GSJ: Volume 9, Issue 9, September 2021, Online: ISSN 2320-9186

www.globalscientificjournal.com

Economic Importance and Management of Insect Pests- A Review

Enock Asante Osei[1*], *Daniel Akansake*[2], *Mariam Olamide Kareem*[1], *Letey Clement Gbaal*,[1] *and Daniel Aluah*[1]

[1]*Authors and* [2]*Author are currently pursuing master's and doctoral degree programs respectively in Irrigation and Drainage Engineering at the West African Center for water, Irrigation and Sustainable Agriculture, University for Development Studies, Tamale, Ghana.*
*Correspondence: enockos2098@uds.edu.gh

ORCIDs: *https://orcid.org/0000-0002-5526-2863

Keywords: Control, Crop, Damage, Economic, Injury, Insects, IPM, Pests

Abstract

Insects are known as one of the most successful class of animals on earth, being a major player in the ecosystem. The economic importance of insects encompasses both their negative and positive importance. Often found on leaves, flowers and stems of crop plants, insects cause both direct (eat the leaves, fruits or vegetables of crop plants and many times too, do destroy the crops prior to fruiting) and indirect damage (transmit infections; viral, bacterial and fungal) to crops. The amount of damage an insect causes to a crop, which justifies the need to adopt an artificial control mechanism when valuated, is termed economic damage. Thus, most control and protection measures are initiated to stop pests from reaching the point that the least pest population can cause an economic damage, and this is known as the Economic Injury Level (EIL). Besides, the economic importance of pests is also numerous; ranging from direct to indirect benefits. However, since insect pests are in a rivalry loop, directly and indirectly with

man in the agri-food system, the adoption of good pest management practices can help reduce the losses substantially. The Integrated Pest Management approach has proven an effective model since it encompasses all the primary pest control methods.

Introduction

Due to the various environmental impact of mankind, obviously, he is seen as the main dominating specie on earth. That notwithstanding, other species in the kingdom animalia compete with man in various ways and are known to be important. Insects, belonging to the class insecta are in a rivalry loop, directly and indirectly with man in the agri-food system. This is as a result of the adaptability of insects and their diversified nature, which has been their competitive advantage (Hendrichs *et al.*, 2007). Thus, insects are known as one of the most successful class of animals on earth, being a major player in the ecosystem. Though 1 million insects have already been identified by scientists, research has revealed that there are still more to be identified since there are over 5 million on-earth insect species (Stork, 2018). An insect may be categorized as a predator, herbivore, fungivore, or a scavenger based on its nutritional mode. As revealed by Pimentel *et al.* (2014), insects, diseases and weeds destroy an estimated 40% of the world's food produce prior to harvesting, whilst about 20% is lost in the storage phase. With the huge damage caused by insect pests, the adoption of good pest management practices can help reduce the losses substantially (Dhaliwal *et al.*, 2004).

1. Insect Pests in Crop Production

Piercing and sucking insects: The mouthparts of these insects are developed for piercing and sucking. In a bid to feed on crops, they insert their mouthparts into plant tissue and draw the juices (Benson, 2016). Thus, these insects decolorize attacked plants and render them wilted in a yellowish state, stunted or deformed which may end up dying. Common examples of such insect pests are the Cotton strainers, Mealy bugs, White flies, Cocoa thrips, Mirids/capsids, Fruit piercing moths, Aphids etc. (Benson, 2016).

Biting and chewing insects: These insects have formidable maxillae and mandible (mouth-parts) which aid them to easily bite and chew plant parts. Locusts, Termites, Grasshoppers, Leaf worms, Budworms, Armyworms, Caterpillar, Crickets, Mantids, Stick insects, Rhinoceros beetles are some common examples of such insect pests (Benson, 2016).

Boring insects: Boring insects create holes into crop steams, crops, wood, leaves, and other parts of crops. Whilst most pests create holes in food products to inhabit it, some boring insects actively feed on the materials they eat into. Examples of boring and chewing insects are Rice weevils, Maize weevils, Bean beetles, Yam beetles, Sorghum weevils, Stem borers, Larvae of Lepidoptera e.g. butterfly, moth, and Pod borers (Benson, 2016).

Aphids: These are small, 1-3mm, soft-bodied insects that come in colors such as black, grey and green is a major crops pest. Being an all-year round crop pest, aphids can be winged or wingless and are usually slow when moving. Aphids gather around the tips of the shoots, and reduce plant vigor by sucking the sap from the plant. Aphids can also spread viruses which can damage the plant.

2. Economic Damage

The amount of damage an insect causes to a crop, which justifies the need to adopt an artificial control mechanism when valuated, is termed economic damage. Thus, most control and protection measures are initiated to stop pests from reaching the point that the least pest population can cause an economic damage, and this is known as the Economic Injury Level

(EIL). When pest population appreciates to Economic Injury Levels, control interventions should be used (Matthews, 2018).

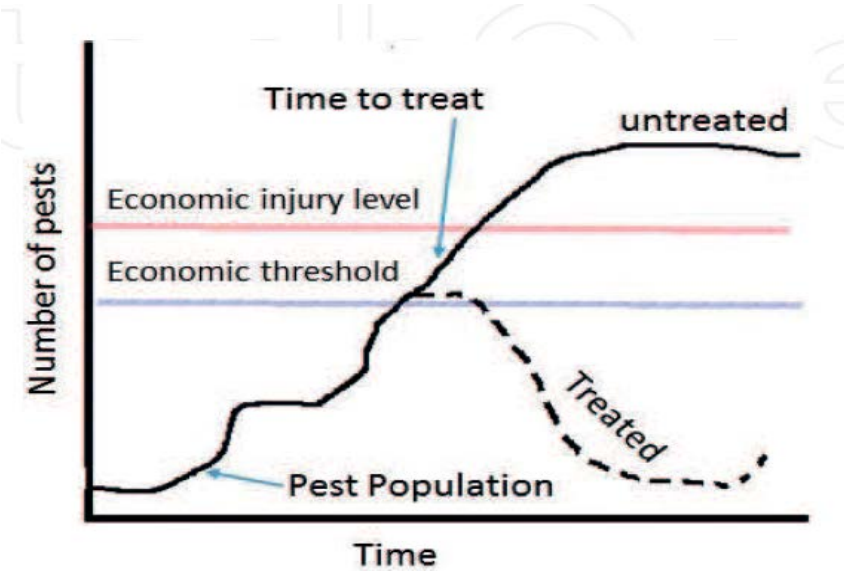

Fig. 1. The economic injury level and threshold (*from* El-Shafie, 2018).

3.1 Negative Effects of Insect Pests

They cause direct damage to crop plants by eating plant leaves and/or burrowing into fruits, root and stems. In as much as the damage caused by pests is visible, it is a direct damage. However, the levels and intensity of damage differs, with the most crucial type of direct damage being the damage of part to be harvested.

Several insects belonging to the orders coleoptera, diptera, heteroptera, homoptera, lepidoptera, orthoptera cause direct damage to crops, in the larvae and adult stages, and this predisposes crops to infections and diseases.

It has become known that almost all viral diseases in crop production are spread by feeding insects -aphids (Aphididae), leafhoppers (Cicadellidae), planthoppers (Delphacidae) and some other bugs. There are some insects that do not inflict injury on crops but rather transmit infections (viral, bacterial and fungal) to crops. When such damage is caused by an insect, it is termed an indirect damage or injury. For example, aphids, belonging to the order hemiptera are known to transmit the viral diseases of potato and sugar beet.

Crop and seed infestation by pests reduces its quality and thus, its market worth and value. Pests feed on parts of crop plants, especially the leaves, hence, lowering the photosynthetic activity of the plant.

Summarily, below are some negative impacts of pests on crops;

a. Crops are likely to fail if insect pests attack it heavily
b. They cause injury which may predispose crop to diseases attack
c. Pests reduce the quality of crops
d. Infected seeds, crops, and vegetables have low market value
e. Pests eat up leaves of crops, thereby reducing the photosynthetic activity of the plant
f. High infestations cause stunting, deformation and retardation of plant growth, and the nematodes can transmit viral diseases from one plant to another.

3. Economic Importance

The importance of insect pests has been categorized as direct and indirect. Today, direct benefits of insects are less valued since it is mainly about utilizing the insect as in the case of using draught animals to plough. Though some insects produce honey, silk and wax which have wide range patronage, it is believed such products' economic importance are limited. Thus, the highly-ranked importance of insects is indirect; hence, they are unnoticed and unappreciated. Below are such of these benefits;

4.1 Aid in Pollination

Mainly, insects and winds fall out as the agents of pollination. Insect-pollinated and wind-pollinated flowers are known as 'entomophilous' and 'anemophilous' flowers respectively.

Many insects such as ants, butterflies, bees visit flowers to collect pollens and nectar. Thus, they keep moving from flower to flower, facilitating cross-fertilization by transferring and dispersing pollen grains from male to female. In order for most plants to produce seeds for continuous propagation, pollination must take place. Plants can propagate either asexually (vegetative) or sexually, and whilst most plants blend these two processes, others use one method exclusively. However, sexual reproduction which involves cross-pollination is necessary in maintaining genetic diversification.

4.2 Source of utile products

Apiculture is the rearing of Honey Bees *(Apis mellifera)*, purposely for honey, wax and other substances, and now than never, for assisted crop pollination. Through apiculture, a myriad of products such as wax, honey, 'royal jelly', and propolis can be sourced and sold, aside selling swarms to establish new colonies. Sustainably producing honey and other products and also keeping the bee colony robust and healthy to control the chances of swarming of the colony will require that good bee management practices are adhered to.

4.3 Assisting as Scavengers

Many insects like flies eat debris and human wastes. Through this habit, they fast-track the degradation of biodegradables, thus, helping mankind by keeping the earth’s surface clean.

4.4 Food

For some groups of people, insects like large caterpillars, grasshoppers and locusts are regarded as edible.

4.5 Help in Decoration

Blisters and ornaments are made from various beetles and butterflies and are used by many people as decoration of house and body.

4. Insect Pests Management and Control

5.1 Historical overview

Insect pest control is as old as the evolution of the various insect species. Sulfur compounds were used by the Sumerians prior to 2500 B.C to control insects. The Chinese also used plant-based chemicals known as botanicals to treat and fumigate seeds. Other times too, wood ash and chalk were used to control and prevent insect pests. Later part in the 1940s, DDT was compounded to control insect pests (Flint and Van den Bosch, 1981). The overuse of chemical-base insecticides led to crucial environmental challenges with no outstanding result in the control and management of insect pest. This has been the bedrock for the development of an environmentally-friendly approach in the control and management of pests. Thus, entomologist thought of it wise to develop a model known as the Integrated Pest Management (IPM) in 1959 as a new paradigm of insect control (Stern *et al.*, 1959). In the development process of IPM, scientists realized that the exclusive use of chemical products to control pests is futile, and not eco-friendly. In the view of Kogan (1998), the resistance of insects to organosynthetic insecticides, massive reappearance of primary pests, the ever-increasing population of secondary pests, and the pollution of the environment inspired the whole idea of IPM. Scientists now suggest that chemical control should be resorted to only when the natural and eco-friendly approaches are not sufficient. According to El-Shafie (2018), the IPM concept is made up of three components:

1. Keep insect populace below Economic Injury Level; the level that causes economic damage.
2. Adopting multifaceted strategies in a combined manner to control and keep insect populations.

3. Conserving environment quality.

Now, it has become apposite to protect agricultural produce and stored products against insects, control and manage insect pests with the IPM method (Bajwa and Kogan, 2002; Hendrichs *et al.*, 2007). The whole idea of IPM runs along the path of using eco-friendly techniques to prevent pests from getting to the EIL by using an array of tactics such as biological, chemical and cultural methods.

Basically, IPM consists of three main objectives:

1. Keeping a suitably-balanced ecosystem and a healthy environment by cutting down on the use of pesticides.
2. Cutting down on the overarching expenditure on chemical pesticides inputs in crop production, thus reducing the pest management cost.
3. Third, protecting human and animal health by providing food and feed that is free of pesticide residues (Dhawan and Peshin, 2009).

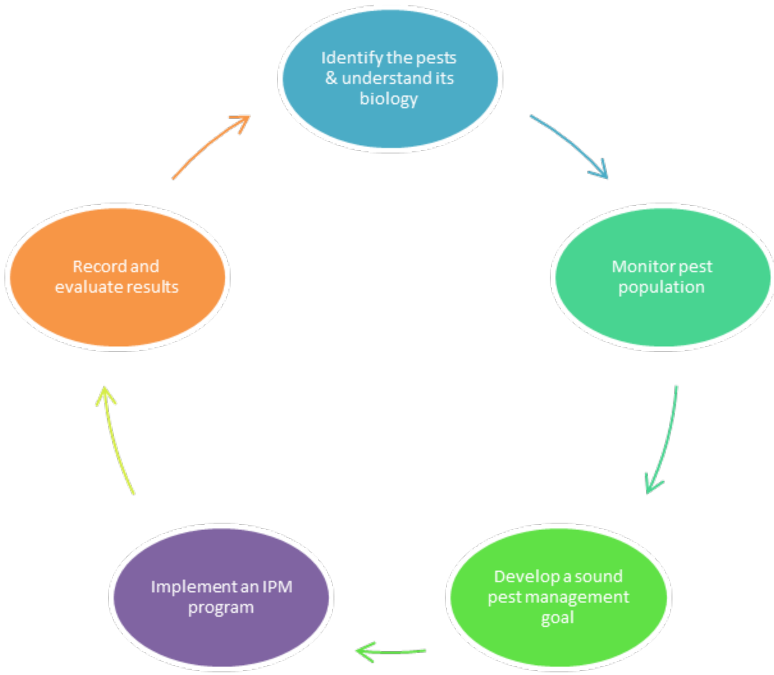

Fig.2. Framework for IPM Program (modified from El-Shafie, 2018)

In implementing an IPM program, it will be necessary to identify the various pests so as to gather relevant information about their biology, behavior, ecology, and monitor their population levels. The center of every successful IPM program is the monitoring stage. Monitoring encompasses various processes and activities that facilitate the detection and documentation of insects present, growing and increasing in population levels. According to Barzman *et al.* (2015), tools for monitoring should be done with the use of light traps and pheromones, field observations, and sounding warnings, forecasting based on scientific information, and early diagnosis systems. When there is the need to control pests, on the basis of monitoring, then an implementation and evaluation preceded by a management program should be initiated.

5.2 Primary pest control approaches

5.2.2 Biological Pests Control

This is the advertent introduction of predators, pathogens or parasites to mortify the insect pests and cut down their populace. The pathogens are bacteria, fungi and viruses that introduce infections amongst the insect populace. In some published articles, 'biological control' is employed in a broader sense to include components that fall headings like 'cultural control', 'use of resistant plant varieties', 'autocide', etc. However, the common definition, in a strict sense, is the above-stated. In recent times, it is shortened as 'biocontrol'.

5.2.3 Chemical control

Synthetic chemical-base pesticides should only be employed when the need indeed arises to maintain pest populations below the economic damage threshold. Selective pesticides' side effects on the environment are minimal and thus, should be used in accordance with spelt out principles of IPM. Particularly, microbial and botanical (biorational) pesticides should be considered in the control of pest population. In an attempt to unleash the full potential of biorational pesticides, it should be applied together (Barzman *et al.*, 2015). Various types of pesticides should be applied with precision and appropriate dosage on the field to prevent insects from building resistance to the pesticides (Dhawan *et al.*, 2009).

5.2.4 Cultural control

On cultivated crop fields, cultural control will include introducing robust varieties of crop plants, getting the timeliness for crop production (sowing and harvesting) right as far as some agronomic practices (fertilizer application, crop rotation, irrigation) are concerned. The overall objective of best agronomic practices is to create a conducive environment for crop growth and yield whilst making it unconducive for pests' development. The cultural control therefore helps with the cut-down of pests' outbreaks and population (Hill, 2008). Also, cultural practices help in conserving of utile insects that play pivotal role in IPM.

5.2.5 Mechanical and physical control

Mechanical and physical control methods create a non-conducive environment which prevents pests form accessing their resources. Conversely, they affect important life activities of pests such as reproduction, feeding, dispersal, and survival. Physical control methods may include heat and steam sterilization of soil or soil-less medium and this is common in the control of greenhouse insect pests. Plants can be guarded against insect pests by the use of barriers, screens, fences, nets, and also light trapping. Mechanical and physical controls are carried out purposely for pest control, which differentiate them from cultural practices.

Conclusion

Though man is seen as the main dominating specie on earth, other species in the kingdom 'animalia', also known to be important compete with him in various ways. Insect pests, belonging to the class 'insecta' are in a rivalry loop, directly and indirectly with man in the agri-food system. An insect may be categorized as a predator, herbivore, fungivore, or a scavenger based on its nutritional mode, and as piercing and sucking insects; biting and chewing insects; boring insects based on their mouthparts. In crop fields, damage caused by insects and their economic importance can be dichotomized as direct and indirect. Insects damage to crops become significant and of economic connotations when pest population reaches Economic Injury Level (EIL); the point at which measures (biological, cultural, chemical and, mechanical and physical) should be employed to control pest population. However, the overuse of chemical-base insecticides results in crucial environmental challenges with no outstanding result in the control and management of insect pest. Thus, the IPM model which encompasses all the primary control techniques (biological, chemical and cultural), and has proven to be eco-friendly comes in handy in forestalling the incidence of pest population reaching the EIL. Since IPM has been found to be effective and yet eco-friendly, it should be encouraged among farmers right from planting through to crop storage.

Acknowledgement

This publication was made possible through support provided by the West African Centre for Water, Irrigation and Sustainable Agriculture (WACWISA), University for Development Studies, Ghana with funding support from the Government of Ghana and World Bank through the African Centres of Excellence for Development Impact (ACE Impact) initiative.

References

[1] Bajwa, W. I. and Kogan, M., "Compendium of IPM Definitions (CID) - What is IPM and how is it defined in the worldwide literature," IPPC Publication No. 998, Integrated Plant Protection Center (IPPC), Corvallis or, USA: Oregon State University, 2002. DOI: 10.1213/00000539-200202000-00035

[2] Barzman, M., Bárberi, P., Birch, A. N. E., Boonekamp, P., Dacchbrodt-Saaydeh, S., Graf B, *et al.*, "Eight principles of integrated pest management," *Agronomy for Sustainable Development*, vol. 35, no. 4, pp. 1199-1215, 2015. DOI: 10.1007/ s1359DOI 10.1007/s1359-015-0327-9.

[3] Benson, E. A., **"**Pests of Crop Plants-*JSS1 Agricultural Science Third Term,"* 2016 (*https://passnownow.com/jss1-agricultural-science-third-term-pests-crop-plants/*).

[4] Dhaliwal, G. S., Koul, O., and Arora, R., "Integrated pest management: Retrospect and prospect", Integrated Pest Management: Potential, Constraints and Challenges, London: *CAB International*, pp. 1-20, 2004.

[5] Dhawan, A. K. and Peshin, R. "Integrated pest management: Concept, opportunities and challenges," *Integrated Pest Management: Innovation Development Process*, Springer Science, The Netherlands, pp. 51-81, 2009. DOI: 10.1007/978-1-4020-8992-3

[6] El-Shafie, H. A. F., "Integrated Insect Pest Management," Pest Control and Acarology, Dalila Haouas and Levente Hufnagel, IntechOpen, 2018. DOI: http://dx.doi.org/10.5772/intechopen.81827. Available from www.intechopen.com/chapters/64227

[7] Flint, M. L. and Van den Bosch, R., *Introduction to Integrated Pest Management.* New York: Plenum press; 18(2), pp. 31-50, 1981.

[8] Hendrichs, J., Kenmore, P., Robinson, A. S, and Vreysen, M. J. B., *Area-wide integrated pest management (AW-IPM): Principles, practice and prospects*. Springer, pp. 3-33, 2007.

[9] Hill, D. S., *Pests of Crops in Warmer Climates and their Control*. Springer Science & Business Media, pp.704, 2008.

[10] Kogan, M., "Integrated Pest Mnagement: Historical Perspective and Contemporary Developments," *Annual Review of Entomology*, vol. 43, pp. 243-270, 1998. DOI: 10.1146/annurev.ento.43.1.243.

[11] Matthews, G. A., "IPM - a strategy since 1959 - mini review," *CAB Reviews*, vol. 13, no**.** 12: pp. 1-2, 2018. http://www.cabi.org/cabreviews DOI: 10.1079/ PAVSNNR201813012

[12] Pimentel, D. and Peshin, R., "Integrated Pest Management," *Pesticide Problem*, vol. 3., 2014, Dordrecht: Springer Science. DOI: 10.1007/978-94-007-7796-5

[13] Stern, V. M., Smith, R. F, van den Bosch, R., and Hagen, K. S., "The integrated chemical and biological control of the spotted alfalfa aphid: the integration control concept," *Hilgardia*. Vol. 29, pp. 81-101, 1959. http://ucanr.edu/repository/fileaccess.

[14] Stork, N. E., "How many species of insects and other terrestrial arthropods are there on earth?", *Annual Review of Entomology*, vol. 63**,** no. 1, pp. 31-45, 2018. DOI: 10.1146/annurev-ento-020117-043348