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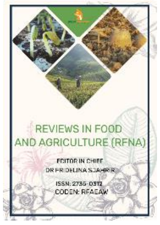

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RESEARCH ARTICLE

INSECT PEST MANAGEMENT: MECHANICAL AND PHYSICAL TECHNIQUES

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ABSTRACT

In order to survive and thrive in nature, every organism interacts with the ecosystem's components, including insect pests. In most situations, the interaction of insects and pests with the ecosystem is detrimental and necessitates control measures. Successful and sustained pest control in agroecosystems is dependent on understanding of the approach, pest biology, and pest ecology. There are occasions when a farmer must use pesticides to control a pest infestation, but there are also numerous non-chemical options. Some of these options are classified as mechanical and physical controlling approaches. Physical and mechanical control measures, which are the oldest of all tactics used directly against pests, kill the pest, interrupt their usual behavior, or alter the environment to discourage pest activity. They are one-of-a-kind in that they have no or minimal negative environmental impacts and leave no residue on agricultural goods. Unlike pesticides, there is no need for official regulation/registration, which would necessitate millions of dollars in research to fulfill environmental and animal toxicity, food safety, and effectiveness criteria. This study has merely highlighted the most important findings in past and recent research on physical and mechanical insect pest management techniques.

KEYWORDS

Physical method, mechanical method, insect, pest, management

1. INTRODUCTION

Every creature interacts with the ecosystem's biotic and abiotic components in order to improve its chances of survival and existence in nature. Insect, Pests and other ecosystem components, including humans, plants, and animals, have a variety of interactions. These interactions may result in food and space rivalry (Arif et al., 2017). Insects and pest may be found at every stage of the food production process, from open fields and greenhouses to household larders and pantries. Not just because of their look and the immediate deterioration they bring to food goods, but also because of the microbial pollutants, their exuviae and frass inducing allergic responses and diseases they may contain, their presence is concerned (Bell, 2013). Regardless of the farming technique used, damage produced by these agricultural enemies is a key role in lowering crop productivity, whether in the field (preharvest) or subsequently during storage (post-harvest) (Costa et al., 2018). Preharvest pests rob an average of 35% of potential crop output worldwide, with postharvest losses (transport, preprocessing, storage, processing, packing, marketing, and plate waste) accounting for another 35% (Molden, 2007; Popp et al., 2013).

However the wide fluctuations may occurs in these estimations owing to a variety of factors such as weather conditions, plant species being farmed, agricultural techniques, farmer socioeconomic situations, and the amount of technology employed (Oerke and Dehne, 2004; Oliveira et al., 2014). The ultimate challenge in applied ecology is the eradication, or local extinction of high-profile undesirable insect pest species, since it displays the use of sufficient knowledge to regulate ecological conditions to accomplish the desired goal (Suckling et al., 2014). Successful eradications and management need in-depth understanding of the target species, early identification, and a significant financial, political, and time investment (Brockerhoff et al., 2010). Such information also improves the efficacy of pest management techniques, lowers the operating cost of the approach employed, increases productivity and profitability by decreasing inputs, and eliminates or decreases the dangers of environmental degradation and human health concerns (Arif et al., 2017).

Pesticides have grown to be such an essential element of insect pest control that they are often the first line of defense addressed when a problem arises. As a result, pesticides have become increasingly important in the development of low-cost, aesthetically attractive foods for both growers and consumers. Despite the documented negative effects on human and environmental health, insecticides and pesticides continue to be the control strategy of choice due to their availability, cheap cost, high efficiency, and simplicity of application (Boiteau and Vernon, 2001). However, growing public and media awareness of the harmful side effects, the erosion of the current pesticide arsenal, and the continuous development of insecticide, pesticides resistance species have sparked renewed interest in alternative control approaches (Boiteau and Vernon, 2001). Physical and mechanical control measures, which are the oldest of all direct pest management approaches, kill insect pest, interrupt their usual behavior, or alter the environment to prevent their activity. They're one-of-a-kind in that they have no or little negative environmental impacts and leave no residue on agricultural products. They are also not subject to import taxes, quarantine laws, food safety legislation, or negative consumer attitudes, and can even improve the efficacy of biological control and pollination methods (Weintraub and Berlinger, 2004a). This article focuses on and discusses the physical and mechanical approaches that have been used to manage insects and pests.

2. MATERIAL AND METHODOLOGY

This evaluation relies entirely on secondary sources of data. Literature was gathered from various journal publications, agricultural institutions

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publications, book, search engines such as Google Scholar and other sources such as the FAO and CABI, as well as pertinent reports, and the key conclusions were summarized.

3. Discussion

Agriculture has been transformed from a strictly empirical activity, largely based on tradition and aimed primarily at avoiding famine, to a quantitative form of agriculture focused on producing large quantities of food as a result of rapid advances in the physical, chemical, and biological sciences since the late nineteenth century. Because of the enormous effectiveness of chemical control, physical control methods have been left aside throughout this transition, which has been sustained at an increasing rate over the last 50 years (Vincent et al., 2009). A variety of physical controls were widely used long before chemical measures were developed and implemented to control pest populations. In a multitude of ways, cultural pest management approaches serve in the restoration of plant health. Physical and mechanical control now has all of the necessary features for incorporation into IPM strategies, thanks to technical advancements and improved precision in the implementation of such systems. Physical and mechanical controls are based on a detailed understanding of the pest's ecology and the recognition that there are tolerance levels that may be tested by physical means. (Osmun, 1972). Pest ecology and biology is regarded as the primary logical underpinning for all approaches to insect management, and it is especially important if physical and mechanical measures are to be effective. The problem is that there are far too few pests that are ecologically and biologically well understood.

Various aspects of pest biology can aid in the enhancing the effectiveness of physical and mechanical pest management techniques, including:

- What type of environment does the pest prefer to live in? (Darkness, inside, outside, humid, hot, cold, aquatic, terrestrial, and so forth.)
- What are the pest's favorite foods?
- How long does a pest live in total?
- What is the length of the pest's incubation period?
- Where can you find distinct life stages?
- What is the pest's breeding location and season?
- What type of behavior does the pest display during its life? (Pedigo and Rice, 2009)

3.1 Physical Techniques

Physical strategies of insect pest management encompasses all approaches aimed at restricting pest access to the crop by causing behavioral changes or killing the insect (Vincent et al., 2009). As the phrase implies, physical measures are used to either kill the insect, impair normal physiological function by non-chemical ways, or alter the environment to the point that it is unacceptable or intolerable to the insect. Heat and cold treatments, as well as energy sources such as light traps, irradiation, light regulation and sound, are some of the physical approaches used to limit the spread of insect pests (Vincent et al., 2003; Lal and Rohilla, 2007).

3.1.1 Manipulation of Temperature

Temperature, among other environmental variables, can lengthen or shorten the life cycle of insects (Régnière et al., 2012). This behavior can be exploited for insect control. For most stored grain insects, a temperature of 25-33 °C is ideal for growth, and the insects can finish development and produce young at 13-25°C or 33-35 °C. Grain insects will perish if the temperature is below 13°C or over 35°C.

3.1.1.1 High Temperature

High thermal temperatures can affect the stage of an insect's life cycle, growth, and several internal metabolic functions (Khaliq et al., 2014) . For example, the egg period of *Helicoverpa armigera* was 7.9 days at 28 °C but increased to 10.4 days at 25 °C. The rise in temperature from 10 to 27 °C has a negative correlation with hatching degree days (Khaliq et al., 2014). Most pests may be eradicated at a temperature of about 70°C for 30-60 minutes. (Katan, 2000). Soil solarization, steaming, seed drying can be done to increase temperature so as to manipulate the insect ecology. Soil solarization has been shown to be beneficial in controlling plant diseases caused by soil fungus (*Fusarium oxyporum, Plasmodiophara brassicae, Pythium ultimum, Sclerotinia spp., Pyrenochaeta terrestris, P. lycopersici, Rhyzoctonia solani* and *Verticillium dahlia)*, soil nematodes *(Heterodera carotae* and *Meloidogyne spp.*), bacteria *(Agrobacterium tumefaciens)*, and arthropods (Costa et al., 2018). To pathogens, insects, and vertebrates, the high temperatures in solarized soil reach fatal and sublethal levels (Yaduraju and Mishra, 2004). Hot water dipping can be done to fresh fruits and vegetables to disinfect fruits and vegetables (Rajendar, 2020). For the disinfestation of fresh fruits and vegetables, vapor heat treatment is also widely used (Rajendar, 2020). Heat treatment can be used on both durables and perishables, as well as their storage and processing facilities (Tang et al., 2007). Continuous flow fluidised bed (70°C for 2 min) or spouted bed techniques are used to heat treat food grains. The rate of temperature increase is slower at 3 to 5°C per hour in empty storage facilities and processing units, and the deadly temperature of 50 to 60°C is maintained for 24 hours. Heaters that are powered by electricity, forced-air gas, or steam are used. The heating rate for sensitive commodities, such as dried fruits and tree nuts, is quicker at 1 to 15 °C/min, and the commodities are only exposed to 60–85°C for a few minutes. Fresh food, on the other hand, is heated at 40 to 50°C for minutes to hours using hot water or hot air techniques. Heat treatment in conjunction with regulated atmospheres (15 percent CO2, 1% O2) has been found to be beneficial for both fresh produce and processing facilities (Neven, 2005). Pests in stored grains are also usually eliminated by spreading the grains outside in the sun. The pink bollworms that hide in the double seeds of cotton are also killed with this approach (Omkar, 2018).

3.1.1.2 Cold Temperature

Cooling and freezing have a significant impact on the physiological, mechanical, and behavioral characteristics of insects (Karl et al., 2011a; Overgaard and Sørensen, 2008a) . It can alter chemical components, causing cell dehydration or preserving bodily fluids by keeping liquids below the melting point (Sinclair et al., 2003). Many experiments were carried out to determine the impact of temperature on insect reproduction, development, and survival. According to the researchers, insects were unable to withstand the challenge of high and low thresh hold temperatures. There was a lot of death, and the developing pace was slowed down (Khaliq et al., 2014). To increase the shelf life of fresh food and prevent pest infestations, cold storage is used extensively (e.g., fruit flies). It's a lengthy treatment (a few weeks to months, depending on the pest). Freezing, or storing expensive dry goods at –13 to –18°C for 2–3 weeks, efficiently disinfests and is beneficial in organic markets (Rajendar, 2020). In Hawaii, for example, freezing green coffee beans for 48 hours at –13.9 to –15.5°C proved effective against the coffee berry borer *(Hypothenemus hampei*) (Hollingsworth et al., 2013). In Asian nations, storing potatoes in cold storage is a popular practice to protect them against the potato tuber moth (Omkar, 2018)

3.1.2 Irradiation

Irradiation therapy for spices (mainly for microbial control), food grains, and fresh fruits and vegetables has been allowed in a number of nations (Hallman, 2013). Ionizing radiation is used to treat a variety of pest issues, including: 1) The sterile insect technique (SIT) is used to eliminate pests from areas or to keep pest populations at low levels (Dyck et al., 2005). To prevent effective reproduction, factory-reared pests are reproductively sterilized with radiation and reintroduced into pest-infested areas to breed with local populations. For SIT to work, the quantity of pests introduced must outnumber local populations (Hallman, 2013). 2) Phytosanitary irradiation (PI) inhibits the development and/or reproduction of regulated pests, allowing regulated goods to be transported out of regulated regions (Hallman, 2011). For example, citrus fruit transported from Mexico is irradiated at 150 Gy to prevent the entry of tephritid fruit flies. 3) When stored items are relocated, irradiation is employed to reduce insect populations (Salimov et al., 2000). Irradiation may be classified into two types: ionizing (gamma radiation, electron beam, and X-rays) and non-ionizing (radiofrequencies, microwaves and infrared rays). The treatment is quick, leaves no residue, and may be used on packaged units without affecting the commodities. The public is skeptical about the safety of exposed goods, particularly those treated with gamma irradiation caused by radio isotopes (cesium-137 or cobalt-60). Unlike gamma radiation from radioactive isotopes, e-beam and X-rays from machine sources are thought to pose no harm to consumers or applicators (Rajendar, 2020). The major objective for irradiating spices is to control pathogenic germs; any insects present are easily destroyed by the high dosages employed (5-10 k Gy). Far smaller dosages (0.05-0.45 k Gy) can prevent insects from finishing development or reproducing in stored items when the goal is to control insects (Hallman, 2013) . Cobalt-60 is currently being utilized to suppress the orchid thrip (Omkar, 2018). When thrips-infested orchids were treated with Cobalt-60 for 5 days in a row, found that 80 percent of the thrips died (Bansiddhi, 2004).

3.1.3 Manipulation of Moisture/ Humidity

It is critical for insects to keep their internal water levels within reasonable limits; this level is heavily impacted by external stimuli (Osmun, 1972). Abiotic variables such as humidity have varied effects on various insects (Khaliq et al., 2014). This abiotic variables have an impact on insect behavior as well as physiological mechanisms (Overgaard and Sørensen, 2008b; Karl et al., 2011b). Humidity may have a significant impact on entire communities in some cases. In marginal habitats, for example, as relative humidity approaches the minimal tolerance, the number and distribution of some species might fall noticeably. Abiotic variables in soil, such as soil moisture content, are is well recognized to have a significant influence on insects that spend a significant portion of their lives in soil (Pacchioli and Hower, 2004; Shililu et al., 2004). Arid environments can provide significant amounts of protection against insects and mites (Beckett, 2011). In general, a dry environment guarantees that these pests do not become entrenched, and if the moisture level is just enough to maintain some survival and reproduction, the pest population may be kept very low. Adults do not live as long under this dry conditions, the quantity of eggs produced per female is decreased, and younger stages take longer to grow and struggle to survive (Beckett, 2011). Many storage pests cannot reproduce at relative humidity levels of 50% (Banks, 1976).

3.1.4 Flooding

This is a pre-planting procedure that might be considered a soil disinfestation therapy. Flooding may be detrimental to soil-borne pathogens due to a lack of oxygen, increased CO2, or other microbial interactions, such as the creation of pathogen-toxic chemicals during anaerobic processes (Katan, 2000). For 3-4 months or longer, the soil is saturated with a minimum of 30 cm of water. Flooding was ineffective when there were huge populations of the pathogen present, or when the soil had unknown characteristics that promoted the infection. Insects that thrive in soil are typically destroyed when crop fields are flooded. For example, when rice nursery beds are flooded, the rice hispa floats to the surface and drowns (Omkar, 2018). Flooding/stagnation of water prevents termite infestation too (Mahapatro and Sreedevi, 2014). Long-term summer soil flooding with or without paddy rice culture efficiently reduced *Verticillium dahliae*. Controlling *V. dahliae* was closely related to controlling Verticillium wilt in following cotton harvests and increasing lint production (Katan, 2000). Soil flooding during the winter months, on the other hand, and irrigated rice without flooding were unsuccessful (Pullman and DeVay, 1981; Katan, 2000).

3.1.5 Manipulation of Light

Insects are known to fly toward streetlamps or other forms of outdoor illumination at night. The design of electric insect killers is based on this intrinsic phototactic tendency (Shimoda and Honda, 2013). Light intensity and wavelength, as well as combinations of wavelengths, period of exposure, light source direction, and the contrast of light source intensity and color to ambient light, all have a significant impact on these reactions to light. For catching insect pests via light manipulation, a variety of light traps have been created and are available. Light trapping is one of the most widely utilized pest management methods worldwide against a variety of lepidopteran and dipteran pests (Jonason et al., 2014). Light traps in agricultural fields are most commonly used to gather and destroy moths, termites, winged aphids, and whiteflies. Thrips are drawn to white or blue light, while whiteflies and winged aphids prefer yellow light (Yano, 2005). Rice stem borer Walker moths in paddy fields are drawn towards blue light (Shimoda and Honda, 2013) .

3.1.6 Flaming

Flaming, rather than burning leftover plant debris, is done using a hand-held or tractor-mounted equipment that produces an extremely hot, confined flame, usually by burning propane (Vernon and van Herk, 2013). The sudden rise in temperature as the burner passes causes death; muscular function in the legs is disrupted, and the insects are unable to climb back onto the plants (Pelletier et al., 1995). The eggs are also extremely vulnerable to flaming (Lagu√´ et al., 2002).

3.1.7 Sound Wave

For a long time, noise has been utilized in agriculture to get rid of pests using loud claps and shouts. The first attempts to manipulate insect behavior using vibrations date back to the late 1970s, when airborne noises of 200 Hz picked up by plants disrupt the mating communication of two leafhoppers, Amrasca devastans and Nilaparvata lugens (Agarwal & Sunil, 2020) . It was indicated that music might be utilized to interrupt mating, as long as noise pollution is minimized (opportune frequencies, intensities, temporal activation, and so on) (Agarwal and Sunil, 2020). Ultrasonic audio is a frequency spectrum with a frequency range of more than 20,000 hertz that may be described as advanced auditory frequency spectrum (Rashid et al., 2017). People are unable to hear ultrasound because their eardrums do not vibrate rapidly enough, however some animals can successfully listen to ultrasonic frequencies (Jhaveri et al., 2009). Pests are repelled by ultrasonic waves, which produce a loud and hostile atmosphere (Rashid et al., 2017). The most essential impact of ultrasonic sound is that it reduces the mating and reproduction of many hazardous insects in addition to acting as a repellant (Rashid et al., 2017). Grasshoppers and locusts, for example, can perceive frequencies ranging from 50,000 to 100,000 Hz, whereas lacewings and moths can sense ultrasonic sound up to 240,000 Hz. Ultrasonic sound waves with frequencies ranging from 50,000 to 240,000 Hz have been experimentally proved to kill these pests in the field (Arvind et al., 2018). The pests are confused by the ultrasonic noises, which have an effect on their brain and neurological system (Arvind et al., 2018).

3.1.8 Seed Drying

Grain can be harvested dry, however owing to weather conditions, this is not always the case. Grain can also be harvested at a greater moisture content earlier in the season to decrease the risk of weather damage and harvest losses. In these cases, it must subsequently be dried in order to retain quality throughout storage (Banks, 1999; Beckett, 2011). Furthermore, drying has a significant influence on insect and mite management in terms of both protection and disinfestation.

3.2 Mechanical Techniques

Mechanical control approaches involves the employment of devices, machinery, and other physical processes to manage pests or change their habitat to restrict their growth (Omkar, 2018). Hand destruction, suction devices, trapping, collecting equipment, crushing and grinding processes, and other mechanical ways are used to manage insect pests (Reddy et al., 2011).

3.2.1 Handpicking and Killing

Hand picking is an exclusion method that cannot be used in large-scale pest control programs; however, it may be used in small-scale pest management programs such as lawns, kitchen gardening, small-scale tunnel farming, and within greenhouses. In some situations, such as when inexpensive labor is available, insects and their eggs/egg-masses are huge and prominent, insects are too slow, exhibit congregating tendency, and are easily accessible to pickers, this approach is the most practicable (Arif et al., 2017). They're often used to manage cabbage butterfly eggs and larvae, lemon butterfly larvae, semiloopers and loopers, cutworms, red pumpkin beetle, army worm, borer and mango mealy-bug females. In this approach, insects and their eggs are physically gathered and destroyed. This traditional and oldest technique aids in the collection and destruction of adults before they begin laying eggs, the collection and destruction of eggs before they hatch, the selection and killing of larvae/nymphs before they cause economic losses, and ultimately the prevention of pest population build-up and the resulting damage. Cutworms are controlled using this approach. This approach involves chopping up potatoes, turnips, and cabbage leaves and storing them at various locations in cutworm-infested fields. Cutworms that come out to harm the crop at night hide under these piles during the day, and cutworms are gathered and exterminated from the heaps (Omkar, 2018; Devendrappa, 2005).

3.2.2 Hand Net

The collection of adults with hand nets is recommended for Pyrilla (pest of sugarcane), when these insects are migrating in April- May from maize to sugarcane. Sugarcane leafhoppers and cabbage butterflies are popular pests controlled using hand net (Omkar, 2018).

3.2.3 Trapping

Trapping is a popular method for controlling insect pests in a variety of economically important crops. Traps of different sorts, including as pheromone traps, bait traps, suction traps, and so on, are employed in the trapping technique, which is utilized for monitoring, mass trapping, mating disruption, and control of many species of insects. At night, certain diurnal insects are drawn to light sources. However, artificial light sources, on the other hand, are less efficient (or ineffective) for pest management during the day due to the intensity of sunlight. Hence in order to capture diurnal pests, we use this sort of trap other than light trap (Shimoda and Honda, 2013). Pink bollworm, gypsy moth, cotton grey weevil, pine beetle, oriental fruit fly, melon fruit fly and European chaffer monitoring, catching, mating disruption, and control are all being done successfully using pheromone traps. The predilection for various colors by different insects has been exploited for pest attraction and capture through adhesive color cards in tomato for thrips management (Ranamukhaarachchi and Wickramarachchi, 2007).

Planthoppers, leafhoppers, aphids, whiteflies, thrips, and leaf miner flies are controlled with yellow sticky traps on a variety of crops (Esker et al., 2004; Mainali and Lim, 2010). Fruit flies are controlled in orchards using red colored spherical traps (Arif et al., 2017). Light traps containing poisonous compounds are used to capture and destroy nocturnal insect pests. A bait-trap containing a food supply as a kairomone and an odorless pesticide as a killing agent is used to attract, trap, and kill a variety of insects. Fruit flies in orchards and cucurbit crops are controlled using GF-120 food-bait. Cutworm larvae are attracted to and aggregate in a cutworm-infested crop when chopped turnips or potatoes are placed in a mound. The cutworm larvae can be gathered and killed from such piles. For attracting and destroying different soft-bodied tiny insects such as whiteflies, thrips, winged aphid, leaf miner and adults of psyllids, air-suction traps and tractor-mounted light-plus-air suction traps can be used.

3.2.4 Physical Beating and Shaking

In the event of small-scale agriculture, kitchen gardening, or landscaping, slow or immobile insects like as mealybugs, aphids, and psylids can be removed from the plants/tree canopy using a simple shaking and jarring approach (Arif et al., 2017). Shaking small trees and bushes, especially early in the morning during the winter season when the insects are dormant and collecting them in open tubs with kerosine water or simplify burying them in trenches, is efficient against locust and defoliating beetles. Flies and locusts are killed with fly flappers and locust beaters, respectively. This technique is also efficient for controlling hornets, which are the primary predators of honeybees (Omkar, 2018).

3.2.5 Banding

It's an excellent way to get rid of mango mealy bugs. Polythene sheets ranging in width from 9 inches to 1 foot are wrapped around the stems of mango trees, usually at a height of 4 feet, to protect them against mango mealybugs (Arif et al., 2017). Gunny bags made of jute are also used to gather, kill or reduce codling moth populations on apple plants (Devendrappa, 2005). The use of various types of bands around tree trunks prevents various crawling insects' upward crawling and protects leaves, floral parts, and fruits from harm. The banding substance, which is similar to grease sprayed over trunk trees, stops crawling insects below the banded area, where they either die of starvation or become entangled with the sticky banding material. The use of adhesive bands on trees to disrupt oviposition is well established in timber crops such as oak to control gypsy moths and winter moths on fruit trees (Thorpe et al., 1995).

3.2.6 Rope Dragging

Rope dragging can be used to reduce the numbers of spotted bollworms. Two men pull a rope over the crops, causing the infected bolls to fall to the ground. The land is then watered, and any bollworms found in the bolls are drowned. This technique is also efficient in destroying cabbage butterfly larvae (Devendrappa, 2005).

3.2.7 Pressurized Water Spray

A strong jet of water can remove insects like aphids and spider mites off plant leaves and stems. Because many of the insects are likely to return, this procedure must be repeated. Cotton whitefly adults are killed by these in severely infected cotton fields. To avoid plant damage, water pressure should be use only on strong plants. This approach may also be problematic since repeated water treatments may exacerbate illnesses such as black spot in roses or produce root issues if the soil is already excessively moist. As a result, water sprays should utilize in the morning so that plants can dry out during the day (Hillock, 2014).

3.2.8 Clipping/ Pruning

Pruning and destroying infected shoots and floral parts is helpful in reducing the number of scales, mealy bugs, and gall midges attacking fruit trees such as grapes, citrus, ber, fig, custard apple, and so on. The oviposition sites of *H. armigera* are reduced when terminal shoots in cotton and chickpea are clipped (Lingappa, 2001). Several management strategies have been proposed and supported for the management of ESFB (Eggplant Shoot and Fruit Borer). The ESFB (Eggplant Shoot and Fruit Borer) IPM method includes frequent pruning and timely removal of infected eggplant shoots up until the first harvest (Srinivasan and Huang, 2009).

3.2.9 Bird Perches

To attract predatory birds that feed on insect pests, wooden or metallic "T" or "Y" perches are randomly put in agricultural regions (Arif et al., 2017).

3.2.10 Sieving and Winnowing

Using sieving and winnowing techniques, various life stages of insect pests of stored grains may be separated, gathered, and killed inside go-downs or any storage structures (Arif et al., 2017). These are often used to combat insect pests of stored grains. These procedures eliminate a large number of pests, notably *Tribolium* and *Trogoderma* grubs that infest wheat.

3.2.11 Bagging

Bagging, screening, and barrier installation are also thought to be highly beneficial for protecting crops and fruits from insect pests, as well as for keeping away insect pests that function as carriers or vectors of many deadly diseases in animals and humans, or cause annoyance. Because of its effectiveness and lack of pesticidal residue in the fruit, bagging is a better choice for fruit fly management than traditional pesticide spraying (Mondal et al., 2015). For example, dragging field bags in maize or sorghum fields and sugarcane ratoon crops (April/May) to collect sugarcane Pyrilla might minimize the likelihood of mass migration from maize/sorghum to sugarcane and Pyrilla population build-up during the early stages of sugarcane ratoon crop growth. Field bags of this sort can also be used to gather huge numbers of grasshoppers, beetles, crickets, and other tiny, medium, and big insects that live in plants. Individual fruits wrapped in paper bags, polythene bags, butter-paper bags, or net bags are protected against fruit flies in 95 percent of cases (Arif et al., 2017). Fruit fly and guava weevil were efficiently suppressed in guava fruits packed with biodegradable poly-films 6-9 weeks before harvesting (Bilck et al., 2011). Bagging not only keeps female flies away from the fruits, but it also improves their texture, color, and quality (Singh et al., 2007; Mitra et al., 2008). The assault of numerous insect pests can be reduced by covering entire tiny trees with any transparent material.

3.2.12 Barriers

The concept of barriers is straightforward: to physically prevent insects from accessing plants. Barriers might be made of wood, metal, or plastic, or they can be made from living material. Barriers are frequently some types of vertical projection, such as fences, at a height suited to the pest's activity. They can be used to repel crawling or low-flying insects (Vernon and van Herk, 2013). An overhang is critical in the case of flying insects because it traps them and prevents them from just strolling over the top (Bomford et al., 2000). Fences are used to keep flying insects from landing on plants. These are generally employed in vegetable crops such as cole and crucifer, where the principal issue is root-feeding pest that fly close to the ground as they move from crop to crop (Vernon and Mackenzie, 1998; Weintraub and Berlinger, 2004b). Screening and mulching are also form of barrier which are probably the most important physical control method. Fine meshed wire gauze is used to screen windows, ventilators, and doors in rooms and sheds to keep house flies, mosquitoes, and other insects at bay. The different types of Insect Exclusion Screen (woven, knitted, and microperforated) have all been thoroughly examined (Weintraub and Berlinger, 2004b). Mesh screening, as opposed to solid plastic sheets, allows for air flow and helps to decrease humidity, which promotes the growth of plant pathogens. Mulching with aluminum coated plastic and foil is mostly used on vegetable crops. In vegetable crops, they decrease insect pests such as aphids and viruses (Ghouse, 2020). Aluminum foil and grey plastic were shown to be efficient in repelling the aphid vector Myzus persicae Sulz from pepper crops reduced Cucumber mosaic virus and Potato virus Y transmission (Loebenstein et al., 1975; Antignus, 2000). Likewise, aluminum foil mulch protects summer squash from *M. persicae* and decreases the spread of a non- persistently transmitted Watermelon mosaic virus by 94% (Wyman et al., 1979; Antignus, 2000). Growers often use plastic sheets to mulch soil when cultivating watermelon, cucumber, tomato, pepper, strawberry, and other plants. Insect infestations are greatly decreased as a result of this method (Huang, 2005). Growers also use basic facilities, such as tunnels made of clear plastic sheets under which crops are cultivated, to efficiently manage insect pests (Huang et al., 1999).

3.2.13 Trench Digging

Some insect pests migrate on foot rather than flying away from overwintering locations and/or into fields. Insects of this type are easy to catch in trenches. The construction of a water-filled or dust-treated trench between wheat and berseem fields can limit armyworm larvae migration from wheat to berseem fields and lessen their harm to berseem. Bands of locust hoppers can be prevented from migrating from breeding sites to nearby field crops using similar trenches. The depth and vertical angle of the trench sides are key elements in preventing trapped bugs from crawling out. Crawling skills can be hampered by various types of synthetic lining, such as smooth plastic. The trench must be at least 25cm deep and at least 50° on all sides (Vernon and van Herk, 2013).

4. Conclusion

Pest management is an essential part of controlling, managing, and regulating natural resources and agricultural systems. Prior to the development of crop protection sciences, and even before the biology of pests was known, farmers developed numerous techniques to limit the damage caused by insect pests, primarily via trial and error. However, the demand for more efficient and non-hazardous pest control techniques has opened the way for the development of an advance physical and mechanical insect pest management techniques. The widespread use of very toxic pesticides, particularly for agricultural purposes, has raised growing worries about pesticides' detrimental influence on human health and the environment. Physical and mechanical pest control approaches aim to reduce the usage of pesticides and can be used to treat pest problems while posing the least amount of danger to humans and the environment. In recent years, changes in cropping patterns, ecosystems and habitat, climate, and the introduction of input demanding high yielding varieties/hybrids have resulted in a shift in pest status in time and place. Many pests have broadened their host range, acquired pesticide resistance, and subsequent outbreaks are common. Keeping up with the newest agricultural developments, physical and mechanical pest control techniques might be regarded a feasible alternative for pest population management.

References

Agarwal, M.L., Sunil, V., 2020. Basic behavioural patterns in insects and applications of behavioural manipulation in insect pest management. Journal of Entomology and Zoology Studies, 8 (2), Pp. 991–996.

Antignus, Y., 2000. Manipulation of wavelength-dependent behaviour of insects: An IPM tool to impede insects and restrict epidemics of insect-borne viruses. Virus Research, 71 (1–2), Pp. 213–220. https://doi.org/10.1016/S0168-1702(00)00199-4

Arif, M.J., Gogi, M.D., Sufyan, M., Nawaz, A., Sarfraz, R.M., 2017. Principles of Insect Pests Management. February 2019.

Arvind, G., Athira, V.G., Haripriya, H., Rani, R.A., Aravind, S., 2018. Automated irrigation with advanced seed germination and pest control. Proceedings - 2017 IEEE Technological Innovations in ICT for Agriculture and Rural Development, TIAR 2017, 2018-Janua(Tiar), Pp. 64–67. https://doi.org/10.1109/TIAR.2017.8273687

Banks, H., 1999. High moisture levels increase yield and quality. Farming Ahead, No. 94 (94), Pp. 39–40.

Banks, H.J., 1976. Physical control of insects-recent developments h. j. banks. McFarlane, Pp. 89–100.

Bansiddhi, K., 2004. IAEA-TECDOC-1427. Irradiation as a phytosanitary treatment of food and agricultural commodities. November, Pp. 189.

Beckett, S.J., 2011. Insect and mite control by manipulating temperature and moisture before and during chemical-free storage. Journal of Stored Products Research, 47 (4), Pp. 284–292. https://doi.org/10.1016/j.jspr.2011.08.002

Bell, C.H., 2013. Pest control of stored food products: Insects and mites. In Hygiene in Food Processing: Principles and Practice: Second Edition. Woodhead Publishing Limited. https://doi.org/10.1533/9780857098634.3.494

Bilck, A.P., Roberto, S.R., Grossmann, M.V.E., Yamashita, F., 2011. Efficacy of some biodegradable films as pre-harvest covering material for guava. In Scientia Horticulture, 130 (1), Pp. 341–343. https://doi.org/10.1016/j.scienta.2011.06.011

Boiteau, G., Vernon, R.S., 2001. Physical Barriers for the Control of Insect Pests. Physical Control Methods in Plant Protection, Pp. 224–247. https://doi.org/10.1007/978-3-662-04584-8_16

Bomford, M.K., Vernon, R.S., Pats, P., 2000. Importance of collection overhangs on the efficacy of exclusion fences for managing cabbage flies (Diptera: Anthomyiidae). In Environmental Entomology, 29 (4), Pp. 795–799. https://doi.org/10.1603/0046-225X-29.4.795

Brockerhoff, E.G., Liebhold, A.M., Richardson, B., Suckling, D.M., 2010. Eradication of invasive forest insects: Concepts, methods, costs, and benefits. New Zealand Journal of Forestry Science, 40, Pp. 117–135.

Costa, C.A., Guiné, R.P.F., Costa, D.V.T.A., Correia, H.E., Nave, A., 2018. Pest control in organic farming. In Organic Farming: Global Perspectives and Methods. https://doi.org/10.1016/B978-0-12-813272-2.00003-3

Dyck, V.A., Hendrichs, J., Robinson, A.S., 2005. Sterile Insect Technique. In Sterile Insect Technique. https://doi.org/10.1007/1-4020-4051-2

Esker, P.D., Obrycki, J., Nutter, F.W., 2004. Trap height and orientation of yellow sticky traps affect capture of Chaetocnema pulicaria (Coleoptera: Chrysomelidae). In Journal of Economic Entomology, 97 (1), Pp. 145–149. https://doi.org/10.1603/0022-0493-97.1.145

Ghouse, P., 2020. Mulching: Materials, Advantages and Crop Production. Protected Cultivation and Smart Agriculture, December. https://doi.org/10.30954/ndp-pcsa.2020.6

Hallman, G.J., 2013. Control of stored product pests by ionizing radiation. Journal of Stored Products Research, 52, Pp. 36–41. https://doi.org/10.1016/j.jspr.2012.10.001

Hillock, D., 2014. Mechanical Pest Controls. Oklahoma Cooperative Extension Service, Pp. 6432.

Hollingsworth, R.G., Jang, E.B., Follett, P.A., 2013. Freezing as a treatment to prevent the spread of hypothenemus hampei (Coleoptera: Curculionidae), in coffee. Journal of Economic Entomology, 106 (2), Pp. 653–660. https://doi.org/10.1603/EC12373

Jonason, D., Franzén, M., Ranius, T., 2014. Surveying moths using light traps: Effects of weather and time of year. In PLoS ONE, 9 (3). https://doi.org/10.1371/journal.pone.0092453

Karl, I., Stoks, R., De Block, M., Janowitz, S.A., Fischer, K., 2011a. Temperature extremes and butterfly fitness: Conflicting evidence from life history and immune function. Global Change Biology, 17 (2), Pp. 676–687. https://doi.org/10.1111/j.1365-2486.2010.02277.x

Karl, I., Stoks, R., De Block, M., Janowitz, S.A., Fischer, K., 2011b. Temperature extremes and butterfly fitness: Conflicting evidence from life history and immune function. In Global Change Biology, 17 (2), Pp. 676–687. https://doi.org/10.1111/j.1365-2486.2010.02277.x

Katan, J., 2000. Physical and cultural methods for the management of soil-borne pathogens. Crop Protection, 19 (8–10), Pp. 725–731. https://doi.org/10.1016/S0261-2194(00)00096-X

Khaliq, A., Javed, M., Sagheer, M., Sohail, M., Sohail, M., Sagheer, M., 2014. Environmental effects on insects and their population dynamics. Journal of Entomology and Zoology Studies JEZS, 1 (22), Pp. 1–7.

Lagu, C., Khelifi, M., Gill, J., and Duchesne, R.M., 2002. Thermal Control of Colorado Potato Beetle. In Encyclopedia of Pest Management (Print). https://doi.org/10.1201/noe0824706326.ch393

Lal, R., and Rohilla, H.R., 2007. Insect pests of pulses and their management. National Journal of Plant Improvement, 9 (2), Pp. 67–81.

Loebenstein, G., Alper, M., Levy, S., Palevitch, D., Menagem, E., 1975. Protecting peppers from aphid-borne viruses with aluminum foil or plastic mulch. In Phytoparasitica, 3 (1), Pp. 43–53. https://doi.org/10.1007/BF02981220

Mahapatro, G.K., and Sreedevi, K., 2014. Indigenous approaches for the management of termite and white grub in upland rice. Current Biotica, 8 (1), Pp. 97–108.

Mainali, B.P., and Lim, U.T., 2010. Circular yellow sticky trap with black background enhances attraction of Frankliniella occidentalis (Pergande) (Thysanoptera: Thripidae). In Applied Entomology and Zoology, 45 (1), Pp. 207–213. https://doi.org/10.1303/aez.2010.207

Mitra, S.K., Gurung, M.R., Pathak, P.K., 2008. Sustainable guava production in West Bengal, India. In Acta Horticulturae, 773, Pp. 179–182. https://doi.org/10.17660/ActaHortic.2008.773.25

Molden, D., 2007. Water for food, water for life: a comprehensive assessment of water ...

Mondal, C.K., Garain, P.K., Maitra, N.J., Maji, A., 2015. Bio-friendly management of Guava fruit fly (*Bactrocera correcta Bezzi*) through wrapping technique. Journal of Applied and Natural Science, 7 (1), Pp. 358–363. https://doi.org/10.31018/jans.v7i1.616

Neven, L.G., 2005. Combined heat and controlled atmosphere quarantine treatments for control of codling moth in sweet cherries. In Journal of Economic Entomology, 98 (3), Pp. 709–715. https://doi.org/10.1603/0022-0493-98.3.709

Oerke, E.C., and Dehne, H.W., 2004. Safeguarding production - Losses in major crops and the role of crop protection. Crop Protection, 23 (4), Pp. 275–285. https://doi.org/10.1016/j.cropro.2003.10.001

Oliveira, C.M., Auad, A.M., Mendes, S.M., and Frizzas, M.R., 2014. Crop losses and the economic impact of insect pests on Brazilian agriculture. Crop Protection, 56, Pp. 50–54. https://doi.org/10.1016/j.cropro.2013.10.022

Omkar. 2018. Pests and Their Management. In Pests and Their Management. https://doi.org/10.1007/978-981-10-8687-8

Osmun, J.V., 1972. Physical Methods of Pest Control. Journal of Environmental Quality, 1 (1), Pp. 40–44. https://doi.org/10.2134/jeq1972.00472425000100010012x

Overgaard, J., and Sørensen, J.G., 2008a. Rapid thermal adaptation during field temperature variations in Drosophila melanogaster. Cryobiology, 56 (2), Pp. 159–162. https://doi.org/10.1016/j.cryobiol.2008.01.001

Overgaard, J., and Sørensen, J.G., 2008b. Rapid thermal adaptation during field temperature variations in Drosophila melanogaster. In Cryobiology, 56 (2), Pp. 159–162. https://doi.org/10.1016/j.cryobiol.2008.01.001

Pacchioli, M.A., and Hower, A.A., 2004. Soil and moisture effects on the dynamics of early instar clover root curculio (Coleoptera: Curculionidae) and biomass of alfalfa root nodules. In Environmental Entomology, 33 (2), Pp. 119–127. https://doi.org/10.1603/0046-225X-33.2.119

Pedigo, L.P., and Rice, M.E., 2009. Entomology and Pest Management (6th edition).

Pelletier, Y., McLeod, C.D., Behnard, G., 1995. Description of Sublethal Injuries Caused to the Colorado Potato Beetle (*Coleoptera: Chrysomelidae*) by Propane Flamer Treatment. In Journal of Economic Entomology, 88 (5), Pp. 1203–1205. https://doi.org/10.1093/jee/88.5.1203

Popp, J., Pető, K., Nagy, J., 2013. Pesticide productivity and food security. A review. Agronomy for Sustainable Development, 33 (1), Pp. 243–255. https://doi.org/10.1007/s13593-012-0105-x

Pullman, G.S., and DeVay, J.E., 1981. Effect of soil flooding and paddy rice culture on the survival of Verticillium dahliae and incidence of Verticillium wilt in cotton. In Phytopathology, 71 (12), Pp. 1285–1289.

Rajendar, S., 2020. Ipm in Stored Products. Outlooks on Pest Management, Pp. 24–35. https://doi.org/10.1564/v31

Ranamukhaarachchi, S.L., and Wickramarachchi, K.S., 2007. Color Preference and Sticky Traps for Field Management of Thrips Ceratothripoides Claratris (Shumsher) (*Thysanoptera:Thripdae*) in Tomato in Central Thailand. Int. J. Agri. Biol., 9 (6), Pp. 392–397.

Rashid, H., Ahmed, I.U., Reza, S.M.T., Islam, M.A., 2017. Solar powered smart ultrasonic insects' repellent with DTMF and manual control for agriculture. 2017 IEEE International Conference on Imaging, Vision, and Pattern Recognition, IcIVPR. https://doi.org/10.1109/ICIVPR.2017.7890869

Reddy, V.D., Rao, P.N., Poduri, N., and Rao, K.V., 2011. Pests and pathogens: management strategies (Issue September 2014). https://doi.org/10.13140/RG.2.1.3783.6640

Régnière, J., Powell, J., Bentz, B., Nealis, V., 2012. Effects of temperature on development, survival and reproduction of insects: Experimental design, data analysis and modeling. Journal of Insect Physiology, 58 (5), Pp. 634–647. https://doi.org/10.1016/j.jinsphys.2012.01.010

Salimov, R.A., Cherepkov, V.G., Kuksanov, N.K., and Kuznetzov, S.A., 2000. The use of electron accelerators for radiation disinfestation of grain. In Radiation Physics and Chemistry, 57 (3–6), Pp. 625–627. https://doi.org/10.1016/S0969-806X(99)00484-3

Shililu, J.I., Grueber, W.B., Mbogo, C.M., Githure, J.I., Riddiford, L.M., and Beier, J.C., 2004. Development and survival of Anopheles gambiae eggs in drying soil: Influence of the rate of drying, egg age, and soil type. In Journal of the American Mosquito Control Association, 20 (3), Pp. 243–247.

Shimoda, M., Honda, K. Ichiro, 2013. Insect reactions to light and its applications to pest management. Applied Entomology and Zoology, 48 (4), Pp. 413–421. https://doi.org/10.1007/s13355-013-0219-x

Sinclair, B.J., Vernon, P., Klok, C.J., Chown, S.L., 2003. Insects at low temperatures: An ecological perspective. Trends in Ecology and Evolution, 18 (5), Pp. 257–262. https://doi.org/10.1016/S0169-5347(03)00014-4

Singh, B.P., Singh, R.A., Singh, G., Killadi, B., 2007. Response of bagging on maturity, ripening and storage behaviour of "winter guava." In Acta Horticulturae, 735, Pp. 597–601. https://doi.org/10.17660/ActaHortic.2007.735.77

Srinivasan, R., and Huang, C.C., 2009. The effect of simulated borer infested shoot pruning on yield parameters of eggplant. In Journal of Asia-Pacific Entomology, 12 (1), Pp. 41–43. https://doi.org/10.1016/j.aspen.2008.10.001

Suckling, D.M., Stringer, L.D., Stephens, A.E., Woods, B., Williams, D.G., Baker, G., and El-Sayed, A.M., 2014. From integrated pest management to integrated pest eradication: Technologies and future needs. Pest Management Science, 70 (2), Pp. 179–189. https://doi.org/10.1002/ps.3670

Tang, J., Mitcham, E., Wang, S., Lurie, S., 2007. Heat treatments for postharvest pest control: Theory and practice. In Heat Treatments for Postharvest Pest Control: Theory and Practice, Pp. 1–349. https://doi.org/10.1079/9781845932527.0000

Vernon, R.S., and Mackenzie, J.R., 1998. The effect of exclusion fences on the colonization of rutabagas by cabbage flies (Diptera: Anthomyiidae). In Canadian Entomologist, 130 (2), Pp. 153–162. https://doi.org/10.4039/Ent130153-2

Vernon, R.S., and Van Herk, W.G., 2013. Wireworms as Pests of Potato. In Insect Pests of Potato. https://doi.org/10.1016/B978-0-12-386895-4.00005-3

Vincent, C., Hallman, G., Panneton, B., and Fleurat-Lessard, F., 2003. Management of Agricultural Insects with Physical Control Methods. Annual Review of Entomology, 48, Pp. 261–281. https://doi.org/10.1146/annurev.ento.48.091801.112639

Vincent, C., Weintraub, P., Hallman, G., 2009. Physical Control of Insect Pests. Encyclopedia of Insects, Pp. 794–798. https://doi.org/10.1016/B978-0-12-374144-8.00209-5

Weintraub, P.G., and Berlinger, M.J., 2004a. Physical Control in Greenhouses and Field Crops. Insect Pest Management, Oseto, Pp. 301–318. https://doi.org/10.1007/978-3-662-07913-3_12

Weintraub, P.G., and Berlinger, M.J., 2004b. Physical Control in Greenhouses and Field Crops. In Insect Pest Management, Pp. 301–318. https://doi.org/10.1007/978-3-662-07913-3_12

Wyman, J.A., Toscano, N.C., Kido, K., Johnson, H., Mayberry, K.S., 1979. Effects of Mulching on the Spread of Aphid-Transmitted Watermelon Mosaic Virus to Summer Squash1. In Journal of Economic Entomology, 72 (1), Pp. 139–143. https://doi.org/10.1093/jee/72.1.139

Yaduraju, N.T., and Mishra, J.S., 2004. Soil Solarization: An Eco-Friendly Approach for Weed Management. Weed Biology and Management, Pp. 345–362.