Strategy of Rice Gall Midge Control

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The rice gall midge, *Orseolia oryzae* (Wood-Mason) in family Cecidomyiidae of Diptera, is one of the important pests of rice plants in tropical Asia. The insect is distributed[5,6] in Bangladesh, Burma, Cambodia, southern China, India, Indonesia, Laos, Sri Lanka, Thailand, and Vietnam. The insect causes severe damage to rice plants by producing galls called silver shoots or onion tubes, resulting in grain yield losses of more than 60%. No panicles are formed when rice plants are severely attacked by the insect.[5]

Since the insect was recorded as a serious pest of rice in India in 1880,[6] the rice gall midge has been fragmentarily studied with emphasis on insect control measures, especially insecticidal application[11] and utilization of resistant varieties.[3] However, the insect is still giving serious damage in many localities in these countries.

Comprehensive studies[4,6,7] on ecology and control of the rice gall midge have been carried out by the cooperative program between the Department of Agriculture, Thailand and the Tropical Agriculture Research Center, Japan, and then the research program of the Directorate of Food Crop Protection, Indonesia supported by the Japan International Cooperation Agency. One of the authors, T. Hidaka, has joined the programs for more than 10 years in order to clarify the mechanism of population dynamics and to establish effective control measures of the rice gall midge.

On the basis of the results obtained in the studies, strategy of the insect control is proposed in a present paper. The techniques for controlling the insect are rather complicated under different environments of insect occurrence which varied with highland and lowland paddy fields, different planting time of rice plants, and the dry and wet seasons, etc. Efforts for depressing insect population were made in many ways such as forecasting of insect occurrence,[7] insecticidal control,[6,7,11] cultural practice,[1,10] biological control,[7,8] and utilization of resistant varieties.[3,4,9]

Forecasting of insect occurrence

At first, it is very important to grasp the insect occurrence for protecting rice crop from serious damage,[7] and the insect has to be controlled to a level lower than the economic injurious level. In paddy fields of tropical countries, adequate timing to control the insect can not be exactly predicted by using light traps[7] as far as a number of experiments so far conducted are concerned.

Therefore, studies to clarify the relationship between growth stage of rice plants and insect damage[6] were conducted and it was found out that the susceptible stage of rice plants was within 30 days after transplanting in varieties non-sensitive to photoperiod.[7] During this period, the insect population remarkably increased. Therefore the vegetative growth stage of rice plants is suggested an important period to take action for control measures.[5,6]

In the field condition, the timing for checking damaged tillers caused by the insect is recommended to be 14 and 28 days after transplanting.[7] Such an early monitoring of damaged tillers caused by the insect in paddy fields is the most important activity of pest observers in the extension services.[7] For checking damaged tillers in paddy fields, a total of 48 hills (16 hills with 3 replicates) are sampled at random for each checking site. Then, the number of galls and healthy tillers is carefully counted. For further checking, all of the growing points of the tillers collected are dissected for counting the number of larvae and pupae of the insect. Each checking site is able to cover 5 ha of paddy fields.

Damaged tillers and injurious level

There are 2 kinds of evaluating methods for insect damage: a) Damaged tillers identified by visible galls from outside are counted and expressed by percentage by the following formula:

$$\frac{\text{Number of galls}}{\text{Total number of galls and healthy tillers}} \times 100$$

b) After dissection of growing points of tillers, damaged tillers are identified by the presence of larvae and pupae of the insect, and calculated as follows:

$$\frac{\text{Number of larvae, pupae, and galls from which adults emerged}}{\text{Total number of healthy tillers, larvae, pupae and galls}} \times 100$$

Based on the relationship obtained between the injurious level and rice yields, it can be said that when damaged tillers reached more than 5% by the a) calculating method, the control measures are immediately needed. When damaged tillers are over 10% by the b) method, a control action has to be taken as early as possible. It must be emphasized that control measures have to be taken in an early stage of growth of rice plants, at least within 30 days after transplanting.

Insecticidal control

Insecticidal applicatin is recommended as follows. Timing of insecticidal applications is 14 and 28 days after transplanting at the rate of 1.0 kg of active ingradient per ha when damaged tillers (%) are over the injurious level. (Fig. 1) Effective insecticides are known to be carbofuran 3% and ekalux

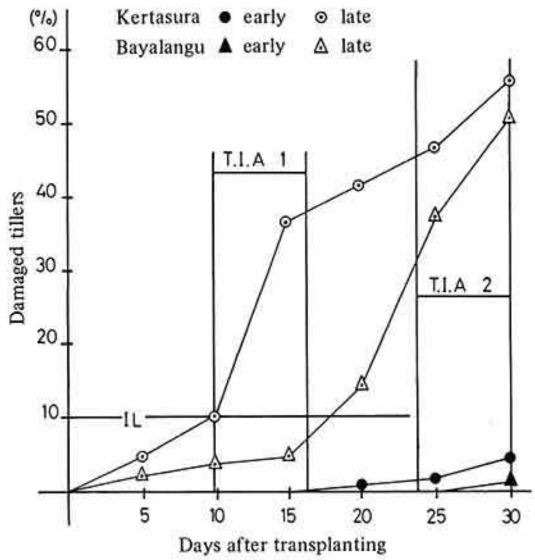

Fig. 1. Damaged tillers caused by the rice gall midge in early-transplanted rice and late-transplanted rice, an economic injury level (IL), and time of insecticidal application (T.I.A) in Cirebon, west Java (the wet season 1981/1982)
Early and late at Kertasura and Bayalangu represent early-transplating (December 1981) and late-transplanting (January 1982).

5% of granules. The following formulae of insecticides i.e. powder, emulsified concentration, and liquid are not effective in paddy fields. Insecticides must be systemic to kill larvae in the growing points of rice plants. It can be said that insect control by the insecticides is not necessary after panicle primordium formation of rice plants,[5] because insect population remarkably decreases due to lack of vegetative growing points. In other words, larvae of the rice gall midge can not grow in panicle primordia. Preventive control for the insect is strongly recommended to achieve effective population depression.

On the other hand, insecticidal control is also needed in seedling-beds[11] in the endemic areas of the rice gall midge. Insecticidal application to seedling-beds is made 10 days before pulling out of seedlings at the rate of 0.5 (A.I.) kg per ha. In general, these granule insecticides exert their effectiveness for a period of 14 to 20 days after application.

Cultural practice

The rice gall midge is known to be a serious rice pest in the wet season, while the insect infestation in the dry season is extremely low.[3] In lowland areas of paddy fields, the early planting (December) of rice is recommended to evade insect damage in Indonesia.[7] Serious damage is seen in rice plants transplanted in January (Fig. 1). In Cirebon District, which is one of the endemic areas of the rice gall midge in west Java the wet season rice is planted to a total of 60,000 ha. of paddy fields. Although late-planting was practiced on 70% of paddy fields before 1982, early planting of rice was recommended in 95% of paddy fields in 1983, resulting in low infestation.[7] As 5% of paddy fields are distributed in flooding areas, the early planting can not be done there. The reason why the insect damage is low in the early planting is considered attributable to low population of the insect which was strongly depressed by the long drought from September to the beginning of November. However, in the late planting, the insect raised in rice plants already planted in December starts to gregariously attack the young rice crop transplanted in January. Then, the population of the rice gall midge is remarkably built up, whereas parasites and predators are maintained at a low level during the vegetative growth period of rice plants.

Natural enemies in relation to cultural practice

In highland areas in west Java of Indonesia, consecutive planting of rice is seen throughout a year.[7] In general, 5 crops per 2 years are observed. Local varieties non-sensitive to photoperiod are mainly planted.

In the consecutive planting areas, infestation by the rice gall midge is very low due to high activities of parasites and predators which are *Platygaster oryzae*, egg-larval parasite, *Neanastathus oryzae*, larval parasite, and *Amblyseius imbricatus*, egg predator.[7,8] Population balance between the rice gall midge and the natural enemies was clarified to be kept in good condition throughout the year (Fig. 2).

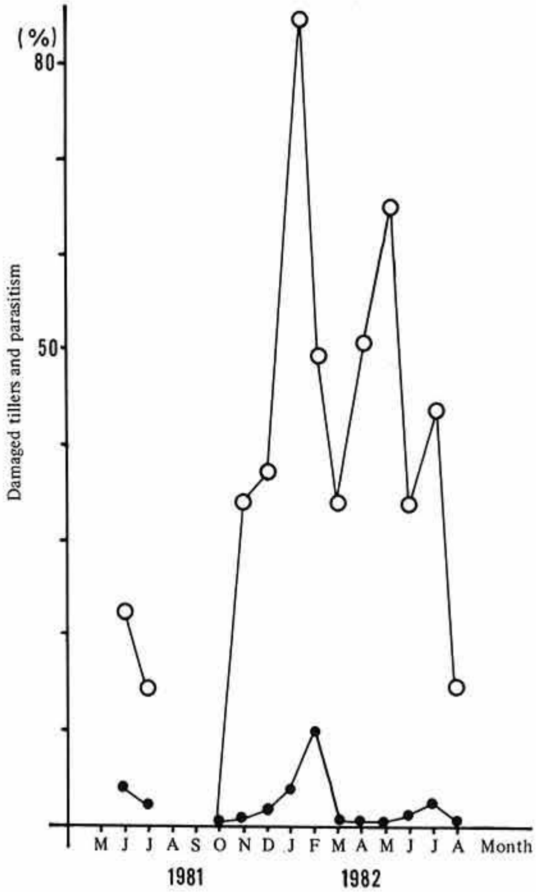

Fig. 2. Damaged tillers caused by the rice gall midge and parasitism of the hymenopterous parasites at Caringin in Bogor, west Java, Indonesia
—●— Damaged tillers, —○— Parasitism

Therefore, in highland areas, biological control is more important than insecticidal control. The insect damage is usually less than 5% even in the wet season.

It is also noteworthy that *Platygaster oryzae* has an alternate host of *Orseoliella sp.*[7] which occurs on *Imperata cylindrica* abundantly growing around paddy fields. During the fallow season, *Platygaster oryzae* attacks mainly the alternate host. However, the parasite starts to attack the rice gall midge after transplanting of rice. *Orseoliella* sp. has an important role as an origin of the parasite occurrence.

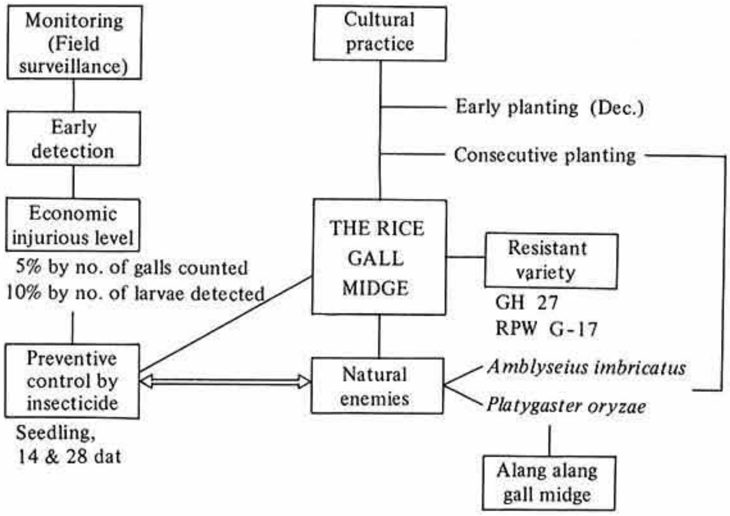

Fig. 3. Strategy of the rice gall midge control

Utilization of resistant varieties

Promising varieties resistant to the rice gall midge were established in Thailand[5,12] (RD 4, RD 7 etc.), and India[3,9] (Shakti, Ptb 18, Leuang 152, Warangal 1263), where some of resistant varieties are utilized in paddy fields for practical control. In Indonesia, although a variety, GH 27[7] was recorded as resistant to the insect, the variety can not be utilized because it is susceptible to the brown plant-hopper. On the other hand, the varieties resistant to the brown planthopper which are being used in huge areas in Indonesia are almost susceptible to the rice gall midge. Multiple resistant varieties are expected to be established in the near future to control the key pests of rice plants.

It is interesting to note that biotypes of the rice gall midge were found in the international nursery test, which was carried out by the cooperation among IRRI, tropical Asian countries, and gall midge occurring countries of Africa. In Thailand, a different level of infestation was found between a variety, Muey Nawng 62M growing in the north region and the same variety growing in the north-east region. Resistant varieties to each biotype of the insect must be established to solve biotype problems, although the mechanism of the occurrence of biotypes is not clarified yet.

Discussion

As shown in Fig. 3, the strategy of the rice gall midge control is very much diversified; different techniques for the insect control have to be applied in relation to the environments of the rice gall midge occurrence. The insect control is achieved not only by insecticidal application, but also by the combination with biological and cultural controls. At first, the monitoring by pest observers within 30 days after transplanting is the most important task to be taken in order to manage the insect pest under an economic injurious level. Environments which protect natural enemies in or around paddy fields should be created to promote activities of biological control agents.

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