Agri Articles
(e-Magazine for Agricultural Articles)
Volume: 04, Issue: 04 (JULY-AUG, 2024)
Available online at http://www.agriarticles.com
©Agri Articles, ISSN: 2582-9882

Impact of Soil Management Practices on Insect Populations

(*G. Ranjitha[1], K. S. Nikhil Reddy[2], K. S. Girish[1] and D. Kavya[1])
[1]College of Agriculture, Mandya, India and [2]Keladi Shivappa Nayaka University of Agricultural and Horticultural Sciences, Shivamogga, India
*Corresponding Author's email: ranjithaggowda96@gmail.com

Soil management practices significantly influence insect populations within agricultural systems, affecting both pest and beneficial species. This chapter explores the effects of various soil management strategies, including tillage, crop rotation, cover cropping, and organic amendments, on the abundance, diversity, and behavior of insect communities. Conventional tillage often disrupts insect habitats, leading to declines in beneficial species, while reduced tillage supports a more stable environment for these organisms. Crop rotation and cover cropping promote insect biodiversity by providing varied habitats and disrupting pest life cycles. Organic amendments enhance soil health, fostering a richer community of soil-dwelling insects, although improper management can attract pests. Conversely, chemical inputs can diminish insect diversity by eliminating non-target species. Sustainable soil management practices that prioritize soil health and ecological balance are crucial for maintaining healthy insect populations, which play vital roles in pest control and ecosystem stability. This study highlights the importance of integrating insect-friendly practices into soil management to enhance agricultural productivity and environmental resilience.

Introduction

Tillage: Tillage can be beneficial because it disrupts the life cycle of insect pests and can expose pests to predators and the elements. Fall tillage can destroy crop debris that serves as over wintering sites for flea beetles, corn borers, squash bugs, and other insect pests. However, excessive tillage can accelerate the decomposition of soil organic matter and deplete the food source that soil microorganisms depend on, decreasing their ability to disrupt pests. Excessive and untimely tillage can also contribute to soil erosion.

Mulches: Mulches, both organic and synthetic, can help reduce insect pest problems. Plastic mulch is often used to speed early season crop growth that makes plants better able to tolerate insect feeding. Reflective mulch repels thrips and aphids and can reduce the incidence of insect transmitted virus diseases in vegetable crops. Note that the National Organic Program (NOP) final rule (USDA, 2000) allows the use of plastic or other synthetic mulches for weed and pest control, provided they are removed from the field at the end of the growing or harvest season. As always, consult with your certifier/inspector before using a new product or input in your certified organic operation.

Research has shown that straw mulch can suppress early season Colorado potato beetle (CPB) activity by creating a micro-environment that increases the number of predators like ground beetles, lady beetles, and lacewings. Mulching with straw can also reduce the CPB's ability to locate potato plants. In these trials, defoliation was reduced and potato yields were increased by one-third compared to plots with no mulch.

Reduced inputs of synthetic fertilizers: Synthetic fertilizers are known to affect populations of insect pests in agricultural fields. Nitrogen levels appear to be especially important, which is not surprising as nitrogen is usually a limiting element for insect herbivores. Excessive amounts of nitrogen fertilizer have been associated with greater pest and disease problems. Malik et al. (2009) reported nearly twice as many thrips on onions supplemented with 200 kg N ha^{-1} compared with 50–150 kg N ha^{-1}. Effects of nitrogen fertilization on Colorado potato beetles appear to be somewhat complicated. On tomato, higher nitrogen rates made plants more attractive to adult beetles (Hunt et al., 1994).

Crop rotation: Crop rotation, the practice of growing different types of crops in the same area across different seasons or years, has a significant impact on insect populations. Many insect pests are adapted to specific crops and have life cycles that are synchronized with the growth stages of those crops. By rotating crops, farmers disrupt the continuity of host plants available to these pests, thereby interrupting their life cycles and reducing their population densities.

Rotating crops can provide habitats for beneficial insects, ensuring that these natural enemies of pests have a continuous presence in the field. For example, rotating to a crop that attracts ladybugs can help control aphid populations in subsequent crops.

Continuous planting of the same crop can lead to the selection of pest populations that are resistant to control measures, such as pesticides. Crop rotation helps to prevent or delay the development of resistance by reducing the selective pressure on pests to adapt to a single crop environment. Pests that feed exclusively on one type of crop (monophagous pests) are especially affected by crop rotation. When their preferred host is replaced by a different crop, these pests are either forced to migrate, starve, or adapt to the new crop, often leading to a decrease in their populations.

Cover Cropping

Increased Habitat Diversity: Cover crops provide a continuous vegetative cover, creating diverse habitats for insects throughout the year. This vegetative cover supports a wider range of insect species, including predators, parasitoids, and pollinators, by offering shelter, breeding sites, and food sources.

Winter Habitat: Many beneficial insects, such as ground beetles and spiders, find refuge in cover crops during the winter, allowing them to survive and control pest populations in the subsequent growing season.

Allelopathy and Pest Deterrence: Some cover crops release allelopathic chemicals that deter insect pests or inhibit their growth. For instance, certain mustard species used as cover crops can suppress soil-borne pests through the release of bioactive compounds.

Enhanced Predator and Parasitoid Populations: Cover crops attract and sustain natural enemies of pests, such as ladybugs, predatory beetles, and parasitic wasps. By providing food resources like nectar and pollen, cover crops help maintain these beneficial insect populations, leading to better natural pest control.

Organic Amendments

Enhanced Soil Fertility: Organic amendments, such as compost, manure, or green manure, enrich the soil with nutrients and organic matter. This enrichment supports a more diverse and abundant soil insect community, including decomposers like earthworms and beetles, which play a crucial role in nutrient cycling and soil structure maintenance.

Symbiotic Relationships: Organic amendments promote the growth of beneficial soil microbes, such as mycorrhizal fungi and nitrogen-fixing bacteria, which can enhance plant health. Healthy plants are less susceptible to pest infestations, indirectly affecting insect populations by reducing the availability of weak or stressed plants that pests typically target.

Conventional tillage has profound impacts on insect populations, often leading to a reduction in beneficial insects and an increase in pest populations over time. While tillage can provide short-term pest control, its long-term effects tend to disrupt ecological balance, reduce insect diversity, and weaken the natural pest control mechanisms. These outcomes highlight the need for more sustainable soil management practices that preserve soil structure, enhance biodiversity, and support the health of insect communities in agricultural systems.

Conclusion

Soil management practices play a crucial role in shaping insect populations within agricultural ecosystems. Practices such as conventional tillage, crop rotation, cover cropping, and the use of organic amendments have profound effects on the abundance, diversity, and behaviour of both pest and beneficial insects.Conventional tillage often disrupts soil structure, leading to habitat loss and a decline in beneficial insect populations, while potentially fostering the proliferation of certain pests over time. Conversely, practices like crop rotation and cover cropping can enhance biodiversity, reduce pest pressure, and support a balanced insect community by providing diverse habitats and food sources. The integration of organic amendments further promotes healthy soil ecosystems, encouraging the presence of beneficial insects and microorganisms that contribute to natural pest control and overall soil fertility. Sustainable soil management practices that prioritize the preservation of soil health and biodiversity are essential for maintaining ecological balance, reducing reliance on chemical inputs, and fostering resilient agricultural systems.

References

1. Malik, M.F., Nawaz, M., Ellington, J., Sanderson, R. and El-Heneidy, A.H. (2009). Effect of different nitrogen regimes on onion thrips, *Thrips tabaci* Lindemann, on onions, *Allium cepa* L. *Southwestern Entomologist*, **34**(3): 219-225.
2. Hunt, D.W.A., Liptay, A. and Drury, C.F. (1994). Nitrogen supply during production of tomato transplants affects preference by Colorado potato beetle. HortScience. 29(11): 1326-1328.