Pest management strategies in organic farming

Ranjith. H. V., Divija S. D., Raghuteja P. V., Arya P. S.

Organic crop protection prioritizes ecological resilience and preventive measures over curative chemical control, aiming to maintain healthy soils, diverse agro-ecosystems and market-acceptable produce. This chapter describes the major strategies used in organic insect pest and disease management, including cultural and agronomic modifications (crop rotation, planting date, fertility and water management, tillage and mulches), conservation, and habitat manipulation to support natural enemies (nectar/pollen resources, refugia, hedgerows and cover crops), augmentative and classical biological control (predators, parasitoids, and entomopathogens), botanical and animal-derived formulations (neem products, Panchagavya, and cow urine derivatives), semiochemical tools (pheromone monitoring, mating disruption, and mass trapping), and organically acceptable materials (kaolin, insecticidal soaps, spinosad and microbial biopesticides). Organic farming practices do not encourage the application of synthetic chemicals or genetically modified organisms (GMOs), making pest control challenging. Constraints, including lower and variable efficacy, higher input costs, limited registered products, and market/infrastructure gaps, are discussed along with research priorities. The chapter concludes that organic pest management is not a single panacea but a suite of context-specific practices that require policy, research and market support for scaling.

Keywords: *Botanicals, biodiversity, neem, organic farming, pest management, pesticides*

Ranjith. H. V[1*]., Divija S. D[2]., Raghuteja P. V[3]., Arya P. S.[4]
[1]ICAR-IIFSR, Modipuram, Uttar Pradesh, India.
[2]ICAR-DMAPR, Anand, Gujarat, India.
[3]RySS-APCNF, Andra Pradesh, India.
[4]CCR(PG) College, Muzaffarnagar, Uttar Pradesh, India.

[*]Email: ranjithhv100@gmail.com

Publisher: Cornous Publications LLP., Puducherry, India.
Integrated Crop Pest Management Using Innovative Approaches
Editors: Dr. Srinivasa N, Dr. Ramesh K B, Mr. Varun Arya, Dr. Twinkle
ISBN: 978-81-993853-5-1
DOI: https://doi.org/10.37446/edibook252025/63-73

Introduction

Currently, environmental contamination and chemical residues that disrupt the food chain pose major challenges to agro-food systems. The growing global human population has heightened the need for environmental conservation and enriched the biodiversity and sustainability of agricultural systems. Organic agriculture re-frames crop protection around prevention, ecosystem health, and low-residue options, rather than routine chemical treatments. The "organic" claim is a process claim rather than a product one. In India, the regulation of organic farming practices is undertaken primarily by the National Programme on Organic Production (NPOP), managed by APEDA, which comes under the Ministry of Commerce and Industry for exports. For consumption in the domestic market, the Participatory Guarantee System (PGS-India) issues a certificate managed by the National Centre for Organic and Natural Farming.

Regulations have restricted the use of chemical pesticides in crop production; hence, alternative and sustainable pest management approaches must be adopted. The focus should be on enhancing host resistance and ecological processes (soil health, biodiversity, and natural enemies) so that pest populations remain below the damaging thresholds. Various pest management approaches include the cultivation of resistant varieties, polyculture, and the use of beneficial microbes such as entomopathogenic fungi, endophytes, and botanical pesticides. Prevention includes a combination of cultural methods (rouging of alternate hosts), crop rotation, tillage, reflective plastic mulching, use of barrier crops, intercrops, trap crops, adjustment of sowing/transplanting/planting dates, and soil nutrient management. Curative measures include mechanical control methods (Hand picking and destruction), insect traps (mass trapping), the release of bioagents such as parasitoids, predators, and entomopathogens, the use of botanicals, insect growth regulators, insecticidal oils and soaps, organic insecticides, and synthetic derivatives used in organic cultivation practices (Mani, 2022). The wealth of traditional knowledge in these fields enhances soil fertility restoration and pest management, thereby reinforcing and establishing a robust foundation for organic farming systems (Sharma & Goyal, 2000). Traditional knowledge is an important source of organic pest management practices, encompassing the use of botanical extracts and maintenance of the population of beneficial insect fauna (Chavan et al., 2020). The ultimate goal of pest management in this system is to implement preventive measures involving a systematic approach that excludes chemical inputs. A systematic approach would enable agroecosystems to be healthy and rich in biodiversity, thus maintaining the balance of nature.

Integrated pest management (IPM) plays a key and vital role in organic agriculture by maintaining pest populations below economic threshold levels. IPM, which comprises crop rotation, intercropping, the use of natural enemies to reduce pest habitats, proactive monitoring and scouting, ecological engineering, and environmental manipulation, is a key pest management strategy. Sticky and pheromone traps are most commonly employed for insect monitoring; however, in organic farming, they also divert pests away from the main crops and disrupt mating techniques. The squash vine borer (*Melittia cucurbitae*) poses a significant challenge to organic farming owing to its destructive nature. One method to control this pest involves mass trapping with pheromones, which attracts males away from females, preventing mating and egg-laying (Jackson et al., 2005). Environmentally friendly pesticides are considered a last resort when insect populations exceed a critical threshold. Chemicals can induce plant resistance to pests and diseases through various mechanisms (Hammerschmidt, 2007). Abiotic agents that trigger resistance include salicylic acid (SA), ethylene, dichloro-isonicotinic acid, and benzothiadiazole (Sticher et al., 1997).

Guiding principles for organic pest management

a) **Prevention before cure:** To minimize the establishment of pests, it is important to select the right site, choose appropriate cultivars, and maintain healthy soils. In organic farming, where curative chemical controls are restricted and limited, preventive strategies are crucial for pest management. Crop rotation enhances soil quality and fertility while helping to prevent outbreaks of insects and diseases.

b) **Diversification and Resilience:** Increasing plant and habitat diversity supports natural enemies and disrupts pest accumulation. Polyculture enhances the stability, richness, and sustainability of yield and crop protection.

c) **Use of the lowest-risk interventions:** Prefer botanical, biocontrol, and cultural tactics and reserve organic-approved pesticides when integrated tactics fail. Organic agriculture is regulated to avoid the use of harmful agrochemicals, which remain in the ecosystem for a long time and cause many unfavourable incidents.

d) **Context specificity:** Soil-borne plant pathogens are less prevalent in organic farming systems than in conventional farming systems (Van Bruggen, 1995). Modules must be tailored to the crop, pest biology, climate, and market constraints. Pest management in this system is knowledge-intensive, and time-bound practices yield the best results.

Cultural & agronomic measures

Cultural practices form the backbone of agriculture and include the use of resistant plant varieties, crop rotation, adjustment of planting schedules, management of crop density and fertility, control of water use, selection of tillage methods, application of mulch, and maintenance of sanitation. The cultural practices are elaborated as follows.

1. Selection of planting material: The selection of pest-resistant varieties plays a critical role in pest-free organic crop production. It is of prime importance to decipher the mechanism of pest resistance rendered by the pest, as genetically modified crops, such as Bt-cotton, are not permitted. The morphological characteristics of plants, including their shape, size, development of leaf hairs, and the presence of natural chemicals that either attract or repel insects, influence the success of insect colonization in crops. Additionally, biochemical traits, such as the levels of total sugars and crude proteins, are positively correlated with fruit borer damage, whereas phenol levels are negatively correlated (Haldhar et al., 2017).

2. Cover crops: Cover crops enhance farm biodiversity by consistently providing nectar, pollen, and other essential nutrients. For instance, buckwheat (*Fagopyrum esculentum*) and phacelia (*Phacelia tanacetifolia*) supply nectar to bees and hover flies, which are beneficial fauna (Pontin et al., 1998). Consequently, the pest life cycle can be broken, and pest outbreaks in farm ecosystems can be reduced. Experimental results have shown that neem cake, FYM, and vermicompost can often decrease the number of pests affecting cotton and brinjal. The various components employed in pest management for organic agriculture are depicted in Figure 1.

3. Planting date: The timing and techniques of planting are crucial for pest and disease management. Additionally, adjusting the planting schedule can reduce the risk of certain pests such as thrips and corn earworms. These tactics change host suitability and microclimate and typically form the first line of defence.

4. Reduced tillage: In organic agricultural systems, several practices are employed to maintain zero to minimum tillage and incorporate either perennial crops or sod producers into the rotation. The significant impact of reduced tillage on pest insect population dynamics was observed. For instance, thrips tend to pose fewer challenges in systems with reduced tillage. Furthermore, there may be an increase in ground-dwelling predators, such as ground beetles that feed on pests. However, it is important to note that the incidence of cutworm and slug infestations may also increase in environments with minimal tillage.

5. Crop rotation: A suitable crop rotation can introduce a non-host crop that is unsuitable for insect pests to carry their life cycle forward. For effective pest management, crop rotation involving susceptible hosts should be extended to 3-7 years. Although this method is not effective against highly mobile insects, it can control pests with lower mobility, such as the Colorado potato beetle (*Leptinotarsa decemlineata*) and other soil-dwelling insects. Alternating crops with those that are not grass can help decrease borer infestation (Alvares, 1999). Thrips are more likely to infest early planted crops than late ones. Moreover, early transplanted crops may experience fewer aphid-transmitted plant viruses. Seeds should be planted when temperatures are ideal for emergence and rapid growth. The effective management of root diseases in organic systems is associated with long and varied crop rotations, crop mixtures, and frequent application of organic amendments (Van Bruggen, 1995).

6. Companion cropping: Mustard was planted in paired rows for every 25 rows of cabbage, which has been proven to be an effective trap crop for managing diamondback moths (Srinivasan, 1992). One of the two mustard rows was planted 15 days before the cabbage was planted, while the other was planted 25 days after. It is also advised to practice intercropping one row of cabbage with a row of tomatoes, which should be planted 30 days after the cabbage, to control diamondback moths and leaf webbers (Srinivasan & Veeresh, 1986).

7. Organic manure and amendments: Incorporating organic amendments and introducing earthworms into the soil has been shown to effectively manage winter diseases in chickpeas (*Cicer arietinum* L.) and mustard (*Brassica juncea* L. Coss.), and peas (*Pisum sativum* L.). The low nitrogen content of organic manure is beneficial. This causes a temporary nitrogen shortage; however, it does not harm the plants. Instead, it helps plants synthesize their own defence chemicals to combat pests. Low nitrogen content causes plants to produce more phenols, tannins, and lignins. These compounds make the leaves tougher and less appealing to herbivorous insects. In addition, crops grown with organic manure have fewer insect problems (Surekha & Rao, 2000).

Conservation of natural enemies

Conservation targets longevity, fecundity, and the retention of predators and parasitoids by providing nectar, pollen, alternate prey, and refugia. Intercropping, cover crops, beetle banks, hedgerows, banker plants, and field borders serve as reservoirs and corridors for beneficial insects in adverse conditions. When provided with nectar from buckwheat, faba beans, phacelia, and nasturtium, adult encyrtid wasps (*Copidosoma koehleri*) lived twice as long as the control group (Baggen et al., 1999). To conserve beneficial insects, additional habitat management strategies include adjusting mowing practices, altering mowing height, creating overwintering habitats, and offering alternative hosts (Landis et al., 2000). Conservation is sensitive to management timing (e.g., mowing) and interactions with other tactics (avoiding high-toxicity sprays and broad-spectrum pesticide spraying). Strategically timed applications of food sprays have been employed to enhance agricultural systems that lack sufficient nectar and pollen (Hagen et al., 1971). In cotton fields, trials with the "Environfeast" product have demonstrated its ability to attract carabid and melyrid beetles, Lygaeidae and nabid bugs and green lacewings (Mensah, 1997). The practice of "weed strip management," common in European nations, appears to boost food availability for carabids, leading to improved reproduction rates (Zangger, 1994). A few ecosystems are rich in biodiversity, and appropriate measures should be taken to encourage them. For instance, a typical tropical rice field is home to approximately 800 species of beneficial insects, such as wasps, spiders, and ants, along with helpful pathogens. When these are identified and preserved, they can manage 95% of insect pests (Alvares 1999).

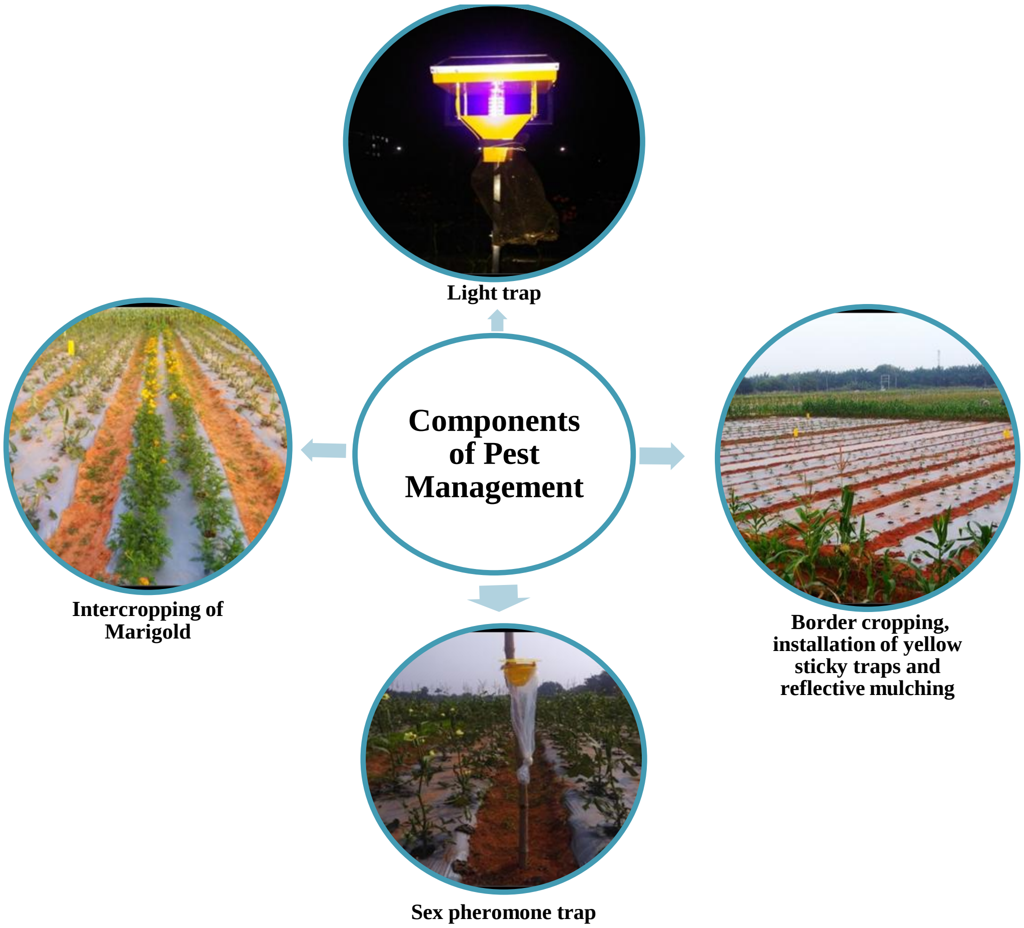

Figure 1. Various components of pest management in organic agriculture

Biological control agents

The augmentative deployment of entomopathogens (e.g., *Beauveria* and *Metarhizium*), *Bacillus thuringiensis*, entomopathogenic nematodes, and parasitoids (e.g., *Trichogramma* spp.) can suppress outbreaks when performed at the appropriate time. In the event of an insect population surge, these agents can serve as curative control methods for pests. Augmented parasitoids also need to be protected from ecological deviations (e.g., elevated temperature and reduced moisture) to create and implement improved strategies.

Orr et al. (1997) inter-cultivated ryegrass with seed maize so as to lower the temperature of the soil surface and enhance the survival of *Trichogramma brassicae* released through augmentation technique. The predator *Cryptolemus montrouzieri* has been shown to be effective in managing mealybugs, which are pests affecting coffee and citrus crops in southern India (Kaul & Dhaliwal, 2000). The benefits of biocontrol agents include precision in attack and minimal risk to non-target organisms. However, their drawbacks include slower effects, sensitivity to environmental conditions, and inconsistent persistence in the field.

Botanicals, fermented products and animal-derived inputs

Biopesticides are important components of integrated pest management (IPM) initiatives aimed at sustainable agriculture and have gained significant practical interest as alternatives to synthetic pesticides. Some plants release secondary metabolites, such as terpenoids, alkaloids, flavonoids, and phenolic compounds, which possess insecticidal properties and can be utilized as botanical pesticides. Plant extracts (Azadirachtin, Karanjin), fermented plant–cow urine formulations (Panchagavya and Dasagavya), kaolin clay, and essential oils have demonstrated efficacy against a range of pests and pathogens in laboratory and field trials. Neem seed kernel extract (NSKE), neem oil, and spinosad (microbial-derived) have been repeatedly cited as effective in reducing chewing pests.

NSKE at a 5% concentration is effective against *Helicoverpa armigera*, whereas seed treatment with 10 mL/kg and the application of a 10% aonla (*Emblica officinalis*) solution at 4 L/ha can effectively control termites in chickpeas (Gaur & Sharma, 2010). Neem-based pesticides have been shown to decrease fruit borer infestations (*Earias* spp.) in okra (Ambekar et al., 2000), possess antifeedant and insecticidal properties against *Achaea janata* in castor (Babu et al., 1997), demonstrate low toxicity to spiders in rice (Baitha et al., 2000a), and efficiently manage leaf rollers in rice (Baitha et al., 2000b). A mixture of cow urine (4 L) and asafoetida (10 g) in water (10 L) can be sprayed to repel sucking pests (Alvares, 1999). Panchagavya and cow urine-based formulations have demonstrated antifungal effects in several trials; however, standardization is required. Field trials in India have shown that organic IPM modules combining resistant genotypes, neem oil sprays, pheromone traps, and spinosad produce favourable benefit: cost ratios. Microbial pesticides have demonstrated promising results in regulating targeted insect pests when applied at the recommended dosage, supported by congenial environmental conditions.

Table 1. Presents the CIBRC-approved microbial pesticides, botanicals, and antibiotics that can be adopted in organic agriculture. Neemastra, Brahmastra, Agniastra, and Dashaparni Ark are key botanical formulations in natural farming that are primarily derived from cow-based inputs and pesticidal plants. Neemastra, prepared from neem leaves, cow urine, and dung, is effective against sucking pests and early instar stages. Brahmastra, a fermented extract of multiple pesticidal leaves (e.g., neem, karanj, and datura), targets borers and concealed feeders. Agniastra, which is enriched with tobacco, chilli, and garlic, exhibits strong insecticidal and nematicidal activities. Dashaparni Ark, a complex mixture of ten plant leaves with bioactive additives, provides broad-spectrum control against insect pests and some pathogens. These neem-based formulations are extensively used in zero-budget natural farming and can be adopted for organic agriculture. These formulations (Table. 2) act through antifeedant, repellent, and toxic effects and are widely adopted in eco-friendly pest management systems (Palekar, 2016).

Natural farming depends on a variety of indigenous bio-inputs that serve as sustainable pest management and growth promoters. Neemasthra prevents feeding and repels against sucking pests of crop ecosystems, while Agniasthra, manufactured from cow urine, chilli, tobbaco and garlic is effective against chewing and lepidopteran pests. Brahmastra, a composite botanical formulation, acts as a broad-spectrum pest control agent. Dashaparni Arka, derived from leaves of medicinal plants, improves resistance against various pests and diseases. Fish amino acids (FAA) are promoted as nutrient-rich growth substances that enhance plant vigour and reduce pest susceptibility. Pullati Majjiga manages fungal diseases and increases plant immunity. All botanical formulations reduce the reliance on chemical pesticides and maintain the ecological balance in crop ecosystems (Palekar, 2016; RySS, 2020).

Table 1. Microbial pesticides, botanicals, and antibiotics permitted under organic farming

Sl No.	Type of microbial / pest control agent	Microbial pesticides, botanicals and antibiotics registered under CIBRC (as on 30.10.2025)
1	Bacteria	*Bacillus thuringiensis* var. galleriae; *B. t.* var. israeliensis; *B. t.* var. kurstaki, *B. sphaericus, B. subtilis*
2	Fungus	*Ampelomyces quisqualis; Beauveria bassiana; Metarhizium anisopliae; Pseudomonas fluorescens; Trichoderma harzianum; Trichoderma viridae; Verticillium lecanii; V. chlamydosporium*
3	Virus	Nuclear Polyhedrosis Virus against *Spodoptera litura* and *Helicoverpa armigera*
4	Antibiotics	Aureofungin, Kasugamycin
5	Botanical	Azadirachtin

Table 2. Plant protection concoctions made from neem-cow dung-based products

Product	Composition	Preparation	Application	Target Pests
Neemastra	200 L water, 2 kg cow dung, 10 L cow urine, 10 kg neem leaf paste.	All the ingredients were mixed in a container. Ferment for 24-48 hours with periodic stirring. Filter using muslin cloth before use.	Used directly as foliar spray (no dilution required).	Sucking pests include aphids, jassids, whiteflies, and small caterpillars. Also shows antifungal & nematicidal activity.
Brahmastra	20 L cow urine, 2 kg neem leaves, 2 kg karanj leaves, 2 kg custard apple leaves, 2 kg datura leaves.	Boil/ferment a mixture of crushed leaves in cow urine. Cooling and fermentation are allowed (typically 2–3 days). Filter before application.	6–8 L diluted in 200 L water for spraying (3%).	Sucking insects and hidden caterpillars (fruit and pod borers). Broad insecticidal action due to alkaloids.
Agniastra	20 L cow urine, 2 kg neem leaf pulp, 500 g tobacco powder, 500 g green chilli paste, 250 g garlic paste, 200 g turmeric powder.	All the ingredients were mixed in cow urine. Boil/ferment mixture (as per the traditional method). Cool and filter before use.	Dilution: 3–8 L in 200 L water depending on severity.	All sucking pests, caterpillars and borers, nematodes (e.g., *Meloidogyne incognita*), and leaf jassids.
Dashaparni Ark	200 L water, 20 L cow urine, 2 kg cow dung, 500 g each of turmeric & garlic, 10 g asafoetida, 1 kg tobacco powder, 2 kg chilli pulp, 200 g ginger paste, leaves of species (neem, pongamia, castor, datura, lantana, guava, vitex, custard apple, red kanheri, calotrophis).	The leaves were crushed and mixed with the other ingredients. Ferment for several days (typically 30-45 days in practice) with regular stirring. Filter before spraying.	6–8 L diluted in 200 L water.	Broad-spectrum: Controls all types of pests. Effective against cutworms (*Agrotis ipsilon*), sucking pests, and borers. Also exhibits antifungal & antibacterial activity.

Semiochemical and volatiles in Organic farming

Pheromone traps are indispensable for monitoring and early detection, and mating disruption and mass trapping can suppress mate encounters and remove large fractions of adult populations from the area. Monitoring data can also inform thresholds and action timing. Practical caveats: Mass trapping must remove very high proportions of males to reduce reproduction, and the efficacy of mating disruption strongly depends on pest density and landscape context. Herbivore-induced plant volatiles (HIPVs), such as methyl salicylate (MeSA), are used to attract and conserve the predator green lacewing *Chrysopa nigricornis* (James, 2003). Endophytes are utilized in pest control because of their mycotoxin-producing ability. For example, endophytes such as *Beauveria bassiana* and *Muscador vitigenus* generate volatile compounds that can deter or control insect pests (Yue et al., 2001; Daisy et al., 2002).

Organic-approved materials

The sanctioned list of insecticidal products includes extracts derived from plants, such as neem oil, pyrethrum, ryania, rotenone, and sabadilla, along with substances obtained from microbes, such as spinosad, which originates from the naturally occurring soil bacterium *Saccharopolyspora spinosa*. Spinosad products are effective against numerous caterpillars but are less effective against insects, such as stink and plant bugs. Spinosad can be used on a variety of vegetables, including potatoes, eggplant, tomatoes, melons, cucumbers, pumpkins, squash, cole crops and sweet corn. It is also appropriate for certain field crops such as peanuts. Spinosad @ 75 g a.i./ha and Vertimec 1.8 EC @ 1.5 g a.i./ha were effective biopesticides against diamondback moths. Bt should be applied at 1.0 kg/ha weekly (Srinivasan, 1992).

Soaps, mineral oils, and potassium salts of fatty acids can be used to manage small, soft-bodied insects. Although many organic pesticides have limited residual effects, some are stable over time. For instance, the alkaloid substances veratridine and cevidine, found in sabadilla, an organic pesticide, break down at slow rates with 50% and 10% degradation, respectively, after 22 days of exposure to sunlight (Rosen & Zang, 2007). Mineral products such as kaolin clay and diatomaceous earth are also permitted. Kaolin provides a physical barrier or repellent film, whereas spinosad and Bt are biologically derived products permitted by many organic standards. These materials are often effective short-term options when integrated with other tactics; however, they can be expensive and may disrupt beneficial organisms if they are misused.

Constraints to adoption and implementation

The major constraints reported include the limited availability and higher cost of organic pesticides, the variable efficacy of natural products, inadequate markets and certification hurdles, limited extension capacity, and the need for farmer training. Limiting the use of chemical pesticides may result in increased pest pressure; however, it also supports and enhances biodiversity. Socioeconomic barriers often outweigh technical barriers in determining the adoption scale.

Research and development priorities

The National Academy of Agricultural Sciences (NAAS) has recommended a thorough approach that incorporates both integrated nutrient management (INM) and integrated pest management (IPM) to enhance the effectiveness of input utilization. Additionally, they advocated for the adoption of promising cropping systems tailored to specific regions as an alternative organic farming approach for India.

Initially, organic farming should focus on high-value crops, including spices, fruits, vegetables, and medicinal plants (Bhattacharyya & Chakraborty, 2005). The key priorities identified were weather-based pest forecasting, systematic surveillance, screening for host resistance, rigorous evaluation of plants and microbes for bioactivity, crop-specific organic IPM module development, and the definition of environment-based economic thresholds. Monitoring resistance in pest/pathogen populations to any used agent was also discussed.

Conclusion

The foundation of organic farming is environmental, social, and economic sustainability. Organic pest and disease management is most effective when prevention, conservation, and targeted curative tactics are combined into context-specific modules. Scaling organic approaches requires research, extension, policy support, and reliable organic production markets. The use of traditional farming methods, including the use of natural fertilizers such as Kunapajala and Panchagavya, as well as herbal extracts for pest management, has proven to be effective and supports environmental sustainability. These practices help sustain biodiversity, reduce environmental impacts, and promote climate resilience. However, it is crucial to recognize the challenges and limitations associated with the integration of traditional knowledge. These include the necessity for additional scientific validation, adjustments to evolving climate conditions, and the possibility of limited resources for implementation. The literature summarized here indicates that with careful design, organic IPM can be both ecologically sound and economically viable.

Conflict of interest statement

The authors declare no conflicts of interest.

References

Alvares, C. (1996). The organic farming sourcebook. The Other India Press, Mapusa, Goa, India.

Ambekar, J. S., Pawar, A. S., & Sakhare, M. V. (2000). Bio-efficacy of certain neem products against okra fruit borer.

Babu, P. B. S., Nair, M. S., & Sumitha, B. (1997). Antifeedant and insecticidal effects of some plant extracts against castor semilooper *Achaea janata* Linn. *Journal of Insect Science*, *10*(2): 179-80

Baggen, L. R., Gurr, G. M., & Meats, A. (1999). Flowers in tri-trophic systems: mechanisms allowing selective exploitation by insect natural enemies for conservation biological control. *Entomologia experimentalis et applicata*, 91(1), 155-161.

Baitha, A., Hameed, S. F., & Singh, R. (2000a). Effectiveness and economics of various treatments and their impact on spider populations in rice ecosystems. *Annals of Plant Protection Sciences (India).*, *8*(1).

Baitha, A., Hameed, S. F., & Singh, R. (2000b). Relative toxicity of neem products against the larvae of rice leaf folder. *Indian Journal of Entomology (India).*, *62*(1).

Bhattacharyya, P., & Chakraborty, G. (2005). Current status of organic farming in India and other countries.

Chavan, A. A., Shinde, B. D., Sanap, P. B., & Kengare, M. N. (2020). Efficacy of biopesticides against thrips (*Scirtothrips dorsalis* Hood) infesting chilli (*Capsicum annuum* L.). *Journal of Entomology and Zoology Studies*, *8*(6), 370-373.

Daisy, B. H., Strobel, G. A., Castillo, U., Ezra, D., Sears, J., Weaver, D. K., & Runyon, J. B. (2002). Naphthalene, an insect repellent, is produced by *Muscodor vitigenus*, a novel endophytic fungus. *Microbiology*, *148*(11), 3737-3741.

Gaur, R. B., & Sharma, R. N. Validation of some traditional wisdom of farming communities of semi-arid region of Rajasthan, India-Regional review. In *Proceedings of the international conference on traditional practices in conservation agriculture* (pp. 142-51).

Hagen, K. S., Sawall, E. J., & Tassan, R. L. (1971). The use of food sprays to increase effectiveness of entomophagous insects.

Haldhar, S. M., Jat, G. C., Deshwal, H. L., Gora, J. S., & Singh, D. (2017). Insect pest and disease management in organic farming. *Book 'Towards Organic Agriculture' edited by B. Gangwar and NK Jat. Today & Tomorrow's Publishers, New Delhi, Page*, 359-390.

Hammerschmidt R. 2007. Introduction: definitions and some history. In: Walters D, Newton A, Lyon G, eds. Induced resistance for plant disease control: a sustainable approach to crop protection. Oxford, UK: Blackwell Publishing, 1-8.

Jackson, D. M., Canhilal, R., & Carner, G. R. (2005). Trap monitoring squash Vine Borers in cucurbits1, 2. *Journal of Agricultural and Urban Entomology*, *22*(1), 27-39.

James, D. G. (2003). Field evaluation of herbivore-induced plant volatiles as attractants for beneficial insects: methyl salicylate and the green lacewing, *Chrysopa nigricornis*. *Journal of chemical ecology*, *29*(7), 1601-1609.

Kaul, O. and Dhaliwal, S. (2000). Phytochemical Biopesticides. *Hardwood Academic Publications Amsterdam*, The Netherlands.

Landis, D. A., Wratten, S. D., & Gurr, G. M. (2000). Habitat management to conserve natural enemies of arthropod pests in agriculture. *Annual review of entomology*, *45*(1), 175-201.

Mani, M. (2022). Organic pest management in horticultural crops. *Trends in horticultural entomology*, 211-241.

Mensah, R. K. (1997). Local density responses of predatory insects of Helicoverpa spp. to a newly developed food supplement 'Envirofeast' in commercial cotton in Australia. *International Journal of Pest Management*, *43*(3), 221-225.

Orr, D. B., Landis, D. A., Mutch, D. R., Manley, G. V., Stuby, S. A., & King, R. L. (1997). Ground cover influence on microclimate and *Trichogramma* (Hymenoptera: Trichogrammatidae) augmentation in seed corn production. *Environmental Entomology*, *26*(2), 433-438.

Palekar, S. (2016). Zero Budget Natural Farming. Amravati, Maharashtra, India: Zero Budget Natural Farming Research, Development & Extension Movement.

PAU. (2017). Package of Practices for Crops of Punjab, Kharif 2017. Punjab Agricultural University, Ludhiana, pp 203.

Pontin, D. R., Wade, M. R., Kehrli, P., & Wratten, S. D. (2006). Attractiveness of single and multiple species flower patches to beneficial insects in agroecosystems. *Annals of Applied Biology*, *148*(1), 39-47.

Rosen, J. D., & Zang, X. (2007). "Photolysis of two pesticides used by organic farmers: sabadilla and ryania". In Crop Protection Products for Organic Agriculture, ACS Symposium Series. Vol 947 Edited by: Felsot, A. S. and Racke, K. D. 222 – 229. Washington, D.C.: American Chemical Society.

Rythu Sadhikara Samstha (RySS) (2020). Andhra Pradesh Community Managed Natural Farming (APCNF): Technical Manual. Government of Andhra Pradesh, India.

Sharma, A. K., & Goyal, R. K. (2000). Addition in tradition: Agroforestry in the arid zone of India. *LEISA India*, *2*(3), 19-20.

Srinivasan, K. (1992). The development and adoption of integrated pest management for major pests of cabbage using Indian mustard as a trap crop. In Diamondback Moth and Other Cruciferous Pests. *Proc. 2nd Intl. Wkshp., Asian Veg. Res. and Dev. Ctr., Shunhua, Taiwan*, 10-14.

Srinivasan, K., & Veeresh, G. K. (1986). The development and comparison of visual damage thresholds for the chemical control of *Plutella xylostella* and *Crocidolomia binotalis* on cabbage in India. *International Journal of Tropical Insect Science*, *7*(4), 547-557.

Sticher, L., Mauch-Mani, B., & Métraux, A. J. (1997). Systemic acquired resistance. *Annual review of phytopathology*, *35*(1), 235-270.

Surekha, J., & Rao, P. A. (2000). Management of fruit borer of bhendi with organic sources of NPK and certain insecticides and its effect on bhendi yield. *Pestology*, *24*(8), 35-39.

Van Bruggen, A. H. (1995). Plant disease severity in high-input compared to reduced-input and organic farming systems. *Plant disease, 79*(10), 976-984.

Yue, Q., Wang, C., Gianfagna, T. J., & Meyer, W. A. (2001). Volatile compounds of endophyte-free and infected tall fescue (*Festuca arundinacea* Schreb.). *Phytochemistry*, *58*(6), 935-941.

Zangger, A. (1994). The positive influence of strip-management on carabid beetles in a cereal field: accessibility of food and reproduction in *Poecilus cupreus*. In Carabid beetles: Ecology and evolution (pp. 469-472). Dordrecht: Springer Netherlands.