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INTRODUCTION

The necessity to meet food requirement of the ever-growing human population around the world has made agriculture become dependent on external inputs, like pesticides, to have a fast-paced increase in agricultural production. But most of the chemical pesticides and other agrochemicals used in conventional farming have a negative impact on the environment, ecological balance and biodiversity as a whole. Here enters the concept of organic agriculture which provides an environmentally safer farming approach and a healthy lifestyle to humans. An ecological understanding of insects is very important in the successful designing of an organic farm plan. Arthropods like insects have numerous beneficial ecological roles as pollinators, predators etc. in agricultural and natural ecosystems. To attain the goal of sustainable organic agriculture, we need to reconsider the role of insects in agricultural ecosystems. Recognizing the function of insects in ecosystems help us to comprehend their significance in sustainable functioning of agricultural systems and their role in future food security.

INSECT ECOLOGY AND ITS IMPORTANCE

In 1869, Haeckel defined ecology as "the study of the natural environment including the relations of the organisms to one another and to their surroundings". When ecological studies primarily focus on insect as the subject organism and the environmental interactions and effects encircling it, this becomes insect ecology. Insect ecology studies the interaction of insects with their surrounding environment or ecosystem, either at an individual level or at a community level. Besides the common fields in ecology, insect ecology deals with population dynamics, abundance and distribution of insect population, their survival adaptations and their implication in an ecosystem. Insects play a very crucial role in any agroecosystem. Thus, we require to have a good knowledge of insect behaviour and their intra and interspecific interactions with others insect, animal species and plants. In all terrestrial ecosystems' insects seen to form the basic biological foundation. They offer a significant food supply for other taxa, cycle nutrients, pollinate plants, distribute seeds, manage populations of other creatures and maintain soil fertility. Since organic agriculture does not support the use of chemicals and only accept approved, non-synthetic or synthetic materials as a last resort when other control measures fail, it becomes even more important to understand the role played by insect ecology to manage insects present in a farming system before it reaches injurious level and compels an organic farmer to take help of the last standing guards.

ROLE OF INSECT ECOLOGY IN ORGANIC FARMING SYSTEM

The knowledge of insect ecology can be applied in an organic farming system to bring effective disease, insect and weed control, along with improving soil health and increasing crop yield.

1. Application of insect life table: A life table is a kind of bookkeeping system which ecologists use to summarise mortality at different life stages of the population they study. By studying the life table, the stage at which the subject insect is most vulnerable i.e., the stage in which maximum mortality is faced by the insect population can be determined. A life table also includes the factors responsible in causing mortality to that stage. Stage specific application of natural and botanical pesticides at the recognised vulnerable stage of the pest insect and other management practices increases efficiency in pest control with minimal expenditure of labour, resource and money.

2. Population distribution pattern: For effective pest management the first step is to identify the pest and know its distribution pattern. Individuals of the same population remain distributed in three patterns

a. Clumped: Where individuals of a population are found scattered in groups.

b. Uniform: Where due to severe competition between individuals they are evenly spaced and tend to be as far apart from each other and

c. Random: Where the probability of locating an individual at a point in a populated area is equal for all the points.

In agricultural systems, insects are most commonly found aggregated or clumped. Identification of their location allows target specific (localised) application of control measures. This localised approach brings down the cost of control and also manages pest more efficiently in organic farm plan.

3. Study of insect biology: Knowledge of the pest behaviour allows the farmer to choose an appropriate control measure. For example, if a crop is being infected by a nocturnal insect, then installation of light traps will provide better control and relieve the farmer from adopting any kind of spray at all. Many diapausing insects and pupa hide beneath soil surface, under crop litter, between leaf sheath etc. Hand picking them or destroying of their hiding location will help reduce pest population. One cultural method used in paddy fields is clipping-off of the leaf tips before transplanting as rice stem borer lay eggs at the tip of leaves.

4. Seasonal or cyclic patterns in behaviour: Cultural practices like selection of resistant varieties date of sowing and prophylactic spraying can be adjusted based on understanding of phenological behavioural patterns like migration timing, plant stage attacked, diapause period.

5. Identification and conservation of beneficial insects: It is necessary to avoid accidental killing of beneficial insects. Beneficial insects are widely categorised as pollinators (honeybee, syrphid), natural enemies (predator-lady bird beetle, aphid lions: parasites and parasitoids- Strepsiptera order) and decomposers (dung beetle).

6. Ecosystem Recycling: Bacteria and insects (decomposers) convert the mineral elements present in soil and air into forms that could be taken by plants to aid in their growth. Hence, they play an important role in moving above-ground to below-ground nitrogen and phosphorus fluxes across entire ecosystems.

7. Weed management schemes: Identification, introduction and conservation of insects feeding on specifically on weeds can help reduce their number. For example, *Zygogramma bicolorata* is introduced in fields to feed and control carrot grass Parthenium species.

8. Implementation of Ecological Pest Management (EPM): Ecological pest management relies on above and below ground preventive strategies to build a farm's natural defences. Reactive strategies are only kept as a last resort. The broad strategies used in EPM are: crop management, soil management, planned supplemental pest management practices, planned supplemental soil practices to reduce crop stress and optimise yield and quality, reactive inputs for pest management and reactive inputs to reduce plant stress.

9. Maintaining and conserving insect species biodiversity: Increase in the diversity of parasitoids and predators is related to reduction in pest population outbreaks. In organic agriculture, a proactive strategy to support complimentary or synergistic effects of predator for pest control necessitate biodiversity management based on biological knowledge of interacting species and functional food webs. Enhanced biodiversity led to effective biological control of pests, pest dilution effects and can compensate for the absence and reduce dependency on synthetic pesticides.

10. Functional importance of species diversity: Functional characteristics of the species determine the properties of the ecosystem. For managing an agricultural pest, we require a natural enemy who will specifically feed on that insect pest and provide desirable control. If it has a broad range of prey, the effectivity of control will decrease.

CONCLUSION

With this knowledge of insect ecology, an organic farmer can design a farm plan that takes advantage of the beneficial roles played by insects. Successful organic farm managers utilize their ecological knowledge of insects to use them as friends in maintenance and improvement of their natural resource base. Future research in sustainable and organic agriculture should thus focus on the role of insects in natural and agricultural ecosystems.