Bihar, Jharkhand, J&K and Punjab. Together these states accounted for more than 96 per cent of the area and production of rapeseed-mustard in the country during 2014-15 to 2018-19. Crop area expansion, either through inter cropping or spreading the crop in rice fallow land in the country may also help in increasing the production of rapeseed-mustard. Keeping the view of vast availability of natural resources and fertile lands offer ample scope to promote rapeseed-mustard cultivation in Assam, there is an urgent need to motivate the farmers to adopt improved varieties and scientific production and protection technologies of rapeseed-mustard in the state.

The adoption of following scientific production technologies will definitely increase the production and productivity of rapeseed-mustard in Assam

Climate and Soil: Rapeseed-mustard grown in rabi season from October-November to February-March. The crop generally do well in sandy/light loam soils. However, other light soils are also equally good.

Field preparation: Adoption of proper land preparation helps for maintaining a proper health and other soil characteristics required for the crop and to reduce the pest and diseases infestation. A fine seed bed is essential for rapeseed–mustard. The field should be ploughed 4-6 times followed by planking in order to obtain a fine tilth. Pulverize the soil, using cultivator before sowing.

Selection of varieties: The selection of the appropriate variety suited to the growing condition and specific characteristics of the region is the most important factor in determining the yield and production of the crop. The majority of farmers in Assam generally grow traditional seeds i.e. locally available materials especially short duration toria (mostly nondescript naturally crossed bred) varieties, which are low yielded. Now improved short duration varieties of Indian mustard, suitable for Assam, have also been developed. The following varieties of rapeseed-mustard have been identified for cultivation in various parts of Assam.

Variety	Maturity (days)	Oil (%)	Av. Yield (kg/ha)
Indian Mustard			
DRMR-150-35	110-120	38-42	1200-1800
NRCHB - 101	105-130	35-42	1382-1500
PM-28	95	41-42	1910-2090
Toria			
TS-38	90-95	40-41	1200
TS-46	94	40-41	900
TS-67	90	40-42	700

Seed treatment: The seed should be treated with metalaxyl (Apron 35 SD) @ 6 gm/kg seed for white rust and downy mildew and carbendazim @ 2 gm/ kg seed or *Trichoderma* 10 g/kg seed for Sclerotinia stem rot disease. Seed should also to be treated with Azotobactor and PSB each @ 50 gm /kg seed.

Time of sowing: The optimum time of sowing is second week of October to middle of November. Early sowing helps in escaping the attack of aphids. In Barak Valley Zone, rapeseed-mustard can be sown as late as November 30 in upland condition and up to third week of November in medium upland condition. However, the seed rate of rainfed late sown toria grown as succeeding crop in rice (Sali)-toria sequence should be 30% higher than normal recommended rate.

Seed rate and Spacing: Seed rate of 10 kg/ha for toria and 8 kg/ ha for mustard has been found to be optimum for broadcasting method. Seed rate can be reduced to 5-6 kg/ ha for line sowing through seed drill.

The distance between rows should be 30 cm and plant to plant distance within the row should be maintained between 10-15 cm under irrigated condition. Plant population should be maintained at 3 to 3.5 lakh/ha. The method of line sowing using seed drills gives a higher yield per unit area when compared to broadcasting of seeds. Seed rate of rainfed or late sown toria after sali paddy (rice-toria sequence) should be 30% higher than normal recommended rate.

Fertilizer management: Application of FYM or compost @ 2-3 t/ha is beneficial for the crop.

Nutrient	Requirement (Kg/ha)	Form	Fertilizer requirement	
			(kg/ha.)	Kg/bigha
For Rapeseed				
(A) Plains:				
Rainfed condition				
N	40	Urea	87	12
P ₂ O ₅	35	SSP	220	30
K ₂ O	15	MOP	25	25
Irrigated condition				
N	60	Urea	130	18
P ₂ O ₅	40	SSP	250	33
K ₂ O	40	MOP	66	9
(B) Hills				
Rainfed condition				
N	65	Urea	140	20
P ₂ O ₅	35	SSP	220	30
K ₂ O	0	MOP	0	0
(C) Central Brahmaputra Valley Zone				
Rainfed condition				
N	60	Urea	130	18
P ₂ O ₅	30	SSP	190	27
K ₂ O	30	MOP	50	6
Mustard (For All Zones)				
N	80	Urea	175	23
P ₂ O ₅	40	SSP	250	33
K ₂ O	30	MOP	50	7
B	-	Borax	7.5	1

- Use 75% N and P when seeds are inoculated with *Azotobacter* @ 50 g/kg seed and PSB @ 50 g/kg seed.
- If SSP is not used as source of P, sulphur @ 20 kg/ha in the form of gypsum (133 kg/ha) should be used.
- NPK may be supplied in the form of mixed fertilizers. Nutrient requirements are to be adjusted according to contents in fertilizers. Rapeseed-mustard have been found to respond well to the application of borax in some agro-climatic zones of Assam. For higher yield of rapeseed and Mustard in the North Bank Plains Zone, a fertilizer dose of 60:40:40kg NPK/ha is recommended. Borax @ 10 kg/ha for North Bank Plains Zone, 5-10 kg/ha for Upper Brahmaputra Valley Zone and 7.5kg/ha for Central Brahmaputra Valley Zone are recommended, in addition to recommended dose of fertilizers.
- *Application of Lime:* CaCO₃ in the form of dolomitic lime @ 500 kg/ha should be applied 15 days before seeding and incorporate in the soil in areas where multiple cropping is practiced.
- *Foliar spray of urea* : Two foliar applications of 1% urea at flowering and pod filling stages along with basal application of recommended fertilizer dose, i.e. 60 kg N, 30 kg P₂O₅ and 30 kg K₂O/ha.
- Half of the recommended dose of N should be applied as basal dose at the time of sowing preferably through drilling at least 5.0 cm below the seeds for proper absorption. The remaining half should be applied by top dressing at the first irrigation and necessarily before flowering.
- Full dose of phosphorous (P₂O₅) and potash (K₂O) is recommended as basal application at the time of sowing of irrigated crop.
- For rainfed crop apply the full-recommended dosages of nutrients at the time of sowing.

Thinning and intercultural operations : To keep an optimum plant population per unit area and uniform plant growth, thinning operation by removing the extra plants should be done at 15 to 25 days after sowing to maintain a distance of 10-15 cm between plants in a row. Apart from thinning, intercultural operation should be done 15-25 days after sowing with khurpi or double wheel hand hoe before the first irrigation to keep the field weed free. The weeding should be done either along with thinning or immediately after thinning.

Irrigation: One irrigation of 6 cm depth of water may be applied either at 50% flowering or at early siliqua formation stage. In case, a rainfall of 20-25 mm is received during this period, no post sowing irrigation is essential. Pre-sowing irrigation is normally not required for timely sown crop. However, in dry areas one pre-sowing irrigation may be applied. As moisture conservation tillage practice for rapeseed after sali rice, one cross ploughing by power tiller incorporating rice stubbles is recommended.

Harvesting, threshing and storage management : The crop should be harvested when 75 per cent of pods turn to golden yellow in colour. At this stage, majority of seeds are firm when pressed between fingers. The oil content in the seed is the maximum at this stage. For manual harvesting, use a sickle that is light in weight and easy to handle (example: Naveen sickle). After harvesting, the harvested plants are made into bundles and stacked in the sun for 7-8 days before threshing. Threshing is done by beating the pods with wooden sticks or by trampling with bullocks. However, threshing should preferably be done by using threshers. Threshing is followed by winnowing, where the seeds are separated from the straw. The seeds should be sun dried for approximately one week to reduce the moisture content. For safe storage, moisture content of seeds should not be more than eight per cent.

Major insects and their management:

Among the major insect in rapeseed-mustard, mustard aphid, saw fly, painted bug, pea leaf miner and bihar hairy caterpillar are the important insects commonly seen in Assam.

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 insects lives in colonies and has a high rate of multiplication. 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 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*): The insect is also known as “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 and low humidity persists during October-November and March-April. 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 and fall down.

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-contro agents such as *Alophoraspp*, 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. Freshly hatched first instar larvae are 2 mm long, cylindrical, violet or greenish grey or green in colour. Full grown larvae measure about 15-18 mm and look like pseudo caterpillar. The insect attacks the crop at seedling stage. Usually the infestation occurs on three to four week old crop during the months of October and November. The larvae make irregular holes in the leaves. Grown up