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Rice Varieties Vary in Susceptibility to Stem Borers

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Abstract

Generally, all borer larvae suffer low mortality during winter. In Japan, where the winter temperature is much lower than in most other rice regions, mortality of Chilo suppressalis and Scirpophaga incertulas has been low even during severe winters. Chilo suppressalis is more tolerant of low temperatures than Scirpophaga incertulas. In years of high precipitation during autumn, higher percentages of larvae hibernate, and if the winter or spring is warm, more of these successfully pupate and emerge as adult moths. These conditions, however, also accelerate pupation and emergence.

Keywords: Rice stem; Larvae; Subtropical regions; Crop harvest; Leaf sheath; Diopsids

Introduction

Oviposition then occurs on seedlings, on which the larvae suffer high mortality and the population is reduced. However, if late spring is somewhat cooler and delays moth emergence, or if the rice is planted slightly earlier, the population builds up rapidly and heavy damage may occur. Warm weather is essential for population build-up; the moths in cool areas are generally smaller and lay fewer eggs [1]. If the weather stays warm during the remaining rice crop seasons, the larvae develop rapidly and the total number of generations may increase. The problem is exacerbated particularly in areas of multiple rice crops. Larvae suffer high mortality on seedlings. Some workers in Japan attribute this to high water temperature. Increased larval mortality is recorded whenever the average temperature of floodwater exceeds 35 °C for any 5 d in July. Measurements of the temperature of the floodwater and within the rice stem suggest that temperature itself is not directly lethal [2]. Rather, high temperature might reduce larval vitality, thereby increasing their vulnerability to bacterial diseases or other natural hazards. Rearing has high survival, and it is unlikely that the greater larval mortality in the field is due to nutritional deficiency. However, because the early-instar larvae feed gregariously, the food available on the seedlings is inadequate and the larvae are forced to migrate much earlier, probably resulting in high mortality [3]. In areas of double cropping, the seedlings of the second crop carry a heavy egg load, leading to subsequent high larval mortality. Such regulation of the population may not be operative, however, where planting seasons are not distinct. Both in tropical and subtropical regions, the population have been reported to decline drastically during the summer months after the second crop harvest [4]. The decline has frequently been attributed to high temperature, but the fact that most rice fields have been harvested and Larvae on seedlings used for mass often ploughed during that time is equally important. The age and variety of the host plants and the level of soil fertility have an effect on the size of the stem borer population. Generally, rice plants in the vegetative phase and early heading stage receive more eggs than those nearing maturity. The extended periods of host plants at the more attractive stages should therefore encourage a population increase [5]. For oviposition, stem borer moths prefer rice fields receiving high rates of nitrogenous fertilizers. Rice plants containing higher levels of N are more suitable for larval growth. The stem borer problem is more intense in areas with soils deficient in silica as shown in (Figure 1).

Both field and laboratory studies have shown that larval survival is significantly reduced if silica is applied to these soils. It has also been demonstrated that the soil itself renders rice plants less attractive to the insect, and the silica particles in the plant interfere with larval feeding, often causing excessive mandible wear. A similar effect of silica on stem borer larvae was recorded in larvae reared on varieties containing different percentages of silica. Silica level also significantly affects lodging and disease incidence in the rice plant [6]. The initial boring and feeding by larvae in the leaf sheath cause broad, longitudinal, whitish, discoloured areas at feeding sites, but only rarely do they result in wilting and drying of the leaf blades. About a week after hatching, the larvae from the leaf sheaths bore into the stem and, staying in the pith, feed on the inner surface of the walls. Such feeding frequently severs the apical parts of the plant from the base. When this occurs during the vegetative phase of the plant, the central leaf whorl does not unfold, but turns brownish and dries off, although the lower leaves remain green and healthy. This condition is known as dead-heart, and the affected tillers dry out without bearing panicles. Sometimes dead-hearts are also caused by larval feeding above the primordia; if no further damage occurs, the severed portions are pushed out by new growth [7]. After panicle initiation, severance of the growing plant parts from the base dries the panicles, which may not emerge; panicles that have emerged

Figure 1: Stem borer.

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do not produce grains. Affected panicles later become conspicuous in the fields. Being empty, they remain straight and are whitish. They are usually called whiteheads. When the panicles are cut off at the base after spikelet filling is partially completed, shrivelled grains are observed. The plants can compensate for a low percentage of early dead-hearts, but for every 1% of whiteheads, 1-3% loss in yield may be expected. Although stem borer damage becomes evident only as dead-heart and whitehead, significant losses are also inflicted by larvae that feed within the stem without severing the growing plant parts at the base. Such damage results in reduced plant vigour, fewer tillers, and many unfilled spikelets [8]. Diopsid larvae have small mouth-parts and can penetrate only a young tiller. Usually, only one generation per crop develops. The larva cuts through the tiller at a slanting angle about 10 cm aboveground and the leaf sheath is not cut. After the dead-heart develops and the tiller rots, the larva moves on to another tiller. On average, one larva can damage three tillers. Diopsids seldom cause whiteheads. The synchrony of emergence of the flies with the onset of the wet season concentrates the attack on a newly planted crop as shown in (Figure 2).

Damage from succeeding generations is more spread out over time. The damage potential is also related to the inner diameter of the stem in relation to the diameter of the larvae. If the tiller is wider than the larva, damage is less. There may be differences between species in this regard.

Methodology

Although high levels of infestation can occur with R. albinella and Maliarpha separatella, recorded yield loss is minimal. Plant type, crop vigour, and the pest complex can play a large role in determining eventual yield loss by stem borers. Low-tillering varieties have less opportunity to compensate for dead-hearts than high tillering varieties. A high- tillering variety can produce a replacement tiller for a dead-heart. Similarly, a vigorous, well -nourished crop can tolerate higher levels of dead-hearts and whiteheads than can a stressed crop as shown in Figure 2. Crop cultural practices have a pro-found bearing on the stem borer population [9]. Some methods are effective only if carried out through communitywide cooperation; others are effective on a single field. Communitywide practices act to prevent colonization and have the greatest potential to minimize infestation. China and prewar Indonesia developed effective cultural practices, often in combinations that isolate the rice crop through time and space. Practices that can be carried out on a single field include using optimal rates of N fertilizer in split applications [10]. Applying slag increases the silica content of the crop, making it more resistant. Since the eggs of Scirpophaga incertulas are laid near the tip of the leaf blade, the widespread practice of clipping the seedlings before transplanting greatly reduces the carryover of eggs from the seedbed to the transplanted fields. However, this control method has merit only if older seedlings are transplanted. Similarly, the height at which a crop is harvested is an important factor in determining the percentage of larvae that are left in the stubble.

Figure 2: Emergence of flies.

Discussion

At harvest, Chilo suppressalis larvae are usually about 10 to 15 cm aboveground. Although Scirpophaga incertulas larvae are located somewhat lower, most of them are aboveground as well. Therefore, harvesting at ground level can remove a majority of the larvae of all species. To destroy those remaining in the stubble, burning or removing the stubble, decomposing the stubble with low rates of calcium cyanide, ploughing, and flooding have been suggested [11]. Burning is only partially effective because after harvest the larvae generally move below ground level. It is also difficult to uniformly burn stubble in a field. Ploughing and flooding are apparently most effective. Since stubble is the major source of the overwintering stem borer population, proper stubble management cannot be overemphasized. In several countries, delayed seeding and transplanting have been effective in evading first-generation moths [12]. This practice has not been highly effective against Chilo suppressalis in Japan since emergence is delayed if planting is delayed. It has been effective, however, against Scirpophaga incertulas, the appearance of which is not affected by planting dates. The number of generations of this species is determined by the growth duration of the crop [13]. Thus, where continuous rice cropping is practiced, a change in planting time has little effect unless practiced over large areas. In such areas, crop rotation to include some short-duration non-graminaceous crops should significantly reduce the borer population. Changing planting time may not always be feasible because of other agronomic considerations. In Pakistan, the planting date has been regulated by releasing canal water only after the first brood Scirpophaga incertulas moths have emerged. This late-planted crop is far less infested than fields planted early with private irrigation systems. The early planted fields, however, minimize the full impact of late planting on the stem borer population. In Japan, where highly effective insecticides are available, early planting has been reintroduced at several sites, resulting in high survival of first-generation Scirpophaga incertulas larvae [14]. Also, the first and second broods of Chilo suppressalis moths appeared earlier, possibly introducing a distinct third generation in the warmer sections of the country. Light –trap catches of moths reveal a change from a unimodal to a bimodal pattern in both the first and second broods. Biological control Most biological control of stem borers in tropical Asia and Africa comes from indigenous predators, parasites, and entomopathogens. The conservation of these valuable organisms is the key to development of stable and successful integrated pest management systems. Over 100 species of stem borer parasitoids have been identified. The three most important genera are the egg parasitoids Telenomus, Tetrastichus, and Trichogramma. Tetrastichus wasps have elongated ovipositors and can lay their eggs in stem borer eggs, Even if the latter are covered with a mat of hair. Telenomus wasps, however, parasitize stem borer eggs while the moth is in the act of oviposition before the eggs are covered with hair. The wasp locates the female moth, possibly by the sex pheromone, attaches itself to the tuft of anal hair near the ovipositor, and waits for the moth to lay eggs. Egg masses are also the food of several predators. The longhorned grasshopper Conocephalus longipennis preys voraciously on eggs of the yellow stem borer [15]. Other orthopteran predators such as the crickets Metioche vittaticollis and Anaxipha longipennis feed on eggs of Chilo suppressalis. The predatory mirid Cyrtorhinus lividipennis Reuter also attacks eggs of Chilo suppressalis.

Conclusion

A wide range of predatory species attacks the small larvae of stem borers before they enter the stem of the rice plant. Some important predators are coccinellid beetles Micraspis crocea, Harmonia octomaculata, and carabid beetles such as Ophionea spp. When young larvae fall on the water, they are preyed upon by Microvelia douglasi atrolineata Bergroth and Mesovelia vittigera. Ants and a dozen other predators prey upon stem borer larvae.

Acknowledgement

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Conflict of Interest

None

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