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Review Article

Insect Pest Management in Organic Agriculture- A Fast Growing Approach of 21st Century

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A B S T R A C T

Organic farming is only alternative to climate change. Regulations of organic farming in current climate change scenario left behind few voids compared to conventional farming. For maximum of the organic farmers it become difficult to manage pests in their crops compared to other practices, but still main pests could be succeeded through manipulation of agro-ecosystem procedures in merit of the crops and drawback of pests. The few active plant protection substances approved for use in organic farming can deliver provision to natural and biological control agents in suppression of pests and diseases. In this article, we will remark the principles and strategies of crop protection in organic farming, the cultural practices implemented, the active substances permitted for use to conquer pests and the influences on diversity. In Ladakh region, due to climate change the glaciers have shown a significant reduction in volume and much of the ice mass has melted in many glaciers, some had already perished, and that had a direct impact on the pest paradigm, especially outbreak of brown tail moth, Agrotis and locusts. Therefore, the organic farming had an overall adverse impact on subsistence living system in this tribal area.

Keywords: Climate Change, Insects, Biodiversity, Organic Farming, Agriculture, Pest, Ladakh

Introduction

Organic agriculture is a universal production system that tolerates the health of soils, ecosystems, and people, trusts on ecological processes, biodiversity and cycles altered to indigenous situations rather than the use of efforts with adverse effects.[13] Organic agriculture syndicates tradition, innovation, and science to help the shared environment and endorse fair relationships and a good quality of life for all convoluted, considering nutrient and energy cycle system and the whole farm as one organism.[11] Organic agriculture count on a number of farming performs based on ecological cycles and purposes at diminishing the environmental influence of the food industry, preserving the long-term sustainability of soil and dipping to a minimum use of nonrenewable resources; besides being both a philosophy and a system of farming aiming to produce food that is

nutritious and uncontaminated with substances that could harm human health. Further, the organic farming benefits to the ecosystem in many ways, for example conservation of soil fertility, carbon dioxide storage, fossil fuel reduction, preserving landscape, and preservation of biodiversity.

In organic farming the insect and disease management is achieved by using appropriate cropping techniques, biological control, and natural pesticides.[8] Weed control, the main problem for organic growers, can be managed through cultural practices including mechanic cultivation, mulching, and flaming, burning. Organic farming is considered by higher diversity of arthropod fauna and maintenance6, 7 of natural enemies than predictable agriculture as long as the area has appropriate climate for insect existence. According to the IFOAM, organic agriculture is guided by four principles: health, ecology, fairness and care; similarly US Congress passed the organic food product act in 1990, while the European Union (EU) set up the first regulations on organic farming in 1991, and in the same year, the Codex Alimentarius Commission officially recognized organic agriculture. Gomiero T et al. gave more details on history of organic farming, total global areas, organic standards, and impact on the environment.[11]

Organic Agriculture and Pest Control

In organic farming insect pest management is a holistic and area wide approach that largely depends on the ecological processes and biodiversity in the agro-ecosystem, use of biopesticides[3] and pheromones.[9] Since, the IPM tactics, principles and components must match with organic farming systems in the current climate change scenario. The goal of this strategy is to prevent pests from reaching economically damaging levels without causing risk to the environment adapting the following successful IPM components: monitoring crops for pests, accurately identifying pests, developing economic thresholds, implementing integrated pest control tactics, and record keeping and evaluation. The limitation of resources, competition, parasitism, and predation are the aspects that reduce crop habitat inappropriate for pests and diseases; and these workings play an important role in keeping equilibrium of the agro-ecosystem and conquest of harmful insect pests and ailments. Faunal and floral diversities play a considerable role in pest and disease controlling in organic farming system, based on the principles of deterrence, evasion, monitoring, and destruction.

Repellent Effects on Insect Pests

This method relies on certain plant features to secret certain substances on their surfaces or in air with repulsive or destructive effects on insects' pests. These plants are cultivated in field or associated with crops or grow naturally on boarders of the crop field. The products used are classified into two categories as vegetal insecticides or mineral insecticides.

Table 1.Natural plants and their target insect pests[14]

Yarrow (*Achillea millefolium*)	**Aphids, Mites, Psyllids, Thrips**
Queen of poisons (*Aconitum* sp.)	Coleopteran larvae
Sweet flag (*Acorum calamus*)	White cabbage butterfly
Onion (*Allium cepa*)	Mites, ants, storehouse pests
Garlic (*Allium sativum*)	Thrips, storehouse pests
Birthwort (*Aristolochia clematitis*)	Bed bug
Absinthium (*Artemisia absinthium*)	Nematodes, caterpillars, fleas
Mugwort (*Artemisia vulgaris*)	Fleas, Colorado beetle
Lamb's quarters (*Chenopodium album*)	Colorado beetle, white butterfly
Hemlock (*Conium maculatum*)	Coleopteran larvae
Coriander (*Coriandrum sativum*)	Aphids, spiders, Colorado beetle (repellent effect)
Spurge (*Euphorbia* sp.)	Caterpillars, aphids
White sweet clover (*Melilotus albus*)	Colorado beetle
Mint (*Mentha* sp.)	Colorado beetle
Tobacco (*Nicotiana tabacum*)	Aphids, mites, Colorado beetle
Black nightshade (*Solanum nigrum*)	Aphids, mites, Colorado beetle, cabbage butterfly
Yew (*Taxus baccata*)	Various insects
Field penny-cress (*Thlaspi arvense*)	Bed bug (repellent)
Common nettle (*Urtica dioica*)	Aphids, mites
Mullein (*Verbascum phlomoides*)	Colorado beetle

Insect Pest Management: Organic vs. Conventional Systems

Organic growers have only a few options available for plant protection compared to conventional one who exclusively depend on the use synthetic chemicals. Therefore organic growers are bound to capitalize on the natural processes and besides the management of ecosystem to control

pests. Organic farms had a more varied arthropod fauna on average than predictable farms. Further, the natural enemies (parasitoids, predators, birds and other non-arthropod insect pest predators) were more abundant on organic farms, as the habitat for natural enemies' establishment is well conserved. Arthropod biodiversity, as measured by species richness, was, on average, 1/3 grater on organic farms than on conventional farms. The essential constituents and natural procedures of ecosystems in organic farming such as soil organism activities, nutrient cycling and species distribution & competition, are used unswervingly and tortuously as farm management tools to avert pest populations from reaching cautiously destructive levels. Soil fertility and crop nutrients are managed through tillage and cultivation practices, crop rotations and cover crops. The ecofriendly farming activities in organic agriculture are supplemented with manure, composts, crop waste material and other allowed substances that are overall beneficial for environment. Soil-borne and root pathogens are typically found in stumpy levels in organic farming as compared to orthodox farming. For example *Pythium* spp., *Sclerotium rolfsii*, *Phytophthora* spp. and some *Fusarium* can survive best in organic farming systems. Since, these organisms thrive well on organic matter of the soil, in the absence of their hosts for long periods. The airborne pathogens cannot be controlled with cultural practice such as crop rotation; however the powdery mildew, rust diseases (airborne) and insect pests such as aphids and whiteflies (sucking insects) are less serious in organic agriculture than in conventional farming due to lower nitrogen concentrations in foliar tissues or phloem of plants that enhances tissue succulence which trigger the air born chemical stimulus to stimulate pest attraction. Organic chemicals have little residual effects and work through direct contact mode of action as distinct to the obstinate systemic pesticides employed in conservative farming.

Organic Farming and Plant Protection Practices

Practices and tactics used in organic farming are based on the three management strategies, which include prevention, monitoring, and suppression. These practices will be intensively discussed in the following paragraphs:

Monitoring of Crop Pests

Crop pests comprise insects, weed, plant pathogens, invertebrate, and vertebrate animals. Identification of insect pests and their normal enemies is an imperative step in any pest management platform. Insect pests and expected enemies could be recognized using keys and field guides or otherwise referring an official documentation bodies. Unlike insect pests, plant pathogens including fungi, bacteria, virus, and nematodes are difficult to identify in the field and may need laboratory diagnosis. However, signs of insect damage and symptoms of plant diseases may be easily distinguished in the field. Weeds could be effortlessly recognized using key and field guides. Monitoring is the even review or scouting of field crops for pests, comprising insects, pathogens, nematodes and weeds, to regulate their abundance and level of impairment. It helps as an early cautionary system for the incidence of pests and diseases providing evidence for decision-making concerning management action and assessment of control methods. Insect pests can be checked through visual observation, pheromone & light traps, sticky traps, water traps, yellow traps, sweep nets, beating trays and pitfall traps. Scouting data are used to develop economic thresholds, a useful decision-making tool to start control action when a pest population reaches or exceeds the specified economic threshold.

Pest Prevention and Suppression in Organic Farming

A effective integrated pest management (IPM) program in organic farming includes a diversity of pest management strategies such as cultural, mechanical/physical, biological, and biopesticide (permissible for organic use) tactics independently or in combination. Each control tactic employs a dissimilar set of mechanisms for averting and conquering pest populations.

Cultural Pest Control

The goal of cultural control is to alter the environment, the condition of the host, or the behavior of the pest to prevent or suppress an infestation. It interrupts the normal relationship between the pest &the host and makes the pest less likely to endure, rise, or replicate. In agricultural crops, crop rotation, assortment of crop plant changes, timing of planting and harvesting, irrigation management, crop rotation, and use of trap crops aid reduce populations of weeds, microorganisms, insects, mites, and other pests. These cultural practices are more preventive than curative and thus may require planning in advance. The expanded habitat delivers these parasites and predators with alternate food sources, shelter, and breeding sites. Tillage can cause annihilation of the insect or its stagnating chamber, removal of the protective cover, abolition of food plants, and disturbance of the insect life cycle usually killing many of the insects through direct contact, famishment or acquaintance to predators, and weather. Trap strip crops can control insect impairment at the field edges and at the same time avail refuge and food for valuable insects. Insect resistance is an important component of pest and disease management. Quality-based resistance can be induced in plants through management of nutrients and irrigation. Intercropping and biodiversity play an imperative role in pest in organic farming management.

Mechanical and Physical Pest Control

One of the easiest methods of physical or mechanical pest

control is selecting insects or hand-pulling weeds. This method works best in those situations where the pests are visible and easily accessible. Physical or mechanical commotion of pests also contains methods as mowing, hoeing, flaming, soil solarization, tilling or cultivation and washing. Animals such as kangaroos cause impairment by eating yellow dates; hence, fruit bunches are enclosed to defend them from such injury. Devices that can be employed to eliminate insect pests from reaching crops in organic farming comprise, but not limited to, row covers, protective nets with fluctuating mesh size according to the pest in question and sticky paper collars that stop crawling insects from climbing the trunks of trees. Water pressure sprays can be used to extricate insect pests such as aphids and mites from the plant surface. Insect vacuums, on the other hand, could be employed to eradicate insects from plant surface and gather them into a collection box.

Biological Pest Control

Biological methods are the use of beneficial organisms that can be used in the field to reduce insect pest populations. Biological control is congregated into three groups: importation or classical biological control, which presents pest's natural enemies to the locations where they do not ensue naturally, increase contains the supplemental release of natural enemies, enhancing the naturally occurring population, and conservation, which implicates the conservation of prevailing natural enemies in the environment. The role of helpful species on pests is of comparatively greater position in organic agriculture than in conventional agriculture, because organic cultivators do not have alternative to extremely potent insecticides with which to challenge major pest glitches.

Biopesticide Control

Biopesticides are characterized by having minimal or no risk to the environment, natural enemies, and non-target organisms due to their mode of action, rapid degradation, and the small amounts applied to control pests. They are deliberate acting, have a comparatively grave application times, and conquer rather than eradicate a pest population. Biopesticides have limited field persistence and shorter shelf life and present no residue problems. Thus, they are approved for pest management in organic crops.

Plant Protection Products (PPPs)

The crop protection in organic farming is universal, and, hence, it is tremendously problematic to distinct inputs as plant nutrients (fertilizers) and protectants. Plant protection products authorized for use in organic farming fluctuate among countries liable on the differences in crops, pests, and cropping systems, as well as regulations and standards approved by these countries (Table 2). Organically accepted pesticides fall into the following groups: biorational, in-organics, botanicals, microbial, oils, and soaps. The most broadly used as insecticides are microorganisms, natural pyrethrins, rapeseed oil, and paraffin; the most extensively employed as fungicides are copper compounds, sulfur, and microorganisms. The rules of organic agriculture permit the use of unregistered products such as nettle slurry, which is used against aphids. It can be prepared on the farm or common among farmers.

The basic constituents of plant and animal source, which are employed as foodstuff, can be validly used in crop protection in organic farming with the omission of being used as herbicides. These basic substances contain chitosan hydrochloride, fructose, sucrose, *Salix* spp. cortex and *Equisetum arvense* L. (field horsetail) which are employed as elicitors of the plant self-defense mechanism. Sunflower oil, whey and lecithins are used as fungicides, while vinegar is used as fungicide and bactericide and *Urtica* sp. is used as insecticide, fungicide and acaricides.

Table 2. Natural products, target organisms (Insects, mites, fungi, bacteria, viruses, vertebrates and invertebrates) specifications, and application rates [14]

Name of product	Purpose and specifications of use
Azadirachtin from the neem tree (*Azadirachta indica*)	Insect pest control
Beeswax	Used as protectant for treatment of cuts and wounds after pruning or in grafting
Plant oils	Used for control of small-bodied insects such as thrips, aphids and whiteflies
Laminarin (from *Laminaria digitata*) or kelp or brown algae seaweed	A polysaccharide from the group of the glucans, used to protect plants against fungi and bacteria. Kelp should be grown according to the organic standards
Pheromones	Used only in traps and dispensers
Pyrethrins from the leaves of *Chrysanthemum cinerariaefolium*	Used as insecticide
Pyrethroids (only deltamethrin or lambdacyhalothrin)	Used only in traps with attractants or pheromones

Quassia from the plant *Quassia amara*	Only insecticide and repellent
Microorganisms, e.g., *Bacillus thuringiensis*, *Beauveria bassiana* and *Metarhizium anisopliae*	Origin should not be GMOs
Spinosad from the soil bacterium *Saccharopolyspora spinosa*	Used as insecticide
Ethylene	Insecticidal fumigant against fruit flies
Paraffin oil	Used as insecticide against small-bodied insects
Fatty acids (soft soaps)	Insecticide against mite, thrips and aphids
Lime sulfur (mixture of calcium hydroxide and sulfur)	Used as fungicide
Kieselgur (diatomaceous earth) from the hard-shelled diatom protist (chrysophytes)	Used as mechanical insecticide
Naturally occurring aluminum silicate (kaolin)	As insect repellent against a wide range of insects at a rate of 50 kg/ha
Calcium hydroxide	Used as fungicide
Sodium hypochlorite (bleach or as javel water). It is a disinfectant with numerous uses and its effect is due to the chlorine	Used in seed treatment as viricide and bactericide
Sulfur	Used as broad-spectrum inorganic contact fungicide and acaricide
Copper compounds such as: copper hydroxide, copper oxychloride, copper oxide, tribasic copper sulfate and Bordeaux mixture (copper sulfate and calcium hydroxide)	Used as fungicide and bactericide maximum of 6 kg copper per ha annually
Sheep fat (obtained from fatty sheep tissues by heat extraction and mixed with water to obtain an oily water emulsion)	A triglyceride consisting predominantly of glycerine esters of palmitic acid, stearic acid and oleic acid. A repellent by smell against vertebrate pests such as deer and other game animals. It should not be applied to the edible parts of the crop
Hgh Quartz sand	Used as repellent against vertebrate pests

The exclusion of synthetic fertilizers and pesticides lead to maintenance of natural enemies comprising predators and parasitoids. The absence of harmful pesticides also increase diversity of pollinators of the crops and minimize the pesticides residues in the food products. Microorganisms community that flourish fine in organically accomplished farms leading to augmented organic matter decomposition, soil fertility, and sustainability of the ecosystem. The invasion of the pests is managed by establishment of the organic farms.

Organic Farming Favors Wild Bee/ Insect Pollination

Pollination of insect pollinated crops has been found to be correlated to pollinator abundance and diversity.[5] Since organic farming has the latent to alleviate undesirable effects of agricultural intensification on biodiversity, it may also advantage crop pollination, but direct suggestion of this is limited. The effects have been evaluated involving the organic farming on pollination of plants focusing on many aspects of pollinators and their health. The pollination success and the proportion of fully pollinated berries were advanced on organic compared to predictable farms and this alteration was already obvious 2-4 years after alteration to organic farming. It was also observed that conversion to organic farming may rapidly increase pollination success and hence benefit the ecosystem service of crop pollination regarding both yield quantity and quality. Conservation of insect pollinators is very essential[2] besides their protection from anthropogenic factors declining pollinator populations in ecosystems.[1,4] Insect pollinators are adversely impacted by many pathogenic disease,[15] if proper management options along with organic farming practices are not followed, the apiculture industry would end soon, there of reducing the crop yield to lowest leave, with consequences of causing the economic and food crisis in the world. The vegetables pests especially the fruit fly damage[12] has been considerable in India, so organic farming using biopesticides have been successful in many places. Therefore, a combined approach for the pest management have been found desirable in many cases,[9] using pheromones along with other control tactics.

Organic farming has been planned to be a means to lessen the declining biodiversity in agricultural landscapes and varies from orthodox farming by the proscription of most pesticides and inorganic fertilizers, requiring more intricate crop-rotations such as the use of nitrogen-fixing plants.[8,10] Organic farming has been shown to mark biodiversity of numerous taxonomic groups, but effect strength and direction can vary with taxonomic group, scale and landscape setting. However, current results suggest that management effects benefiting biodiversity may not necessarily translate into improved ecosystem services. Pollinator diversity and profusion often advantage from organic farming, which may lead to enhanced pollination. However, how pollination is prejudiced by farming practice is not methodically tacit and studies have produced conflicting results, and the effects of organic farming on pollination are not essential simply related to pollinator productivity or abundance as pollination rates may be altered by e.g. community composition, visitation frequencies and foraging behavior.[7] Therefore, it is imperative to first comprehend if the effects of organic farming on pollinator diversity and abundance translate into improved crop pollination, and then further inspect the causes.

Beyond Organic Control of Insect Pests

Beyond organic, we are in a new era of agriculture, as reflected in the words of US Secretary of Agriculture Tom Vilsack "Organic agriculture is one of the fastest growing segments of American agriculture and helps farmers receive a higher price for their product as they strive to meet growing consumer demand". Organic agriculture has tremendous ability to provide jobs, be profitable, benefit the soil and environment, and support social interactions between farmers and consumers. Though organic agriculture has an untapped budding role in global food and ecosystem security, no one farming structure alone will securely feed the planet. Rather, a blend of organic and other inventive farming systems, comprising agro-forestry, integrated farming, conservation agriculture, mixed crop and livestock will be desired for future global food and ecosystem security. To make this ensue will require mobilizing the full arsenal of effective policies, scientific and socioeconomic advances, farmer inventiveness and public appointment.

Conclusion

Prevention is better than control; therefore practices like crop rotation, fertilization, cultivation, use of resistant varieties and preservation of natural enemies play an important in IPM. When cultural and biological control methods fail to control the insect pests below Economic Damage Level, the organic control tactics come into play. Therefore the organic production system form the corner stone for the management pest and support the prolong production of crops in a sustainable way.

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