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## A review on insect pest complex of wheat (*Triticum aestivum* L.)

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### Abstract

Wheat (*Triticum aestivum* L.) is the most important cereal crop for majority of the world's population. It is the staple food of about two billion people (36% of the Global population) and is in increasing demand in countries undergoing urbanization and industrialization. It has an immense yield potential. However, the productivity is limited by a large number of abiotic and biotic constraints. Among the biotic constraints, insect pests cause considerable loss in yield and change their status over time. The crops are heavily attacked by Armyworm, Cereal leaf beetle, wheat aphid, Grasshopper, White grubs, Ghujia weevil, and Termites. This review endeavors to piece together all known information about the insect that attack on wheat.

**Keywords:** Wheat, insect pest, attack

### Introduction

Wheat (*Triticum spp.*) is the most important cereal among the field crops, not because of its antiquity but due to being an excellent food for mankind. Wheat is accorded a premier place among cereals due to its vast acreage 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) [12]. Wheat crop is grown over a wide range of latitudes covering a considerable diversity of conditions; the largest quantities of best wheats are produced in countries with cool, moist weather during a fairly long growing period followed by dry warm weather to enable the grain to ripe properly. The cultivation of wheat is so widely distributed geographically that the crop is being harvested in one country or the other all the year round (Tiwari and Shoran, 2011) [22]. Wheat is grown on 220.4 mha area with production of 749 million tons (Anonymous, 2016) [2]. Wheat cultivation in India started 5000 years ago (Feldman, 2001) [10]. It is the second most important cereal in India after rice and is grown on an area of 31.781 million hectares with total annual production of 96.64 million tons (Anonymous, 2016. a) [2]. India is today the second largest wheat producer in the whole world. Its cultivation has traditionally been dominated by the northern region of India. The major wheat producing states of India are Uttar Pradesh, Punjab, Haryana, Madhya Pradesh, Rajasthan, Bihar, Maharashtra, Gujarat, Karnataka, West Bengal, Uttarakhand, Himachal Pradesh, and Jammu & Kashmir. Out of these states Punjab and Haryana have been prolific wheat producers.

Various arthropods causes considerable damage to wheat (*Triticum aestivum* L.) plants throughout their life and no stage of the crop is free from damage. Pests of wheat are either polyphagous (damaging a wide range of plants) or oligophagous (feeding on only a few plant species) and it is very rare, any insect found to be monophagous to wheat crop. In India, wheat is ravaged by a number of insect pests viz., Termites, *Odontotermes obesus* (Ramb); shoot fly, *Atherigona naqvii* (Steyskal); Brown wheat mite, *Petrobia latens* (Muller); Armyworm, *Mythimna separata* Walker) and Aphid, *Sitobion avenae* (Fabricius) (Deol, 1982) [7].

It has been estimated that global yield losses due to insect pests in the pre-green revolution era were about 5.1%, however, the losses increased to 9.3% in the post-green revolution in 1990s (Dhaliwal *et al.*, 2010) [8]. Insect pests are dynamic and highly adaptable. Changes in environmental temperature can modify their physiology, behavior, voltinism and distribution.

For instance, with warmer winters, the number of aphid generations per wheat growing cycle may increase and extend their distribution further (Macfadyen and Kriticos, 2012) [14]. It has also been proven that aphids can modify their behavior in response to either high or low temperature stress (Ma and Ma, 2012; Alford *et al.*, 2014) [13, 1], enabling them to adapt in the presence of natural selection if genetic variation exists for such traits. While the work on disease resistance has tremendously contributed to protect wheat yields, control of arthropod pests has largely depended on the use of chemicals. In order to fix the priorities and for evolving suitable pest management practices, continuous review of the pest complex of wheat crop under agro climatic conditions of India is need of the day which has not been carried systematically so far. Considering the growing need and yield losses in grain as well as fodder, it is imperative to devise an effective pest management tactics. The present review could help farmers to align the wheat production with the changing conditions and demand of time.

### Aphids

There are six species of aphids that damage wheat. These species include *Rhopalosiphum padi*, *Schizaphis graminum*, *R. Maidis*, *Metopolophium dirhodum*, *Sitobion avenae* and *Diuraphis noxia*. Two of the species commonly known as

Russian Wheat Aphid (*Diuraphis noxia*) and Bird Cherry-Oat Aphid (*Rhopalosiphum padi*) are considered notorious for their direct and indirect losses. Aphids feed on the leaves and grain heads of wheat (Fig: 1). Adult aphids are only about 1/8 inch long, and adults may or may not have two pairs of nearly transparent wings. Oat-Bird cherry aphid and English grain aphid are the most commonly species observed in wheat. Aphid infestation cause rolling of flag leaf, trapping of emerging heads and awns that result in poor pollination. Aphid outbreak during early growing stages of wheat is very alarming. It damages the crop by sucking the cell sap from leaves, stem and kernels. Honey dew secreted by the aphid encourages black sooty mould development that leads to 20-80% damage by covering the leaves and interrupted the process of photosynthesis (Aslam *et al.* 2005). For past few years, there has been an increased buildup of aphid on wheat crop which is challenging sustainable wheat production. Under such condition, the role of environmental factors and natural enemies like lady bird beetle (*Menoclisussex maulatus*), Syrphid fly (*Syrpus balteatus*), Chrysopa (*Chrysoperla carnea*) can be helpful for the control the aphid population. Also these pests are significant in that they are capable of transmitting diseases to the plant such as barley yellow dwarf virus.



Fig 1: Aphids on wheat grains (left) and on leaves (right).

### Cereal leaf beetle:

The cereal leaf beetle, *Oulema melanopus* L. (Coleoptera: Chrysomelidae), is an invasive insect from Europe that feeds on cereal crops, including wheat, barley and oats. It was first discovered in North America in 1962 in the state of Michigan (Herbert *et al.* 2007). The cereal leaf beetle is now found in most cereal production areas of the world.

The cereal leaf beetle has a wide host range in cereals and grasses. It prefers oat, barley, wheat, rye, timothy, fescue, grain sorghum and corn. Crop yield and quality are reduced due to lost photosynthetic activity resulting from the feeding

damage (Wilson and Shade, 1966) [24]. The fourth larval instar causes most of the crop damage, and this stage is responsible for about 70 per cent of all crop damage. Feeding at the flag leaf stage is most damaging to crop yield. The adult and larvae feed on the plant leaves and chew long strips of tissue between the leaf veins (Fig 2). Adults can eat through the leaf completely while the larvae eat the upper leaf surface and leave a thin membrane of tissue. This feeding pattern can leave a window-pane effect on the leaf. Severe feeding damage can look like frost damage because leaves look whitish (Buntin *et al.* 2004) [4].



Fig 2: Adult (left) and larvae (right) of cereal leaf beetle on wheat crop.



### Surface Grasshoppers

Surface grasshoppers (*Chrotogonus trachypterus* and *C. oxypterus*) are widely distributed in the Orient and Africa. These grasshoppers are polyphagous and feed on a number of cultivated crops. In India, *C. trachypterus* is more common in the north, whereas, *C. oxypterus* occurs in the southern regions. The surface grasshopper (Fig 3) is a pest of pastures throughout the year. The common desert representative of the genus collected from western Rajasthan appeared to belong to



Fig 3: Surface grasshopper collected from wheat field.

Damage to cereal crops is generally concentrated near field margins and is caused when hatchling grasshoppers move out of egg beds into field edges; damage to grasslands tends to be more evenly distributed. Damage to cereals includes leaf notching and stripping but is most costly when stems are severed just below the heads of maturing or mature crops. When grasshopper numbers are extremely high and natural plant hosts in short supply, grasshoppers will consume or attempt to consume any plants or plant products that they come upon during their migrations in search of food.

### Ghujia weevil

*Tanymecus indicus* Faust, belonging to the subfamily, Brachyderinae, of the family Curculionidae, was first described by Faust in 1894 from Bengal (Pajni, 1989). It is a

*C. trachypterus*, being widely distributed on the ground (their habitat is the surface of the soil) and more frequently collected from nurseries, gardens and wheat and oats fields. It is distributed throughout the plains in India including Orissa, South Arcot, Madura, Coimbatore, Bellary, Madhya Pradesh and Rajasthan. 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).

common pest of young wheat and other crops in Uttar Pradesh, Bihar and Punjab. Ghujia weevil are greyish black in colour, measuring about 6-7 mm in length. Basically it is a soil pest. Female lays 50-70 eggs in 8-10 installments in the soil, under clods and in the crevices of the soil. Hatched grubs enter the soil, where they feed on the soil humus and pupate in earthen cocoon at 15-20 cm depth in the soil. Adults emerge out with the onset of monsoon in June and July and became sexually matured in the month of October - November. This weevil (Fig 4) completes one generation in a year. The damage is caused by the adult weevils only and they cut the germinating seedling at ground levels and often crop has to be re-sown. The adults feed on leaves and tender shoots of the plants.



Fig 4: Adult Ghujia weevil

### Termites

Termites ranks first as a pest of wheat not only in India, but in South Asia too (Geddes and Iles, 1991) [11]. 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) [5]. The yield losses ranging 43 to 80 per cent in wheat were recorded due to termite damage (Roonwal 1979, Sattar and Salihah 2001 and Chhillar *et al.*, 2006) [5].

Termites live in colonies which consist of over a few hundreds to a million individuals and their division of labour is based on caste system. Usually in a termite colony, 80 to 90 per cent individual are as workers and about 10 per cent

soldiers (Srivastava, 1993) [21]. Due to termite damage the plants is dry up and can be easily pulled up (Fig 5). The damage starts right from the sowing of the crop till harvest. Damage due to termite may lead to 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) [23]. Mostly the termites live in underground nest with the ramification of galleries in which they move about, it is rather difficult to locate and reach them. So before the adoption of integrated management approach it is essential to know about the life cycle of the pest.



**Fig 5:** Termites (right) with their damage (left).

**Armyworm**

*Mythimna separata* Walker (Lepidoptera: Noctuidae) is a pest of wheat and is prevalent in U.P, Bihar, Rajasthan, and Punjab. The adult moths are stoutly build and pale brown in colour. Larvae have three, orange, white and brown stripes running the length of each side. The larvae will also have a narrow broken stripe down the center of its back. The presence of black spots located at the top of the four pairs of prolegs. The major damage to the seedlings is caused by caterpillars which move in swarm. After destroying crop of

one field, they move to the other crop. The caterpillars feed upon the leaves of the seedlings and devour the ear heads as a result further growth of the plant ceases (Fig 6). They infests spring wheat fields primarily, although winter wheat and spring barley may also be affected. Michaud (2007) [15] reported that Timothy grass (*Phleum pratense*) is also a host crop. The larvae generally feed at night and early in the morning. They hang upside down from the slender bristles on the head (awns).



**Fig 6:** Armyworm in wheat field.

**Pod Borer**

Pod borer, *Helicoverpa armigera* Hubner; Noctuidae; Lepidoptera; is a polyphagous pest, infesting gram, lablab, safflower, chilies, groundnut, tobacco, cotton, wheat etc. Caterpillars are of varying colour, initially brown and later turn greenish with darker broken lines along the side of the body. Moth is stout, medium sized with brownish/greyish

forewings with a dark cross band near outer margin and dark spots near costal margins, with a wing expanse of 3.7cm. Young larva feeds on the leaves for some time and then attacks earheads (Fig 7). Internal tissues are eaten severely and completely hollowed out. While feeding the caterpillar thrust its head inside leaving the rest of the body outside.



**Fig 7:** Pod borer larva (left) and adult (right) from the wheat field

**Brown wheat mite**

*Petrobia lateens* (Muller) (Arachnida: Tetranychidae) occur in wheat in the summer rainfall regions and expected to be severe where drought conditions are frequently encountered

(Fig 8). It has gained importance in recent years. Its incidence has been recorded from Madhya Pradesh, Punjab, Rajasthan and Haryana (Sharma & Srinivasa, 2004) [20]. It is a pest of drier areas and is serious under rainfed condition but its



incidence in the irrigated crops has been reported. The extent of damage to the crop is dependent upon the severity of incidence. Individual mites are too small to be visible with the naked eye without effort. Adults are light brown in colour. The brown wheat mite feeds on sap from leaves by inserting two needle-like stylets into the leaf thereby withdrawing nutrients from the plant. During high mite populations the leaves may have a bronze appearance with some leaves even

dying off as a result of intense feeding. They have a tendency to feed on the tips of the leaves, causing them to dry out and die. Heavily infested fields present a scorched withered appearance. It is also responsible for the transmission of barley yellow streak mosaic virus disease. It has been found that Showers of 12mm or more may lead to the eradication of the mite population, but eggs present in the soil may start a new generation.



Fig 8: Brown wheat mite on wheat leaves

### Pink stem borer

The pink stem borer *Sesamia inferens* (Walker) (Lepidoptera: Noctuidae) is an oriental species that occur in the Indian subcontinent, China, Pakistan, Japan, Taiwan, Indonesia, Solomon Islands, Southeast and East Asia (Fig 9). It is originally a pest of rice (Pathak and Khan, 1994) [17], 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) [19]. Signs of damage in wheat were similar to those recorded in rice and damage caused by larvae of this insect is expressed as “dead hearts” at seedling stage and “white ears” at earhead stage (Deol, 2002) [6].

### Brown stink bug

Brown stink bugs are medium to large-sized bugs (Fig 10). Those that attack small grains are commonly grey brown to green in color and 0.38 to 0.5 inch long. Their bodies have a characteristic shield shape with a large triangle on the center back

Stink bug infest winter wheat during grain development in the spring and are a concern for two reasons. First they may directly damage the wheat grain. More importantly, stink bugs may move as wheat matures to adjacent crops such as corn and vegetables where they may cause damage to seedling plants. Wheat is most sensitive to stink bug feeding injury during the milk stage. Threshold is 1 bug per square foot at milk stage. Despite being very visible on maturing heads, stink bugs number almost always are much below this threshold. Control during medium to hard dough stage is not justified



Fig 9: Pink stem borer

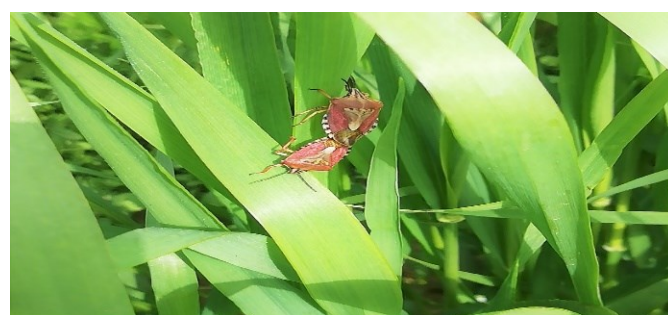


Fig 10: Brown stink bug on wheat leaves

### White grubs

White grubs are the larvae of scarab beetles, often known as May or June beetles (Fig 11). They are C-shaped larvae of scarab beetles. They eat a wide range of materials and all developmental stages occur in the soil. White grubs are abundant in soil with high content of organic matter. The larvae live for several months and eat decomposing plant materials while adults live up to a year and gnaw roots (Bosque-Perez, 1995) [25].

Larvae may damage plants in either fall or spring, feeding on the roots or cutting off plants below the ground. Losses may

become significant when there are four to five grubs per square foot. However, there are many species, and not all are damaging to wheat, so concern is only warranted when stand loss is evident in conjunction with the presence of grubs.

The worst damage—a dead plant—occurs when a grub is feeding near the wheat seeding depth and severs the root system right below the crown. This seedling is left with no root and will die. If grubs feed a little lower on the root system, the plant will be small and its productivity much reduced. This plant will have much less root than a normal plant, but it is often enough to sustain it until cooler weather when the grubs move further down in the soil.



Fig 11: White grubs collected from wheat fields

#### Wireworm

Wireworms, *Agriotes* spp. (Elateridae) are the larval stage of click beetles. Larvae are slender and shiny, yellow to brown, with six slender, short legs (Fig 12). Mature larvae range from 1/2 to 1 inch long. Many species of wireworms are found throughout the world, all of which can attack wheat. These larvae are capable of attacking many different plant species as well. Wireworm damage is very similar to that caused by other soil-inhabiting chewing insects; the only sure means of identifying wireworms as the causal agent is to find them in association with the damaged seedlings. Wireworm larvae may attack wheat as soon as the crop is seeded, eating the endosperm of the kernels and leaving only the seed coat. A common sign of wireworm attack is the wilting and/or dying of a number of adjacent plants, either in a row or patch. The stems of affected seedlings will be chewed just above the seed.



Fig 12: Wireworm in wheat field

#### Yield loss assessment

Crop losses due to pests and diseases are a major threat to the incomes and food security of thousands of rural families worldwide. The assessment of crop losses (yield and economic losses) and their causes is needed to improve the development of agroecosystems capable to offer good crop yields, regulation of pests and diseases, and other ecosystem services. Assessing crop losses due to pests is important in making decisions about pest management based on costs and benefits and in allocating resources to the most important pests. The crop consists of a group of plants and each individual plant is a plastic, dynamic system in which pests reduce the uptake of nutrients or water, reduce photosynthesis and interrupt transport within the plant to stores or reproductive parts. The plant can partly compensate for any loss by increased activity, changes in leaf area or shoot growth. Such compensation can be one of the reasons for the success of cereals as crops.

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