

Chapter 8

Integrated Pest Management in Mustard: Extension Approaches for Sustainable and Climate-Resilient Production

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Abstract

Indian mustard (*Brassica juncea*) is an important rabi oilseed crop in India and contributes significantly to edible-oil production and farm livelihoods. However, production is affected by several insect pests and diseases, particularly mustard aphid (*Lipaphis erysimi*), painted bug (*Bagrada spp.*), mustard sawfly (*Athalia lugens proxima*), Alternaria blight, white rust and Sclerotinia stem rot. Frequent and unnecessary insecticide use can increase production costs and adversely affect beneficial organisms. Integrated Pest Management (IPM) provides a practical approach based on prevention, regular crop monitoring, conservation of natural enemies, biological and botanical methods, and need-based chemical control. Climate variability further complicates pest management because temperature, rainfall and humidity influence pest development and disease occurrence. This chapter discusses the major pest and disease problems of mustard and reviews IPM practices with particular emphasis on agricultural extension. Farmer Field Schools, frontline demonstrations, KVK advisory services, participatory surveillance and digital communication are discussed as important mechanisms for improving farmers' ability to identify problems and make timely management decisions. The chapter also proposes a climate-resilient extension approach that connects field surveillance, weather information, advisory services and farmer feedback.

Keywords: Indian mustard, *Brassica juncea*, Integrated Pest Management, Mustard aphid, Climate resilience, Agricultural extension, Farmer advisory, Sustainable agriculture.

Introduction

Rapeseed-mustard is one of the important oilseed groups grown in India. It provides edible oil and oil cake and also has value as a condiment and forage crop in some farming systems. Indian mustard (*Brassica juncea* (L.) Czern. and Cosson) is the major species of this group. It is cultivated mainly during the rabi season in Rajasthan, Uttar Pradesh, Haryana, Madhya Pradesh and West Bengal. In recent years, its cultivation has also expanded into parts of eastern and peninsular India. The crop is particularly relevant to rainfed and resource-limited farming systems because of its relatively short duration and comparatively moderate input requirement.

Production of rapeseed-mustard has increased considerably over the past seven decades. According to Kumbhare et al. (2025), the area under rapeseed-mustard increased from 2.07 million hectares in 1950–51 to 9.18 million hectares in 2023–24. During the same period, production increased from 0.76 million tonnes to 13.26 million tonnes, while productivity increased from 368 kg/ha to 1,444 kg/ha. These changes reflect the contribution of improved varieties and crop-management practices. However, the difference between potential and farmer-field yields remains an important concern.

Several insect pests and diseases continue to affect mustard production. Mustard aphid is one of the major insect pests, while Alternaria blight and white rust are important diseases in many production areas. Pest problems are often managed after visible damage appears, and repeated insecticide use may increase production costs and affect beneficial organisms. A more suitable approach is to monitor the crop regularly and select a management measure according to pest density and the expected level of economic damage.

This is where Integrated Pest Management (IPM) becomes relevant. IPM combines preventive practices, field monitoring, cultural methods, host-plant resistance, biological control, botanical options and need-based chemical control. The effectiveness of these measures also depends on farmers being able to identify pests correctly and make decisions at the appropriate crop stage.

Agricultural extension has an important role in this process. Farmer Field Schools, frontline demonstrations, Krishi Vigyan Kendra (KVK) advisory services, farmer groups and digital communication can help farmers understand pest identification, field scouting and threshold-based decision-making. Climate variability adds another consideration because changes in temperature, rainfall and humidity can influence pest development and disease occurrence. Therefore, mustard IPM needs to be adapted to local conditions rather than relying only on fixed or general recommendations.

Status of Rapeseed-Mustard Production in India

The long-term growth of rapeseed-mustard in India illustrates both the success of varietal and agronomic research and the scale of the yield gap that persists between research-station potential and farmer-field performance. Table 1 summarises the principal indicators of this growth.

Table 1: Long-term growth of rapeseed-mustard production in India

Indicator	1950–51	2023–24	Change/Interpretation	Source
Area	2.07 million ha	9.18 million ha	343.47% increase	Kumbhare et al. (2025)
Production	0.76 million tonnes	13.26 million tonnes	1,644.73% increase	Kumbhare et al. (2025)
Productivity	368 kg/ha	1,444 kg/ha	Approx. fourfold increase	Kumbhare et al. (2025)

Source: Compiled from Kumbhare, N. V., Padaria, R. N., Ahmad, N., Joshi, P., Punitha, P., Singh, Y. P., Singh, A. K., & Choudam, V. (2025). Status, yield gap and way forward of mustard (*Brassica juncea*) production in India. *Indian Journal of Agricultural Sciences*, 95(10), 1275–1280.

This near four-and-a-half-fold rise in productivity reflects the combined effect of improved cultivars, expanded irrigation and fertiliser use, and progressive strengthening of the extension and seed-delivery system over seven decades. Yet productivity gains have not been uniform across regions, and a persistent gap remains between the yields achievable with recommended technology and those realised on farmers' fields. Kumbhare et al. (2025) report a technology gap the difference between potential yield at research stations or demonstration plots and yield obtained under recommended practices on farmers' fields of approximately 150–580 kg/ha, and an extension gap the difference between demonstration-plot yield and the yield actually obtained under farmers' own practices in a comparably wide range for mustard varieties evaluated in farmer fields of western Uttar Pradesh. The technology gap reflects the influence of location-specific agro-climatic and soil constraints on the expression of varietal potential, while the extension gap reflects the extent to which farmers have adopted the recommended package of practices; a wide extension gap signals weak diffusion of proven technology and constitutes, in effect, the space within which extension intervention can add the greatest value. Regional disparities in productivity, driven by differences in irrigation access, soil fertility, pest pressure and extension contact, mean that yield-gap closure strategies must be calibrated to local conditions rather than applied uniformly across the mustard belt.

Major Insect Pests and Diseases of Mustard

Mustard Aphid — *Lipaphis erysimi* (Kaltenbach)

The mustard aphid is universally regarded as the most damaging insect pest of Indian mustard. Both nymphs and adults colonise the apical shoots, inflorescences and developing siliquae, extracting phloem sap and secreting honeydew that promotes sooty-mould growth and interferes with photosynthesis. Heavy infestation during the flowering and pod-formation stages the period of greatest crop vulnerability leads to curling and distortion of inflorescences, poor pod-set, shrivelled seed and, in severe cases, complete failure of the terminal raceme. Aphid populations build rapidly under cool, dry conditions with moderate humidity and decline sharply with rainfall or a rise in temperature, making weather-based monitoring an important component of surveillance.

Painted Bug — *Bagrada spp*

The painted bug is a polyphagous pest of Brassica crops that attacks seedlings and young plants, both adults and nymphs feeding by piercing leaves and stems and extracting sap, which causes wilting, stunting and, under heavy infestation at the seedling stage, plant mortality. Because damage is concentrated in the early crop stages, timely sowing and prompt seedling-stage monitoring are important preventive measures.

Mustard Sawfly — *Athalia lugens proxima* (Klug)

The mustard sawfly is primarily a defoliator, with larvae feeding voraciously on cotyledons and young leaves, occasionally skeletonising foliage under heavy infestation at the seedling and early vegetative stages. Early-stage crop loss can be substantial where infestation coincides with poor seedling vigour, making early scouting important for timely intervention.

Other Pests

Additional pests of local or seasonal importance include the cabbage butterfly (*Pieris brassicae*), leaf webber and flea beetles, which cause defoliation and foliage damage at various crop stages; their significance varies considerably by region and season and should be assessed through local field scouting rather than assumed uniformly.

Major Diseases

Among fungal diseases, *Alternaria* blight (*Alternaria brassicae* and *A. brassicicola*) causes characteristic concentric leaf-spot lesions that can coalesce and affect pod development under favourable humid conditions; white rust (*Albugo candida*) produces white, blister-like pustules on leaves and can induce staghead malformation of inflorescences when systemic infection occurs; and *Sclerotinia* stem rot (*Sclerotinia sclerotiorum*) causes stem lesions and lodging under prolonged cool, humid conditions, particularly in dense canopies. Powdery mildew (*Erysiphe cruciferarum*) and downy mildew are of regional importance depending on humidity and temperature regimes during the crop season.

Table 2: Major pests and diseases of mustard and IPM components

Pest/ Disease	Scientific Name	Crop Stage	Symptoms/ Damage	Monitoring	IPM Options	Source
Mustard aphid	<i>Lipaphis erysimi</i>	Flowering to pod formation	Curling of inflorescence, honeydew, sooty mould, poor pod-set	Fixed-point counts on apical twig	Timely sowing, resistant/tolerant varieties, conservation of coccinellids and syrphids, threshold-based need-based spray	Sherwani & Mukhtar (2026)
Painted bug	<i>Bagrada spp.</i>	Seedling stage	Wilting, stunting, seedling mortality	Seedling-stage field scouting	Timely sowing, field sanitation, trap crops where feasible	General entomological literature
Mustard sawfly	<i>Athalia lugens proxima</i>	Seedling/ early vegetative	Defoliation, skeletonisation of leaves	Early-stage larval counts	Field sanitation, timely sowing, biological/ botanical options where validated	General entomological literature
<i>Alternaria</i> blight	<i>Alternaria brassicae</i> / <i>A. brassicicola</i>	Vegetative to pod stage	Concentric leaf- spot lesions, pod infection under humid conditions	Visual disease scoring	Healthy seed, crop rotation, resistant cultivars, recomm- ended fungicide use where justified	General plant- pathology literature
White rust	<i>Albugo candida</i>	Vegetative to flowering	White pustules, staghead malformation	Visual scoring	Resistant varieties, field sanitation, recommended fungicide use where justified	General plant- pathology literature
<i>Sclerotinia</i> stem rot	<i>Sclerotinia sclerotiorum</i>	Flowering to maturity	Stem lesions, lodging under humid, dense canopy	Visual scoring, weather monitoring	Wider spacing, crop rotation, field sanitation	General plant- pathology literature

Note: Economic thresholds and region-specific recommendations should be verified against current institutional advisories before field application; values cited for the mustard aphid are discussed in detail in the following section.

Mustard Aphid: A Key IPM Target

Given its status as the principal biotic constraint to mustard productivity, the mustard aphid warrants dedicated attention. Population buildup follows a temperature- and humidity-dependent trajectory: colonies establish on lower/inner canopy leaves during the vegetative phase and migrate to the apical shoot and inflorescence at flowering, coinciding with peak yield sensitivity. Cool nights, moderate day temperatures and absence of heavy rainfall favour rapid buildup, while rain or a temperature rise can cause sharp population collapse, both directly and via enhanced natural-enemy activity coccinellid beetles, syrphid larvae, chrysopid lacewings and parasitoid wasps whose conservation through judicious, threshold-based spraying is a central tenet of aphid IPM; indiscriminate early-season spraying is particularly disruptive to these populations and can precipitate resurgence.

Economic threshold concepts provide the quantitative basis for intervention decisions. A peer-reviewed study under the specific agro-climatic and experimental conditions of Kashmir during rabi 2023–24 reported an Economic Injury Level (EIL) of 72.19 aphids and an

Economic Threshold Level (ETL) of 54.14 aphids per 10 cm of apical twig per plant (Sherwani & Mukhtar, 2026). These values, derived under specific Kashmir-valley conditions, should not be treated as universal; cultivar susceptibility, sowing date and natural-enemy activity all influence the density at which aphids cause economic loss. Advisories for other zones, including eastern Uttar Pradesh around Ayodhya, should draw on region-specific threshold studies rather than combining thresholds across agro-climatic conditions as interchangeable.

Principles of Integrated Pest Management in Mustard

IPM is best understood not as a fixed technology package but as an ecologically informed decision-making system in which pest management interventions are selected and timed on the basis of field observation, economic justification and compatibility with natural regulatory processes. Its core components, adapted to the mustard cropping system, are outlined below.

Prevention

Preventive measures form the first line of defence and include the use of healthy, certified seed; selection of cultivars suited to local agro-climatic conditions and, where available, possessing tolerance to key pests or diseases; timely sowing to avoid the coincidence of vulnerable crop stages with peak pest activity; balanced nutrient management, since excessive nitrogen application can favour aphid buildup and lush, disease-susceptible growth; appropriate crop rotation to break pest and pathogen cycles; and field sanitation, including removal of crop residues and volunteer plants that can harbour carry-over populations.

Monitoring and Surveillance

Regular field scouting at fixed sampling points, using standardised counting units such as aphids per 10 cm of apical twig, together with recording of weather parameters and natural-enemy presence, provides the empirical basis for threshold-based decisions. Digital reporting through mobile applications can strengthen the timeliness and spatial coverage of surveillance data where such systems are in place.

Cultural and Mechanical Management

Adjustment of sowing date, plant spacing and irrigation scheduling to reduce microclimatic conditions favourable to pest and disease buildup, together with mechanical removal of heavily infested plant parts where feasible, complement preventive practices.

Host Plant Resistance

Deployment of cultivars with documented tolerance or resistance to major pests and diseases, where released and regionally recommended, reduces reliance on curative measures and should be prioritised in variety-selection advisory.

Biological Control

Conservation of naturally occurring predators and parasitoids coccinellid beetles, syrphid larvae, chrysopid lacewings and hymenopteran parasitoids through restrained and threshold-based insecticide use is central to aphid regulation in mustard. Entomopathogenic fungi such as *Verticillium lecanii* and *Beauveria bassiana* have been evaluated in the research literature as components of biointensive management modules, though their field performance is influenced by humidity and formulation quality and should be assessed against current, locally validated recommendations before extension promotion.

Botanical and Biorational Approaches

Neem-based formulations containing azadirachtin have been evaluated in the research literature as components of biointensive aphid-management modules and offer a lower-risk option compatible with natural-enemy conservation; their efficacy and appropriate dosage should be based on current, locally validated recommendations rather than generalised across regions.

Chemical Control

Chemical intervention remains a legitimate component of IPM but should be reserved for situations where field monitoring indicates pest density has reached or is approaching the locally validated economic threshold, and should follow current, registered label recommendations rather than outdated practices carried over from older literature. Extension advisories should explicitly discourage calendar-based or prophylactic spraying not justified by field observation.

Climate Change and Pest Dynamics in Mustard

Temperature and rainfall variability influence mustard pest dynamics through several interacting pathways: altered crop phenology can shift the timing of vulnerable growth stages relative to seasonal pest emergence; changes in humidity and temperature directly affect aphid reproductive rates and generation time; and extreme weather events, including unseasonal rainfall or heat spells, can disrupt both pest populations and the natural enemies that regulate them. Disease epidemiology is similarly sensitive to weather: *Alternaria* blight and *Sclerotinia* stem rot are favoured by humid conditions and canopy microclimates that retain moisture, while white rust incidence is influenced by temperature and moisture during the vegetative and flowering phases.

It would be an oversimplification to state that climate change uniformly increases pest pressure in mustard. Responses are pest-specific, region-specific, crop-stage-specific and weather-event-specific: a given change in temperature or rainfall pattern may favour one pest while disadvantaging another, and may simultaneously affect natural-enemy populations in ways that partially offset or amplify the net impact on

crop loss. This complexity underscores the need for an Integrated Decision Support System that draws on real-time weather data, regional pest surveillance and validated pest-weather relationships rather than static, one-size-fits-all recommendations, a theme developed further in Section 15.

Climate-Resilient IPM Strategies

A climate-resilient approach to mustard IPM integrates climate-informed pest surveillance and weather-based advisories with the agronomic elements of resilience: cultivars suited to prevailing and projected agro-climatic conditions, timely sowing calibrated to onset of favourable conditions, moisture-conservation practices, and resource-conservation technologies such as reduced or zero tillage. Balanced nutrient management, conservation and augmentation of natural enemies, habitat management to support beneficial insect populations, and contingency planning for extreme weather events together constitute a resilience-oriented package, delivered to farmers through digital extension and decision-support tools discussed in Sections 14 and 15.

Zero-tillage and residue-retention approaches have demonstrated value in resource-constrained, rainfed contexts. An ICAR extension initiative (Directorate of Extension Education, CAU Imphal, with DRMR Bharatpur) evaluated zero-tillage rapeseed-mustard in rice-fallow land of Imphal East district, Manipur, during rabi 2011, comparing 55 ha under zero tillage with 40 ha under conventional tillage. In the absence of rainfall, growth and yield were better under zero tillage owing to more effective use of residual soil moisture after rice harvest; Ragini (yellow sarson) averaged 10.0 q/ha (range 8.0–14.0) and NRCHB-101 averaged 10.2 q/ha (range 8.0–11.0), with 172 farmers across nine villages reporting improved income (ICAR, 2015). This illustrates how resource-conservation technologies can extend mustard into NEH rice-fallow tracts while reducing moisture stress; these regional values should not be extrapolated uncritically elsewhere.

Role of Agricultural Extension in Mustard IPM

Because this chapter is specifically concerned with extension approaches, this section addresses the mechanisms through which IPM knowledge, inherently technical and context-dependent, is translated into farmer practice.

Extension as a Bridge Between Research and Farmers

Extension functions as the connective institutional layer between entomological and pathological research and farmer decision-making, converting threshold values, monitoring protocols and management recommendations generated at research stations into locally interpretable, actionable advisory content.

Field-Based and Institutional Mechanisms

Farmer Field Schools provide season-long, experiential learning in which farmers conduct field scouting, agro-ecosystem analysis and comparative assessment of IPM versus farmer-practice plots. Frontline and cluster demonstrations, typically conducted by Krishi Vigyan Kendras (KVKs) on farmers' own fields, provide a 'seeing is believing' mechanism for technology diffusion. KVK-based extension, participatory pest surveillance by farmer volunteers, and farmer-to-farmer learning through lead-farmer models further widen the reach and credibility of IPM advisory.

Digital, Collective and Inclusive Approaches

ICT-based extension mobile pest advisories, WhatsApp/Telegram farmer groups, weather-based advisories and decision-support systems has expanded the reach and timeliness of pest information, and is most effective when it complements, rather than replaces, field verification and training. Farmer Producer Organisations can aggregate demand for quality inputs and biocontrol agents, reducing transaction costs for smallholders, while private-sector input dealers, who play a significant day-to-day role in farmer decisions, merit engagement to align commercial advice with IPM principles. Deliberate attention to women and youth in climate-smart IPM training recognises their substantial and growing role in field-level crop management.

Collectively, these mechanisms are oriented toward shifting farmer behaviour from a reactive sequence of "pest appears → pesticide spray" toward a structured, threshold-based sequence: prevent, monitor, identify, assess threshold, select intervention, and evaluate outcome. This behavioural shift is the central extension objective underlying climate-resilient mustard IPM.

Frontline Demonstrations and Extension Gaps

Frontline and cluster demonstrations provide concrete, field-level evidence of the productivity gains achievable through recommended technology packages and constitute one of the most direct extension instruments for narrowing the extension gap identified in Section 2. In eastern Uttar Pradesh, an evaluation of frontline demonstrations on mustard reported meaningful yield advantages of the improved package over farmer practice (Kumar, Singh, & Singh, 2017), while a cluster frontline demonstration programme conducted by a Krishi Vigyan Kendra in the North Eastern Plain zone of Uttar Pradesh (Gorakhpur district) across two consecutive years recorded an average yield advantage of 42.67 per cent over farmer practice. Comparable programmes in the hill states have reported yield advantages in the range of roughly 20 to 34 per cent over farmer practice, depending on the state, variety and agro-climatic zone (AICRP-Rapeseed-Mustard reports). These figures should be read as illustrative of the demonstrated potential of extension-mediated technology transfer in specific locations and years rather than as a single universal percentage applicable across all mustard-growing regions; the magnitude of yield advantage depends on the baseline level of farmer practice, the technology gap prevailing in that tract, and seasonal weather conditions.

Table 3: Extension approaches for improving mustard IPM adoption

Extension Approach	Main Activity	Expected Farmer-Level Outcome	Evidence/Source
Farmer Field Schools	Season-long experiential learning in field scouting and agro-eco-system analysis	Improved pest identification and threshold-based decision skills	Established IPM extension methodology
Frontline/cluster demonstrations	Side-by-side comparison of recommended package with farmer practice on farmers' fields	Technology validation; narrowing of extension gap	Kumar, Singh & Singh (2017); Gorakhpur CFLD reports
KVK-based advisory	Location-specific training, input supply linkage, and field diagnosis	Localised, credible technical support	General KVK extension literature
Participatory pest surveillance	Farmer-led systematic field monitoring feeding into advisory systems	Wider surveillance coverage, earlier pest detection	General extension literature
Mobile/ICT-based advisory	SMS, app, and messaging-group based pest and weather alerts	Timely, low-cost information reach	General digital-extension literature
FPO-based collective action	Aggregated procurement of quality seed/ biocontrol inputs and shared advisory	Reduced transaction costs for smallholders	General extension/ FPO literature

Bio-intensive and Ecological IPM

Bio-intensive IPM modules for mustard aphid, combining azadirachtin-based botanical formulations with microbial biocontrol agents, have been evaluated experimentally as components of an integrated management sequence for the pest (Singh, Singh, Singh, & Prakash, 2020). Such modules are typically compared against unprotected control and standard-insecticide check plots to assess relative aphid suppression, natural-enemy conservation and yield protection. These experimental findings demonstrate the biological feasibility of reduced-insecticide management sequences under the specific trial conditions reported and should be treated as evidence supporting further on-farm validation rather than as universally applicable field recommendations; efficacy of botanical and microbial agents is sensitive to formulation quality, application timing, humidity and storage conditions, all of which require local verification before large-scale extension promotion.

Habitat Manipulation and Conservation Biological Control

Conservation biological control approaches seek to enhance the abundance and effectiveness of naturally occurring natural enemies by manipulating the field and field-margin habitat rather than through inundative release of reared agents. Practices such as retention of flowering field-margin vegetation can provide nectar and pollen resources that support adult coccinellids, syrphids and parasitoid wasps outside periods of prey abundance, potentially improving their persistence and rate of colonisation of mustard fields at the onset of aphid infestation. Reduced and threshold-based insecticide use is a necessary complement to habitat manipulation, since even well-designed habitat interventions can be undermined by indiscriminate spraying that removes the natural enemies the habitat is intended to support. The ecological mechanism provision of alternative food resources and shelter that sustain natural-enemy populations at low pest densities is reasonably well established in the broader agro-ecological literature, though the magnitude of the resulting pest-suppression benefit in mustard specifically varies with field configuration, surrounding landscape composition and regional natural-enemy complex, and should not be overstated in the absence of local validation.

Digital and Data-Driven Extension for Mustard IPM

A conceptual framework for digital and data-driven mustard IPM extension links the farmer's field observation with institutional pest-identification and weather-data resources through a structured information flow:

Farmer → Field Observation → Extension Worker / KVK → Pest Identification → Weather Data → Risk Assessment → Advisory → Farmer Action → Feedback

Within this framework, mobile applications can support photo-based reporting of field symptoms, GIS and remote sensing can assist in

mapping cropped area and, where validated, crop-stress indicators, and weather APIs can feed pest-forecasting models that flag periods of elevated risk. AI-assisted image diagnosis is an area of active research interest for pest and disease identification from farmer-submitted photographs, but claims regarding the field accuracy of any specific AI system should be grounded in an authentic, published validation study rather than presumed; this section describes a conceptual extension architecture rather than an endorsement of a particular deployed system. Village-level pest surveillance networks and digital farmer records, where systematically maintained, provide the longitudinal data needed to refine regional advisories over successive seasons.

Integrated Decision Support System for Climate-Resilient Mustard IPM

A scientifically grounded decision pathway for field-level IPM implementation can be structured as a ten-step sequence, moving from crop-stage identification through to feedback-informed advisory refinement, summarised in Table 4.

Table 4: Decision-support framework for mustard IPM

Stage	Information Required	Extension Action	Farmer Decision
1. Identify crop growth stage	Sowing date, current phenological stage	Confirm stage-specific vulnerability window	Awareness of upcoming risk period
2. Field scouting	Standardised sampling protocol (e.g., apical twig counts)	Guide and support farmer/volunteer scouting	Participate in or report scouting
3. Pest/disease identification	Diagnostic characters, reference material	Confirm identification, correct misdiagnosis	Accept confirmed identification
4. Record pest density/damage	Quantitative counts, damage scoring	Compile and log field data	Report observations accurately
5. Assess weather conditions	Temperature, humidity, rainfall data	Interpret weather-pest relationship	Note local weather pattern
6. Compare with regional thresholds	Locally validated ETL/EIL where available	Communicate applicable threshold and its regional basis	Understand whether threshold is met
7. Prefer non-chemical options	Available cultural/biological/botanical options	Recommend appropriate non-chemical measure	Implement preferred option first
8. Chemical intervention if justified	Current registered recommendations	Advise only if threshold met and justified	Apply only as advised
9. Evaluate effectiveness	Post-intervention field assessment	Support follow-up scouting	Assess outcome in own field
10. Record for future advisory	Season summary, outcome data	Update regional advisory record	Share feedback with extension worker

Authentic Data: Share of Mustard in India's Oilseed Economy

Rapeseed-mustard, of which Indian mustard is the dominant component, occupies a substantial share of India's total oilseed area and production. Published national statistics compiled from the Directorate of Economics and Statistics, Government of India, indicate that oilseed Brassica (rapeseed-mustard) accounts for approximately 23.5 per cent of the area and 24.2 per cent of the production of the nine oilseed crops grown in India (Jat et al., 2019, citing Agricultural Statistics at a Glance, Directorate of Economics and Statistics, Ministry of Agriculture, Government of India). Figure 1 presents the production-share component of this statistic as a pie chart. This is a published historical statistic reported in the cited source and should not be read as a real-time 2026 estimate; current-season shares should be verified against the latest release of Agricultural Statistics at a Glance before use in any time-sensitive advisory or policy document.

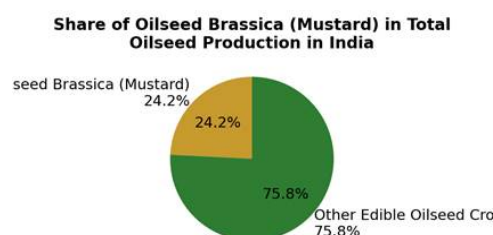


Figure 1: Share of oilseed Brassica (mustard) in total oilseed production in India

Source: Jat et al. (2019), OCL (Oilseeds & fats, Crops and Lipids), citing Agricultural Statistics at a Glance, DES, Ministry of Agriculture, Government of India.



Figure 2: Illustrative representation of field-level integrated pest management (IPM) practices and agricultural extension activities in mustard cultivation

Source: Illustration prepared for this chapter (2026).

Additional Authentic Data Table

Table 5: Selected published evidence relevant to mustard IPM and extension

Evidence	Published Observation	Study/Source
Long-term national production	9.18 million ha area and 13.26 million tonnes production in 2023–24	Kumbhare et al. (2025), Indian Journal of Agricultural Sciences
Productivity	1,444 kg/ha in 2023–24	Kumbhare et al. (2025)
Technology gap	Approx. 150–580 kg/ha	Kumbhare et al. (2025)
Extension gap	Wide range reported for evaluated varieties (see Section 2)	Kumbhare et al. (2025)
Oilseed Brassica share of national oilseed economy	≈23.5% of area, ≈24.2% of production	Jat et al. (2019), citing DES, GoI
CFLD yield advantage, Gorakhpur, eastern UP (NE Plain Zone)	42.67% higher average yield over farmer practice	Cluster frontline demonstration report, Gorakhpur district
Zero-tillage rapeseed-mustard, NEH region (Manipur)	Average 10.0–10.2 q/ha under zero tillage using residual soil moisture	ICAR (2015), Directorate of Extension Education, CAU Imphal / DRMR Bharatpur
Mustard aphid ETL, Kashmir, rabi 2023–24	54.14 aphids/10 cm apical twig/plant	Sherwani Mukhtar (2026)
Mustard aphid EIL, Kashmir, rabi 2023–24	72.19 aphids/10 cm apical twig/plant	Sherwani Mukhtar (2026)

Constraints to Adoption of IPM

Adoption of IPM in mustard is constrained by a combination of knowledge, institutional and structural factors: insufficient farmer skill in distinguishing pest species and life stages, leading to delayed or incorrect diagnosis; aggressive village-level insecticide marketing combined with a farmer perception that visible pesticide effect equates to control, working against threshold-based restraint; limited familiarity with economic thresholds, weak field monitoring, and fragmented landholdings that complicate area-wide management; inadequate extension staff-to-farmer ratios and climate uncertainty complicating timing of interventions; limited local availability of quality biocontrol/botanical

inputs and scarce locally calibrated advisories for several zones; and digital-literacy and connectivity limitations that constrain ICT-advisory reach precisely among the smallholder segments that would benefit most.

Future Research Priorities

- Region-specific economic thresholds for mustard aphid and other key pests across major agro-climatic zones
- Climate-based pest forecasting models integrating weather data with validated pest-weather relationships
- Breeding and evaluation of resistant/tolerant mustard genotypes for key pests and diseases
- Conservation biological control research specific to mustard agro-ecosystems, and microbiome-based biocontrol
- Digital, farmer-participatory pest-surveillance networks, with rigorous published validation of any AI-assisted diagnosis tool before promotion
- Participatory and gender-responsive research embedding farmers, including women farmers, in threshold validation
- FPO-based models for aggregated procurement of biocontrol/botanical inputs, and integrated weather-pest decision platforms
- Long-term insecticide-resistance monitoring and residue/environmental-risk assessment of chemical inputs used in mustard IPM

Proposed Extension Model: Climate-Resilient Mustard IPM Extension Model

Research ↓ KVK / Extension Agency ↓ Pest & Weather Surveillance ↓ Village-Level Advisory ↓ Farmer Decision ↓ IPM Intervention ↓ Field Evaluation ↓ Feedback & Digital Record ↓ Improved Future Advisory

The proposed model conceives of pest-management advisory as an iterative, feedback-driven cycle rather than a one-way transfer of recommendations. Research entomological, pathological, agronomic and breeding work at ICAR institutes, state agricultural universities and the Directorate/Indian Institute of Rapeseed-Mustard Research generates validated thresholds, resistant cultivars and management options. This knowledge is transmitted to the KVK/Extension Agency layer, the principal interface with farmers, responsible for training, demonstrations and diagnostic support. Pest and Weather Surveillance systematic field scouting by extension staff, trained volunteers or digital reporting, combined with local weather monitoring generates the real-time data on which Village-Level Advisory is built, translating field observations into locally interpretable guidance on whether continued monitoring, cultural intervention, biological augmentation or chemical treatment is warranted.

The advisory reaches the Farmer Decision stage, where the farmer, exercising independent judgement alongside the advisory, implements an IPM Intervention. Field Evaluation follows assessing whether pest populations declined and yield was protected and is captured through Feedback and Digital Record via farmer-record systems, KVK reporting or participatory platforms. This accumulated feedback loops back to refine Improved Future Advisory and recalibrate regional thresholds for subsequent seasons. Institutionalising this feedback loop is, in the assessment of this chapter, the single most important structural requirement for translating IPM science into durable field-level practice under increasing climate variability.

Conclusion

Integrated Pest Management in mustard cannot be reduced to a search for less harmful pesticides; it is, at its core, an ecologically grounded and economically rational decision-making framework built on prevention, systematic monitoring, conservation of natural regulatory processes, and threshold-based selection of intervention. The evidence reviewed in this chapter indicates that successful mustard IPM depends on the coordinated application of preventive cultural practices, host-plant resistance, biological and botanical options, and judicious chemical use, calibrated to locally validated pest thresholds rather than generalised or outdated recommendations. Climate variability adds a further layer of complexity, requiring that pest-management advisory be climate-informed and location-specific rather than uniform across agro-climatic zones. Agricultural extension is the indispensable mechanism through which this technically demanding, context-dependent body of knowledge is translated into farmer practice, and the evidence from frontline demonstrations, Farmer Field Schools and KVK-based advisory reviewed here demonstrates the tangible productivity gains achievable when extension delivery is effective. Krishi Vigyan Kendras, Farmer Producer Organisations, digital advisory platforms and farmer groups together constitute the institutional architecture through which surveillance coverage and technology adoption can be strengthened going forward. Future extension and research systems for mustard IPM should aim, above all, to integrate weather data, pest surveillance and farmer feedback into a continuously improving decision-support architecture a climate-resilient system capable of adapting its guidance as both pest ecology and climatic conditions continue to evolve.

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