Review Article

Introduction to insect pests of wheat (*Triticum aestivum* L.) crop and their management: A Review

Abstract

Wheat is one of the most important staple crops globally, providing a major source of calories and nutrients to millions of people. However, wheat production is severely threatened by various insect pests, leading to significant yield losses. These pests attack different parts of the plant throughout its growth stages, from seedlings to grain storage. This review provides an in-depth look at the key insect pests that affect wheat, their biology and lifecycle, the damage they cause, and current management practices. Integrated pest management (IPM) strategies that combine chemical, biological, and cultural approaches are discussed as essential tools for sustainable wheat pest control.

Keywords: Significant yield losses, wheat production, chemical, biological and cultural approaches.

1. Introduction

Wheat (*Triticum aestivum*) is a primary food crop cultivated worldwide, providing food security and livelihood for billions of people. Wheat holds the first rank among the cereals due to huge acreage that is devoted to civilization, high nutritive value and association with some of the earliest and most important civilizations of the world. If rice is the staple food of half of the world, wheat is the chief sustenance for the other half (Kundu *et al.,* 2006). The crop is grown under diverse environmental conditions and is a staple in many regions, particularly in Asia, Europe, North America, and parts of Africa. However, wheat is highly vulnerable to a range of insect pests that affect all stages of its growth, from germination to harvest, and during post-harvest storage. Wheat began being cultivated in India 5000 years ago (Feldman, 2001). It is estimated that yield losses due to insect pests were about 5.1% during the pre-green revolution era but the loss increased up to 9.3% in post-green revolution scenarios of the 1990s (Dhaliwal *et al.,* 2010). These pests not only reduce wheat yield but also degrade grain quality, posing a serious challenge to wheat farmers. Effective management of wheat pests is critical to ensuring

sustainable wheat production. For example, with warmer winters, more generations of aphids per growing cycle of wheat may be produced and be spread further (Macfadyen and Kriticos, 2012). It has been demonstrated that aphids can modify their behavior with intense or low temperature stress (Ma and Ma, 2012;Alford *et al.*, 2014), thereby making it possible to evolve in the presence of natural selection if genetic variation existed for such traits. This review highlights the major insect pests of wheat and the integrated management practices employed to mitigate their impact.

2. Insect Pests

2.1. Wheat Aphids [*Schizaphis graminum* Rondani, *Sitobion avenae* Fabricius and others]

Six species of aphids attack wheat crops, including the cherry-oat aphid, *Rhopalosiphum padi* L., *Schizaphis graminurn* R., *Rhopalosiphum Maidis* F., rose grass aphid, *Metopoliphiurn dirhodum* W., English grain aphid, *Sitobion avenae* F. and Russian wheat Aphid, *Diuraphis noxia* M. Aphids feed on the sap of the wheat plant, causing direct damage through nutrient depletion, resulting in stunted growth, yellowing, and reduced vigor. More importantly, aphids are vectors for viral diseases such as barley yellow dwarf virus (BYDV), which can lead to severe crop losses. Aphid infestations tend to increase during warm, dry conditions, and their rapid reproduction allows populations to grow quickly. The honey dew secreted by an aphid promotes growth of black sooty mould and results in 20-80% damage due to its covering the leaves and interfering with photosynthesis (Aslam *et al.*, 2005). Under such conditions, it has been observed that environmental factors coupled with natural enemies like lady bird beetle (*Monochelus sexmaulatus*), Syrphid fly (*Syrpus balteatus*), Chrysopa (*Chrysoperla carnea*) can be useful for the regulation of aphid population.

2.2. Wheat Thrips [*Haplothrips tritici* Kurdyumov; Thripidae; Thysanoptera]

Wheat thrips are minute, slender insects that feed on wheat by piercing plant tissues and sucking out sap. Thrips infestations can cause damage to wheat leaves, stems, and spikes, reducing the plants ability to photosynthesize and develop healthy grains. Wheat thrips are particularly problematic during dry seasons, and severe infestations can lead to significant reductions in grain size and quality. In addition to direct damage, thrips can also act as vectors for plant pathogens, further exacerbating their impact (Özsisli, 2011).

2.3. Armyworms [*Mythimna separate* Walker; Noctuidae; Lepidoptera]

The common armyworm (*Mythimna separata*), are destructive pests that affect wheat crops across many regions. The larvae feed on the leaves and stems of the plant, defoliating wheat fields and reducing the crop photosynthetic capacity. Armyworm infestations can lead to significant yield losses, especially during outbreak years when their populations spike. The larvae are whitish when fresh, later turning to tum green. These larvae are highly active (Farook *et al.,* 2018). These pests are highly mobile and can migrate across large distances, making them a challenge to control. Another host crop that has been reported to Michaud (2007) is Timothy grass, *Phleum pratense*. The larvae are nocturnal feeders and normally feed during the early morning hours as well. They hang upside down from the slender bristles on the head known as awns. Larvae hide inside cocoons. The larvae emerge from cocoon at night and consume leaves. The larvae feed very greedily behavior, ranging between fields and having a dawn-dusk feeding preference as it shuns direct sunlight (Nikhil, 2020).

2.4 Brown wheat mite [*Petrobia lateens* Muller; Arachnida; Tetranychidae]

This is a small reddish-brown arachnid in the family Tetranychidae. It is an important pest on dryland wheat but may also infest other small grains and grasses. Very small, about 0.5 mm long. Reddish-brown body with pale, yellowish legs. Several generations occur per year, often peaking in spring and fall. Bright red eggs laid in soil or on plant debris. Eggs are the stage that overwinters, hatching when conditions are right, either in the spring or the fall (Farook *et al.,* 2019). When mite numbers are high, leaves may take a golden look, and sometimes they may even be sucked dry by two stylets that resemble needles (Shrivastava *et al.*, 2014).

2.5 White grub [*Cyclocephala* spp.; Scarabaeidae; Coleoptera]

White grubs are C-shaped, soft-bodied with white or cream-colored bodies and brown heads. There are three pairs of legs close to their heads. They range in size from 1 to 3 cm depending on the species and their life cycle stage. Various species of white grubs attack wheat, including June beetles larvae, *Cyclocephala* spp. (masked chafer beetles) and other scarab beetles. The adults lay eggs in the soil during the late spring to early summer. Grubs breed in the soil, feeding on wheat and other crops' roots. Their lifespan varies according to the species, from one to three years. Eventually, after passing several instars, they become pupa in soil before emerging as adult beetles. Wheat crop is not much damaged by adult beetles; however, they can feed on foliage of other plants. They survive for a few months and feed on decaying plant materials, whereas adults can survive for up to one year by gnawing at the roots (Bosque-

Perez, 1995;Farook *et al.*, 2019). White grubs attack the roots of the wheat plants. Infestation causes wilting, yellowing, or stunt growth on a plant. Severely infested ones can even die. Usually, infested fields are characterized by patches of dead or weakly growing crops, often in uneven patterns. The infected plants can easily be pulled out of the soil as the damage is typically made in the root. This is usually observed during spring or summer when the grubs are actively feeding on the wheat roots.

2.6 Pink stem borer [*Sesamia inferens* Walker; Noctuidae; Lepidopteran]

These have their forewings light brown with dark markings, while the hindwings are pale white. The larvae are pinkish or reddish in color and have a smooth body. The larval body is cylindrical and soft, and their heads are brownish. The larvae are actually the damaging phase of this insect. Eggs are laid in clusters on the leaf sheaths near the plant base. Eggs produced are creamy white in color when newly laid, turning yellow as they mature before hatching. The larvae bore into the stem of a wheat plant after hatching. Pupation occurs either within the stem or in the debris of the plant. Adult moths then emerge from the pupae beginning the cycle again. In many warm climates, there may be as many generations in a year as the ability of the plant to produce new inflorescences can allow. The larvae tunnel into the stem, and this can be destructive enough to kill the central growing point of the plant, while the outer leaves may remain green. In young wheat plants, this causes dead heart the central shoot dries out and dies, while the outer leaves may remain green, and this leads to stunted growth that reduces the yield. Whiteheads can cause mature wheat plants when the larvae feed on them; it becomes white in color, although grain development is halted since nutrient flow is cut off. Tunnels formed within the stem due to larvae weaken the plant and increases the chance of lodging, which is an incident of falling over. It is originally a pest of rice (Pathak and Khan, 1994) but became an established pest of wheat due to adoption of this tillage system of sowing of wheat crop in North-Western plains of India and causes major damage by feeding inside the stem causing dead hearts at tillering stage and empty white heads at ripening stage and ultimately reduced yield by more than 11 per cent in India (Saxena *et al.,* 1972). Similar damages were recorded in wheat and the damage caused by larvae of this insect is expressed as “dead hearts” at seedling stage and “white ears” at earhead stage (Deol, 2002).

2.7 Termites [*Odontotermes* spp.; Microtermes spp.; Termitidae; Isoptera]

Wheat termites are subterranean termite species that invade wheat crops by consuming the roots and the basal part of the stem. Termites ranks first as a pest of wheat not only in India but also in South Asia too (Geddes and Iles, 1991). Isoptera order falls under termites, which is considered a serious pest in most wheat-growing regions, especially dry and semi-arid climatic conditions. Common termite species affecting wheat in India and parts of Africa are *Odontotermes* spp. and *Microtermes* spp. termites have a creamish-white or light-brown soft-bodied appearance. About 16 species of termite were found to damage the wheat crop in India, of these two species *viz., Odontotermes obesus* (Rambur) and *Microtermes obesi* (Holm) were found dominant (Chhillar *et al.,* 2006). Their colonies comprise three types of castes, including workers, soldiers, and reproductive alates. These latter include both workers and damage-feeding; their bodies are relatively soft and wingless, whereas defense large mandibles and tend to be more muscular. Alate reproductives are winged and swarm and start new colonies. Termites attack the bases and roots in large numbers. Nymphs and adults feed upon the leaves by mowing germinating plants of cotton, wheat, paddy, oats, barley and others particularly in areas abutting wastelands Akhtar, 1971. They penetrate through soil cracks and feed on the plant's root system, which affects the uptake of nutrients and water. Severely affected plants lose structural support, wilt, or can collapse fully. Termites often girdle the bottom of the stem, and dead or dying plants result in highly infested areas. The infected fields often display irregular patches with plants having collapsed or turned yellow. The yield losses ranging 43 to 80 per cent in wheat were recorded due to termite damage (Roonwal 1979;Chhillar *et al.,* 2006). Damage caused by termite may result in bad germination in crop such as sugarcane, wheat, gram, maize, cotton, groundnut, Chilies etc. but, their incidence at grown up plants, the yields are reduced dramatically because the losses inflicted at or near maturity can never be compensated (Verma and Kashyap, 1980). It consumes plant roots, forms plant stems, trunks, and even breaks down cells (Nikhil, 2020).

2.8 Ghujia weevil [*Tanymecus indicus* Faust; Curculionidae; Coleoptera]

This is a first record of *Tanymecus indicus* Faust (sf-Brachyderinae, f-Curculionidae), described by Faust in 1894 from Bengal, India (Pajni, 1989). It is indeed a damaging pest of wheat attacking different parts of South Asia especially in India and Pakistan. This pest belongs to Curculionidae true weevils family; they mainly attack the early stages of wheat, inflicting immense damage on seedlings and young plants. Adult weevils are 5-7 mm long with a greyish-

brown or ash-colored body having a rough texture. The body is also oblong in shape, and one can always easily identify it since of its weevil snout which is elongated mouthparts. The larvae are white, legless, C-shaped grubs that live in the soil where they feed on the plant roots. Female weevils lay eggs in the soil close to the base of wheat plants. The eggs are whitish, small and oval in shape. Once the larvae hatch, they make holes in the soil and feed on the wheat roots. The feeding stage takes weeks. After the larvae finish feeding, they go underground to pupate where they will emerge as adult weevils. The adult weevils start feeding from the soil once they have emerged. They particularly feed on immature young wheat plants when young. Adult weevils chew holes in the young delicate leaves of seedlings of wheat and feed on them while causing irregular notches in the margin of the leaf. Such feeding can cause heavy damage to the photosynthesis ability of the plant. Severe infestation can lead to wilting of young seedlings caused by damage from the feeding nature. In such cases, the death of the plant follows when drought or poor soil conditions stress the plant. Continuous feeding of the insects weakens the plants, indicating stunted growth, reduced tillering, and poor root development. Sometimes heavy feeding pressure by *Tanymecus indicus* causes uneven or delayed germination in wheat fields. Damage due to termite may result in poor germination in crop like sugarcane, wheat, gram, maize, cotton, groundnut, Chilies *etc.*, however, their incidence in grown up plants, the yields are reduced drastically because the losses inflicted at or near maturity cannot be compensated (Verma and Kashyap, 1980).

2.9 Surface grasshopper [*Chrotogonus trachypterus* Blanchard & *Chrotogonus oxypterus* Blanchard; Acrididae; Orthoptera]

These belong to the family and are majorly found in tropical and subtropical regions, mainly in India and Pakistan. Grasshoppers cause enormous economic loss by destroying the young wheat plants, more particularly in rain-fed and dry land agriculture. The grasshopper has a yellowish-brown to greenish-brown color with mottled pattern over its body that helps them to camouflage by means of their grass and soil colored backgrounds. They have small wings and are quite poor fliers, spending most of their life moving through leaf litter, hence the common name “surface grasshoppers.” Like almost all grasshoppers, they possess powerful hind legs for jumping that allow them to move at high speeds on the soil surface. Eggs are laid in soil pods at or near the surface, usually during the monsoon or rainy season. They hatch after a period of dormancy when conditions become favorable usually in the post-monsoon season. On hatching,

nymphs emerge and start feeding on the vegetation. Nymphs resemble small, wingless adults. Adult grasshoppers often go a short distance to find food. Both nymphs and adults feed on leaves of young wheat with many small, irregular holes or notches. At high intensities, they may strip all the foliage from plants. Grasshopper feeding primarily damages young wheat seedlings, reducing their vigor and killing them in some cases, most easily when the crop is young. Infestations are characterized by patchy damage in fields whereby some areas are worse than others concerning their defoliation. Persistent feeding tends to weaken the plants, lower photosynthesis capacity and reduces growth leading to low yields. Nymphs and adults feed on leaves by cutting germinating plants of cotton, wheat, paddy, oats, barley and others particularly in areas adjoining wastelands (Akhtar, 1971;Farook *et al.,* 2019).

2.10 Cereal leaf beetle [*Oulema melanopus* Linnaeus; Chrysomelidae; Coleoptera]

It is considered to be a serious pest of wheat and other cereals like barley, oats and rye. It is native to Europe and has become widespread around the world, including North America and Asia. It was first found in North America in 1962 in the state of Michigan (Herbert *et al.,* 2007). Cereal leaf beetles feed at both the larval and adult stages, damaging the leaves of wheat that may continue to decline significantly in yield. They have a glossy metallic blue-black body with bright reddish-orange legs and thorax. The beetles are slender and elongated with a hard, protective shell. The larvae are soft-bodied, yellowish, slug-like with a black head, which cover themselves in their feces creating a shiny, sticky black coating. The largest amount of damage is caused by the larvae, which are responsible for most feeding. Eggs are laid in small groups on the dorsal surface of leaves. They are yellowish-orange in color and cylindrical in shape. Adult beetles are leaf-feeders but not nearly as damaging as larvae. Overwintering for adults occurs in fragments of plants or grassy fields, while in spring, these adults erupt in feeding and mating. Adults and larvae feed on the leaves of the wheat plant. The most destructive are the larvae. They skeletonize the leaves by consuming tissue between the leaf veins, leaving long, parallel strips of translucent tissue, often described as “windowpane feeding”. Crop yield and quality are affected as the lost photosynthetic activity as a consequence of feeding damage decreases crop yield and quality (Wilson and Shade, 1966). This pattern of feeding gives the leaves a shredded appearance. Adults feed similarly but cause smaller, irregular holes. Heavy feeding damage may look like frost damage when leaves appear whitish in color (Buntin *et al.,* 2004).

2.11 Gram Pod Borer [*Helicoverpa armigera* Hubner; Noctuidae; Lepidoptera]

After some time, the immature larva starts attacking the ears' heads (Nikhil, 2020). All internal tissue are thoroughly consumed. It is a threat to the gram at maturity, which reflects the potential danger to the crop in the crucial stage of its development.

2.12 Spider [*Steatoda triangulosa* Walckenaer; Theridiidae; Arachnida: Araneae]

They absorb sap from young leaves. White spots on the leaf therefore appear. In case the infection is heavy the leaves turn red and dry up. The insect is very small, shiny brown to black in color with legs pale yellow (Nikhil, 2020).

3. Integrated Pest Management (IPM)

3.1 Cultural Practices: Avoid late wheat sown for the crop to be protected from shoofly and armyworms. Nitrogen fertilizers application at the recommended dose as more its application attracts higher population of armyworms and aphids. Prefer seed treatment for termite control. It's cheap and effective and also causes less pollution. Always use well rotten farm yard manure for damaging. Crop rotation should be carried out for proper pest management.

3.2 Mechanical Methods: Certain mechanical methods have proven to be highly effective in controlling pests in wheat cultivation: Manually collecting and destroying egg masses and removing damaged leaves/plants parts. Setting up bird perches at a rate of 40-50 per hectare. Installing one light trap per hectare to capture adult *Helicoverpa*.

3.3 Biological control: *Trichrogramma* sp. @50,000 per hactare needs to be released for the management of pink borer and armyworm. Biological control agent needs to be conserved and exploited like Coccinellid beetles, Chrysopa, Syrphid flies, *Cotesia* sp., *etc.* 5% Neem seed kernel extracts needs to be sprayed for the proper management of pest.

3.4 Chemical control: Use chemical insecticide application if pest population is above economic threshold levels ETL. Termites- Apply 4ml/kg chlorpyriphos before sowing as seed treatment to kill termites. Crude oil emulsion is used to destroy the colony of termites in the termitarium. **Chewing insect pests:** Profenophos 50 EC 1 ml per liter water or chlorpyriphos 20 EC 1.5 ml per liter water. **Sucking insect pests:** Thiamethoxam 25 WG 1 gm per 3 liter water or imidacloprid 17.8 SL or 30.5 SC 1 ml per 3 liter water.

5. Conclusion

A holistic approach toward integrated management of insect pests, which encompasses ecological and social factors, will incorporate the synergistic integration of cultural, biological, chemical, physical, and biotechnological control methods. Crop losses caused by pests and

diseases are a huge menace to the incomes and food security of thousands of rural families all over the globe. The plant can partly compensate by increasing activity, changes in leaf area, or shoot growth. Such compensation can be one of the reasons why cereals are a success crop.

6. References

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