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# The Killer Chemicals as Controller of Agriculture Insect Pests: The Conventional Insecticides

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## Abstract

This article explores the widespread use of insecticides in agriculture and compares the benefits and problems associated with these helpful but dangerous chemicals. Agriculture is practiced in the world from the earliest history of mankind and even now there are several agrarian countries where the economy is mainly dependent on agriculture. The basic aim of agriculture is to produce sufficient food for the growing population and fodder for cattle, and also to provide agricultural products for global and local trades besides maintaining of buffer stock of food for emergent situations. Plants in the garden or landscape are under constant competition with insects, animals and diseases that use the plants as a host or source of nutrition. This is the reason that farmers and gardeners turn to pesticides to control these competitors. Pesticides include organic forms of pest control, but also are synthetic control options known as conventional pesticides. Insecticides are chemicals used worldwide to manage agricultural pests on plants. These kill and repel unwanted pests, but also cause many human deaths each year. Since the late some decades, Entomologists and Chemists have made outstanding progress in the technology of pest control. Today's the store of weapons is large and diverse, encompassing legal, cultural, physical, genetic, and biological tactics, in addition to the well-known chemical pesticides. This is a most common method of pest control by the use of insecticides, these are chemicals that either kill pests or inhibit their development. Pesticides are often classified according to the pest they are intended to control. For instance, insecticides are used to control insects, herbicides to control plants, fungicides for fungi, rodenticides for rodents, avicides for birds, and bactericides manage bacteria. A perfect insecticide should have high toxicity to target pest, selective toxicity to beneficial insects, low toxicity to plants and other non-target organisms, no harmful residue, cheap and safe to manufacture, stabile under storage, non-corrosive and residues readily and cheaply detectable. Hence, compared to other forms of control, insecticide use is highly effective, easily employed by farmers and in many cases there is no commercially viable alternative. The wise use of insecticide depends on public awareness of long-term health and environmental hazards, and to contact with an expert for help in identifying pest and disease problems, which in turn, give crop owners with some control over protecting their environment.

## Keywords

Pesticide, Environment, Agriculture, Crops, Livestock, Economic Threshold, Public Health

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## 1. Introduction

The main goal of agriculture is to develop and produce crops and livestock for human consumption. As the human population increases, the amount of food produced is very important to fulfil the needs. Unfortunately, there are other organisms that want to devour the crops that are meant for human's consumption. It is estimated that nearly enough amount of all crops produced in the world each year are destroyed by agricultural pests, which results in severe economic losses. The total crop losses from insect damage have nearly been doubled and this rise in crop losses to insects, in part is, caused by changes in agricultural practices.

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An extensive monoculture practice of plants growing further strengthens the pest's problem that leads to an alteration of ecosystem and favours the diffusion of harmful insects on widespread areas. A conventional pesticide is any form of pest control created from man-made substances. Conventional pesticides, also called synthetic pesticides, are chemical-based and created with the specific intent to kill pests of plants or harmful organisms. According to the Environmental Protection Agency, these include everything from weed-killing herbicides, to fungus-killing fungicides, insect-killing insecticides, as well as rodenticides for eliminating of rodents. Conventional pesticides are used everywhere from commercial agriculture to institutions and to the home landscape. Active chemical ingredients are combined with water, solvents or emulsifiers, in addition to other chemical and non-chemical ingredients to repel, kill and control pests in the garden or landscape (Pimentel, 2005).

Conventional insecticides are among the most popular chemical control agents because these are readily available, rapid acting and highly reliable. A single application may control several different pest species and usually forms a persistent residue that continues to kill insects for hours or even days after application. Because of their convenience and effectiveness, insecticides quickly became standard practice for pest control during the previous few decades. Overuse, misuse, and abuse of these chemicals have led to widespread criticism of chemical control, and in a few cases, resulted in long-term environmental consequences. The effectiveness of an insecticide usually depends on when and where the pest encounters to it. Most insecticides are absorbed directly through an insect's exoskeleton and these compounds are also known as contact poisons because these are effective 'on contact'. Other insecticides act as fumigants, and these are released in the vapor state (as gases) and enter the insect's body through its tracheal system. Fumigants are most effective when these are used in an enclosed area such as a greenhouse, a warehouse, or a grain bin. Still other compounds must be ingested before these have an effect and these are known as stomach poisons. These often work more slowly than fumigants or contact poisons, but they are still useful for certain types of pest control in home and businesses places (Kongming and Yuyuan, 2004; Sarwar, 2013 a; Sarwar et al., 2003).

## 2. Use of Insecticides

Due to the high loss in food production, insecticides are often used to try to combat the insect's problems. Insecticides are chemicals that kill or manage the population of pests on target area. There are many different types of pesticides in the market today, but the most common are herbicides and insecticides, which kill or manage unwanted plants and insects. The damage caused by agricultural pests is a global problem, and over the past half-century, the amount of pesticides used has increased fourfold. Pesticides are used worldwide to manage agricultural pests, these kill and repel unwanted pests, but also cause many human deaths each year. This lesson explores the widespread use of pesticides in agriculture and compares the benefits and problems associated with these helpful but dangerous chemicals. Over the years, the widespread use of pesticides has had several benefits and also caused many problems (Minyard and Roberts, 1991; Mascarelli, 2013).

## 3. Considerations of Conventional Insecticides

While conventional chemical insecticides have been used in the various states for many years, there are many drawbacks and adverse reactions to use such means of control. Over time, with continued use, conventional insecticides build up in the soil. This build-up occurs because the chemicals do not break down easily and the result is a depleted soil structure. The soil suffers from a lack of nutrients and nutrients are less available for uptake by plants. Beneficial insects, organisms and pollinators that are once widespread in the garden begin to dwindle in numbers. Overall, the health of garden and landscape suffers with conventional insecticides use. Additionally, these chemicals easily wash into the ground water or drift on the wind, coming in contact with unintended plants and ecosystems. These chemicals also make their way into homes, tracked in by shoes or pets. Chemical control is the use of chemicals to kill pests or to inhibit their feeding, mating, or other essential behaviors. The chemicals used in chemical control can be natural products, synthesized mimics of natural products, or completely synthetic materials. Chemical control includes both behaviour modifiers and insecticides (National Academy of Sciences, 1989; Pimentel, 1996).

Behaviour modifiers are attractants that cause insects to move towards their source, these include pheromones (secreted by insect, species specific, may be used to lay trails, or for aggregation, swarming, alarm or sexual attraction), and food and oviposition attractants (e.g., fruit fly is attracted to $NH_3$, flavouring essences and protein sources. Wide scale use of synthetic sex pheromones may confuse insects sufficiently that they are unable to mate and produce offspring; a few such products are commercially available, such as for codling moth control in apples. Using insect pheromones in this manner is called mating disruption, a practice that works best in large commercial plantings where it is less likely that mated females will move into the planting from outside of the treated area. Many of these types of behavioral chemicals break down or wash away quickly, and must be reapplied frequently, used in an enclosed area, or formulated to release slowly over a long period. Attractants are used for monitoring of pest situation, and traps give an early warning system in quarantine situations and are used in crops to monitor pest intensity to indicate when to apply insecticides e.g., coddling moth control. Also are used for direct control when baits are combined with a lethal trap or insecticide e.g., dark pots against fruit fly in orchards. Mating disruption occurs when the environment is saturated with mating pheromone so that the male is confused and cannot find a mate (used in control of oriental fruit moth). The antifeedants prevent an insect from feeding and it starves, while, with anti-oviposition chemicals females cannot lay eggs. Repellents are not usually toxic to insects, but interfere with their normal behavior and thereby keep the insects from causing damage e.g., fly repellents, mothballs and mosquito repellants (Gosselin et al., 1984; McCauley et al., 2006).

# 4. Economic Injury Level and Economic Threshold for Insecticides Usage

The economic threshold level (ETL) is a key factor to be studied for insect pests control. It is difficult to monitor insect pests separately, and it is not reasonable to base decision-making for spraying on an ETL of individual insects and ignore sub-levels of other insect pests. So, it is wanted to use a combined ETL in a way of insect units, to put all major insect pests for consideration as an insect pests complex. This means delaying the first spray to give a chance for natural enemies to develop and then lowering the number of sprays and consequently reduces the cost of production (Ahmed et al., 2002). The scientific study of pests and pest control strategies is often called economic entomology in recognition of the financial impact that insects have on industry, agriculture, and human society in general. To be sure, economically important insects are not always pests; as have already been stressed their value as pollinators, natural enemies, producers of silk, honey, etc. But wherever pest populations develop, their impact always results in monetary loss, either directly or indirectly. In most cases, losses from insect pests are directly proportional to the density of the pest population i.e., high density increases the extent or severity of damage and makes the need for control more critical. Many peoples use the terms damage and injury interchangeably, the injury is defined as the physical harm or destruction to a valued commodity caused by the presence or activities of a pest (e.g., consuming leaves, tunneling in wood, feeding on blood), while, damage is the monetary value lost to the commodity as a result of injury by the pest (e.g., spoilage, reduction in yield, loss of quality). Any level of pest infestation causes injury, but not all levels of injury cause damage. Plants often tolerate small injuries with no apparent damage and sometimes a low level of injury may not cause enough damage to justify the time or expense of pest control operations. But at some point in the growth phase of a pest population, it reaches a point where it begins to cause enough damage to justify the time and expense of control measures. A pest outbreak, occurs whenever the value of how much financial loss is the pest causing, is greater than the value of how much will it cost to control the pest. The economic injury level (EIL) and the economic threshold (ET) are fundamental pest management concepts (Robert et al., 1977; Sarwar et al., 2007).

## 4.1. Economic Injury Level

It is the smallest number of insects (amount of injury) that will cause yield losses equal to the insect management costs. The EILs are usually expressed as a pest density and are developed from yield-loss relationships derived from field research studies. The EIL has been described as the break-even point, and the level of pest a plant can tolerate, among other things. The main thing is that it is wanted to manage the pest population before it reaches the EIL and that is where the ET comes in (Leon and Larry, 1997; Sarwar et al., 2011).

## 4.2. Economic Threshold

It is the pest density at which management action should be taken to prevent an increasing pest population from reaching the economic injury level. The ET is the practical rule used to determine when to take management action. In fact, some refer to the ET as the action threshold and it is essentially a prediction of when a pest population is going to reach the EIL. It is assumed that once the ET is reached, there is a high probability that the pest population can reach the EIL if no management action is taken (Leon and Larry, 1997; Sarwar et al., 2011).

# 5. Advantages and Disadvantages Associated with Insecticides Use

Compared to other forms of control, insecticide use is highly effective, easily employed by farmers and in many cases there is no commercially viable alternative. With pests control, there are distinct advantages and disadvantages of insecticide use as well, and some of these advantages and disadvantages are listed below:-

### 5.1. Benefits of Chemical Insecticide

The benefits of insecticide include increased food production, increased profits for farmers and the prevention of diseases. Although pests consume or harm a large portion of agricultural crops, without the use of pesticides, it is likely that they would consume a higher percentage. The advantages of insecticide are obvious because these keep gardens and crops safe from insects, are quick-acting, easy to use, cheap (relatively), readily available, can save lives (vector-borne diseases) and much others. A farmer could lose his entire livelihood if these elements get into his fields and destroy his crops, and the follow on effects of that are higher prices at the stores on produce for everyone. Due to the use of insecticide, it is possible to combat pests and produce larger quantities of food. By producing more crops, farmers are also able to increase profits by having more produce to sell. Pesticides also increase farm profits by helping the farmer to save money on labor costs. Using pesticides reduces the amount of time required to manually remove weeds and pests from fields. In addition to save crops and livestock, pesticides have also direct benefits to human health. It is estimated that the use of pesticides has prevented the deaths of around millions of peoples by killing pests that carry or transmit diseases. Malaria, which is transmitted by infected mosquitoes, is one of the most commonly known and deadly diseases that has decreased in prevalence due to the use of pesticides. Other diseases that are minimized due to the use of pesticides include the bubonic plague, which is carried by rat fleas, and typhus which is transmitted by both fleas and body lice (Hart and Pimentel, 2002; Pimentel, 2005).

### 5.2. Problems of Chemical Insecticide

Although there are benefits to the use of pesticides, there have also been many problems associated with their use. When pesticides are used, these do not always stay in the location where they are applied. These are mobile in the environment and often move through water, air and soil. The problem with pesticide mobility is that when they travel, the pesticides come in contact with other organisms and can cause harm. When pesticides are not judiciously used, these may result impact on non-target pests, potentially toxic to humans, potential negative environmental effects, unknown cumulative effects, pest resistance and resurgence of treated populations. The pest populations quickly recover and bounce back, leading to repeated insecticide applications. Large reproductive ability and short generation time of pest help to speed selection of resistant individuals when insecticides are applied at ever increasing concentrations. Selective kill and environments alteration can lead to minor pests becoming major pests, and their applications can be costly and time consuming. Pesticides have also been shown to disrupt the balance of an ecosystem. In many situations when a pesticide is used, it also kills non-pest organisms and this can drastically alter the natural balance of the ecosystem. By removing non-pest organisms, the environment can be changed to favor the pest. In addition to causing harm to wildlife, pesticides that travel from their original location are known to cause harm to humans. Human exposure to pesticides has caused poisonings, the development of cancer and the deaths of thousands of peoples worldwide each year (Akbar et al., 2005).

High yielding varieties which are used during Green Revolution became susceptible and prone to insects, pests and diseases. To overcome this pest and disease menace, chemical pesticides are used as major agriculture inputs. The indiscriminate and liberal use of these chemical pesticides in agriculture became hazardous to human and animal health, environment and bio-diversity. Injudicious use of chemical pesticides polluted environment, created ecological imbalances, and pesticides residues in food, soil and water. It led to pest resurgence, development of pest resistance, secondary pest outbreak, and minor pests becoming major. Also it caused adverse effects on beneficial organisms including natural enemies of crop pests, pollinators, soil microbes etc (Hall, 1991; Pimentel, 1997).

### 5.3. Safe and Judicious Use of Insecticide

The problem of misuse of insecticides is a world-wide problematic. This problem has arisen because of insufficient information and training on insecticides. The manufacturers and distributors of insecticides and the users all carry a responsibility for safe handling and the use of pesticides. The government of a state should implement the program for safe and judicious use of pesticides. Before resorting to any treatment, it is important to find the cause of the problem. Insects or diseases are not always the culprits and if the problem is caused by environmental factors or human mismanagement, the spraying will does nothing more than adding another chemical to an environment that is already overloaded with pesticides. For reducing the use of insecticide, most important is to identify plant problems and take recommended measures to correct them. Be aware that the wisest measures may call only for judicious use of pesticides or for no pesticides at all. One way is to identify pest problems and by looking at a plant sample and determining appropriate procedures and pesticide use almost certainly will be reduced. Further suggestions may include monitoring plants for insects or diseases to catch the culprits in action, identifying beneficial insects to avoid their destruction and spraying for ensuring the coverage on the underside of leaves where pests hide. The problems of pesticides safety can be studied under any one of the three following categories:-

i. Education: It is directed towards various extension and training activities.

ii. Enforcement: It involves government regulations to import, manufacture and sale of pesticides.

iii. Engineering: It is to stress the technological development, such as new containers, dosages, application and safety equipment developed specially for the users.

The above three approaches could be coordinated to provide an efficient and effective solution to deal with the problems of pesticides safety in the developing world (Pimentel and Greiner, 1997; Pimentel and Hart, 2001).

## 6. Implementation of Integrated Pest Management (IPM)

Chemical insecticides have allowed management of larger acreages by fewer individuals because of the reduced labor needed for physical and mechanical controls. Besides their use in agriculture, chemical insecticides have been very important in the battle against disease-carrying insects, such as mosquitoes that carry malaria and dengue. However, chemical controls have many weaknesses, for instance, most chemicals have biological activity against many forms of life and therefore can affect non-target organisms; for the same reason, they present various levels of hazard to humans, especially pesticide applicators and other farm workers; most are highly toxic to beneficial insects, such as pollinators and predatory and parasitic natural enemies; and both target and non-target insects can develop resistance to insecticides, sometimes very rapidly. Over-reliance on chemicals and diminished use of other control methods has helped to push agriculture away from a more natural, balanced state. Still further, in addition to being harmful to pests, they can cause acute symptoms in humans, including nausea, headaches, rashes, and dizziness. Many are also linked to chronic diseases and conditions such as cancer, birth defects, neurological and reproductive disorders, and to the development of chemical sensitivities (Sarwar, 2015 a; Sarwar et al., 2009; 2010; 2012).

Integrated pest management (IPM) is the management of pest problems using a combination of ecologically-sound approaches. Integrated pest management is a program of prevention, monitoring and control which offers the opportunity to eliminate or drastically reduce the use of pesticides, and to minimize the toxicity and exposure to any product which is used. The IPM does this by utilizing a variety of methods and techniques, including cultural, biological and structural strategies to control a multitude of pest problems. The IPM can mean virtually anything the practitioner wants it to mean. Those who argue that IPM requires the ability to spray pesticides immediately after identifying a pest problem are not describing IPM. Conventional pest control tends to ignore the causes of pest infestations, and instead relies on routine and scheduled pesticide applications. Pesticides are often temporary solutions, and ineffective over the long term. Non-toxic and least toxic control products are a major growth area and new materials and devices are increasingly available in the marketplace (Sarwar, 2012; 2013 b; 2013 c; 2014; 2015 b; 2015 c; 2015 d; 2015 e; Sarwar and Hamza, 2013).

## 7. Conclusion

Chemical technology has expanded tremendously during the past some years, and approximately thousands of different chemicals are currently used and released into the environment. Integrated Pest Management (IPM) as the prophylactic and schedule based application of pesticides has been replaced with need based, spot application instead of blanket application by observing Economic Threshold Level and drawing conclusion on the basis of Agro Ecosystem Analysis by adopting ecological engineering on different crops. This program includes pest or disease monitoring, production and release of bio-control agents or bio-pesticides, conservation of bio-control agents and human resource development by imparting training to Agriculture Officers and farmers at grass root level in farmers' fields. Its basic aim is to train the farmers on the latest IPM technology so that they are able to take decision in pest management operation. In training, the farmers are also trained about the safe and judicious use of pesticides on their crops so that the crop can be grown with minimum use of pesticides. Most pesticides, giving their intrinsic properties, are toxic in nature. The use of pesticides should not be regarded as the only solution to any pest problem but if necessary they should be used in a judicious manner. When the use of pesticides is necessary, pesticide users should handle pesticide safely and responsibly, and also read and follow label instructions. Such good practices can protect human health and the environment. It will not only reduce the use of pesticides but also prevent the development of pest resistance and thereby enhance the effectiveness of pest control. Before making a selection of an insecticide, the pest problem should be identified, select a pesticide that would control the pest with minimum danger to other organisms, pesticide should be one that is approved, registered and recommended, and buy only the required quantity of pesticide and avoid storage.

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