Control Measures Of Rice Gall Midge

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Abstract
The rice gall midge is a destructive insect pest of rice. It causes a great loss in the yield of rice. The symptoms of damage caused by gall midge include the feeding of maggot at the base of shoot and the formation of "onion leaf" or "silver shoot", these are white hollow tube gall formation caused by the larvae. Panicles could not be produced by the infested tillers. Many different gall midge biotypes or populations were being observed. Some of the efforts of depressing the insect populations include forecasting of insect occurrence, controlling by insecticides, cultural practice, controlling biologically, and the use of gall midge resistant rice varieties. Molecular markers are being used for analysing the diversity of rice gall midge diversity and genes which are resistant to rice gall midge were being identified.

Keywords: control measures, loss yield, tube gall, resistant gene, rice gall midge

INTRODUCTION

Orseolia oryxae, Asian rice gall midge (Wood-Mason) is an insect pest belongs to the Cecidomyiidae family and Cecidomyiinae sub-family. It is an important pest in the tropical Asia attacking rice plants [1]. This is found to be distributed in Thailand, Cambodia, Vietnam, Burma, southern China, Bangladesh, Sri Lanka, Indonesia, Laos and India [2, 3]. It infests the rice seriously in many of the countries of Asia [3, 4]. Rice gall midge is a major pest causing 10 -100 percent crop damages in India [5]. *Orseolia oryxae* infestation caused an annual yield loss of grains of around 4,77, 00 tons according to the reports from eastern and southern parts of India reporting an economic loss of eighty million US$ [6, 7]. Asian rice gall midge is being reported almost from all the states of India except some few [8]. The main symptoms of rice infected by rice gall midge showed the silvery white hollow tube gall i.e., silver shoot formation. It caused a grain yield loss of more than 60 percent [1]. There is no formation of panicles when the rice plant is seriously infected.

In 1880, the insect pest, gall midge was reported to be a major rice pest in India [3]. The study on gall midge of rice has been reported giving focusing on the control measures of insects, taking insecticidal application into account especially [9]. and the utilization of rice varieties resistant to gall midge [10]. The larvae remain safe inside the tube gall, so gall midge is difficult to be controlled chemically. One major way for controlling rice gall midge infestation is the cultivation of resistant rice varieties [11]. However, many different gall midge biotypes or populations were found to be obtained after the utilization of rice varieties which are resistant to gall midge [12, 13, 14, 15, 16, 17]. There were many reports on the coming up of new rice gall midge virulent populations from India [4]. Many molecular markers as for example RAPD, SCAR and RFLP are being used for studying the diversity of rice gall midge [18, 19]. and microsatellite-based studies were also done showing polymorphism [20]. A new resistance gene namely *gm12* of rice gall midge was characterized on the chromosome 2 of rice in MN62M which is a rice landrace of Thai [21]. The present review paper presented the control measures of rice gall midge and genic molecular studies of rice gall midge.

DESCRIPTION OF RICE GALL MIDGE

Orseolia oryxae (rice gall midge) is an insect pest of paddy and it is a small fly. It is a major pest in tropical Asia attacking the rice plants in the fields. It belongs to Cecidomyiidae family, Cecidomyiinae sub-family and Diptera order. The body of gall midge is characterized by beaded, short-haired wings with few veins and have antennae which are somewhat hairy. Their larvae are brightly coloured and the larvae live on leaves and flowers and caused galls (tissue swelling) formation. The adult rice gall midge is nocturnal. During night time, orange coloured fly like mosquito is observed to be active. They have wing, in females the wings are 3.5 to 4 mm and in males, the wings are 3 to 3.3 mm wingspan [7]. Females are of bright red colour and stout abdomen. Males are with dark abdomen. After few hours of copulation, oviposition begins to start and can lay around 100 to 300 near the plant base, may be on the ligules or near the leaf blade or may be on the leaf sheath [7]. Eggs are tubular elongated. They are shiny white colour with pinkish, red or yellow shading and become shining amber colour before hatching. After three to four days of incubation, there is the formation of larvae. The size of freshly hatched larvae is around one mm. They crawl down along the sheath of the leaf till they meet the growing point

of the tiller. Then the larvae land up on the bud interior and begin to feed inside the developing duds. This leads to the formation of tubular gall which resembles like the onion leaf. The larvae continue feeding until pupation. The pupation occurs near the base after 15 to 20 days of larval period. An adult gall midge will be formed after 2 to 8 days of pupal period.

SYMPTOMS OF RICE GALL MIDGE INFESTATION

The symptoms of damage caused by gall midge include the feeding of maggot at the base of shoot. And then, the formation of "onion leaf" or "silver shoot", these are white hollow tube gall formation caused by the larvae. Panicles cannot be produced by the infested tillers and thus, causing the loss in yield.

MANAGEMENT OF RICE GALL MIDGE

Early planting of the rice crop and fast-growing varieties should be chosen to escape from infestation. Using of resistant varieties should be encouraged. Examples of resistant varieties are Shakti, R 650-1820, Orugallu, Kavya, Erra mallelu, Shrakasha, Rajendran, Asha, Shamlei, Kunti, Phalguna, Lakshmi, Dhanaya, kkatiya, IR 36, Sureka, Vikarm, and MDU-3 [22]. Immediate ploughing of the fields just after the harvest and removal of the alternate host should be done. Application of fertilizers should be in a balanced manner and optimum amount of potash fertilizer is recommended. Setting up of infra-red light as this light can trap gall midge. Predatory spider such as *Tetragnatha*, *Argiope catenulate* and carabid beetle, *Ophionia indica* are to be conserved in the rice ecosystem. And spraying of insecticide can also be done. Release of *Platygaster oryzae* parasitised galls can be performed at 1 per 10 square meter in the field at 10 days after transplanting [23]. The controlling techniques of the insect are complicated because insects occur under different environments, lowland paddy fields, highland paddy fields, different timing of planting the rice, and wet season and dry season, etc [1]. Many efforts were made to depress the population of the insects. Some of the ways of depressing the insect populations include forecasting of insect occurrence [24], controlling by insecticides [3, 9, 24], cultural practice [26, 27], controlling biologically [24, 27], and the use of resistant varieties [10, 28, 29].

Studying the occurrence of rice gall midge

Firstly, for the management of insect, to have better knowledge on the occurrence of insect is important for the protection of rice crop from serious damage [3]. The controlling of the insects has to be done in such a manner that the economic injuries caused by adopting the method has to be at the lower level. The adequate time for controlling the insect cannot be exactly predicted by the use of light traps in the tropical countries rice fields [24]. Studies to understand relationship of the growing stage of rice plants and damage caused by insects' relationship and the studies for understanding the connection of the growing stage of rice and damage were performed and susceptible stage of rice plant was found to be within thirty days after transplantation in those varieties which are not sensitive to photo-period fields [24]. During this timing, the population of insect drastically increased. Thus, the period of vegetatively growing stage of rice plants is the important timing for engaging the control measure [2,3]. 14 and 28 days after transplantation is the recommended timing of checking the damaged tillers which is caused by the insect [24]. And the checking of damaged tillers at the early stage in the rice fields is the most important step [24].

The damaged tillers in paddy fields are to be monitored. Galls number and healthy tillers number are carefully counted. Further monitoring should be done, growing points of all tillers are checked and collected. The collected tillers are dissected and the number of insect larvae and pupae are counted. Two methods of evaluating insect damage are there [1]. They are i) identification of the damaged tillers by visible galls and counted and presented in percentage. The percentage calculation can be done by dividing the galls number by the total number of galls and healthy tiller and multiply by 100. ii) The tillers are cut and identification of damaged tillers are done by checking the larvae and pupae and calculation is done by dividing the number of pupae, larvae and galls [1]. By taking into account the correlation of level of injuries level and the yield of rice grain, if the destroyed tillers are greater than five percent by taking i) technique, it can be concluded that control measures are needed immediately [1]. And if the percentage of destroyed tillers are more than ten percent by taking ii) technique then the control measure should be given at the earliest possible. Control measures are to be given at least within 30 days after transplantation i.e., at an early stage of the rice plants growth [1].

Control measure by using insecticides

For an effective population depression of insects, preventive control is strongly recommended. Spraying of insecticides is a control measure of the insects. Name of the insecticides are phosalone, carbosulfan, chlorpyriphos, fipronil and thiamethoxam. Any one of these insecticides can be sprayed. Insecticide applications timing is fourteen and twenty-eight days after transplantation. It is done one kilogram of ingredient which is active per hectare when the percentage of spoiled tillers are more than the level of injuries [1]. Some of the effective insecticides are carbofuran 3 percent and ekalux 5 percent of granules. Effective insecticides are known to be carbofuran 3% and ekalux5% of granules. Application of insecticides should be in systemic way that the insecticides can kill the larvae. After the formation of panicle primordium of rice plants, the controlling of insects is not necessary [2]. This is because the population of the insect drastically decrease as there is lack of vegetative growing points. Control measure by using insecticides is also important in the seedling beds where gall midge is endemic (Misra et al., 1981). Application of insecticides to seedling beds is done 10 days before pulling out of seedlings and the insecticides granule show their effectiveness for 14 - 20 days after applying [1].

Control measure by cultural practice

Early planting of the rice crop and fast-growing varieties should be chosen. The rice gall midge is serious during wet season. Whereas in dry season insect infestation is quite low. In the paddy fields of lowland areas, early planting should be done to avoid insect damage in Indonesia [2]. In early planting, insect damage is low as the insect population is low because of the long drought from September to November [1]. Immediate ploughing of the fields just after the harvest and removal of the alternate host should be done. Application of fertilizers should be in a balanced manner and optimum amount of potash fertilizer is recommended. Setting up of infra-red light as this light can trap gall midge.

Natural enemies are to be used in association to cultural practice. The highland areas of Indonesia that is west Java are growing rice consecutively throughout the year [24]. Five crops per two years are grown and the local varieties which are not sensitive to photoperiod are grown [1]. Release of *Platygaster oryzae* parasitised galls can be performed at 1 per 10 square meter in the field at 10 days after transplanting. Predatory spider such as *Tetragnatha*, *Argiope catenulate* and carabid beetle, *Ophionia indica* are to be conserved in the ecosystem of rice. Gall midge infestation in rice plants is quite low in areas where continuous planting is done. This is because of parasites and predators are active in these areas. Some examples of the parasites and predators are *Amblyseius imbricatus*, egg predator, *Platygaster oryzae* (the egg larva parasite) and *Neanastathus oryzae* (larva parasite) [24, 27]. Throughout the year, a balance in the population between gall midge and nature enemies is to keep on maintaining in good context. Hence, biological control is more important and preferred over than control by insecticides. In wet season, damage caused by insects is less than 5 percent.

Use of resistant varieties

The developing gall midge resistant varieties is believed to be the most effective and economical aspect in keeping the stability of the grain yield. Promising rice varieties which are resistant to rice gall midge were established and are encouraged to be cultivated in paddy fields for practical control. The resistant varieties are Shakti, R 650-1820, Orugallu, Kavya, Erra mallelu, Shrakasha, Rajendran, Asha, Shamlei, Kunti, Phalguna, Lakshmi, Dhanaya, kkatiya, IR 36, Sureka, Vikarm, and MDU-3 [22].

Gall midge resistant rice varieties were established in Thailand namely RD 4, RD 7, etc. [2, 30] and in India namely Warangal 1263, Shakti, Ptb 18 and Leuang 152 [10, 29]. A variety in Indonesia namely GH 2771 was recorded to be resistant to gall midge however, it was found to be susceptive to brown planthopper and thus, this variety cannot be used [1]. And the rice varieties which are resistant to brown planthopper are found to be almost susceptible to gall midge of rice [1]. Therefore, multiple resistant rice varieties are suggested to be developed for controlling pests in the rice fields. Rice variety namely Muey Nawng 62M was grown in north and north east region of Thailand and an interesting result was observed, different level of insect infestation was reported in the two regions by growing the same variety [1].

GENIC MOLECULAR ANALYSIS ON THE RICE GALL MIDGE RESISTANT GENE

Establishment of varieties which are resistant to each biotype of the insect is suggested for solving the biotype problems. For developing rice varieties which have multiple resistant MAS for pyramiding the genes can be used. There is the need for identifying and characterizing the resistance genes of rice gall midge. The identified genes will be helpful in molecular breeding in pyramiding the resistant gene for the development of durable rice gall midge resistance variety. So far, eleven genes resistant to gall midge have been identified in rice [31]. Mohapatra et al. [31] performed molecular screening of forty-eight rice genotypes by using the linked markers for (*Gm4*) gall midge resistance gene and their results obtained that out of the forty-eight, seven genotypes showed high level of resistance to gall midge. Katiyar et al. [19] assessed diversity of Asian rice gall midge, *Orseolia oryzae* using AFLP marker by taking samples (larvae and pupae) from 15 locations of 5 Asian countries namely Guangdong province of southern China, Laos, India (Imphal, Madhya Pradesh, Assam, Orissa, Kerala, and Andhra Pradesh), Nepal and Sri Lanka. They obtained many biotypes of rice gall midge. Leelagud et al. [21] utilized mtCOI in studying the diversity of Thai rice gall midge populations. The phylogenetic tree deducted during their study showed a homogeneous distribution of the rice gall midge populations. Rice varieties having different types of resistance genes showed many biotypes of gall midge of rice in Thailand. The rice landrace MN62M of Thai was observed to be resistant to rice gall midge populations which were undertaken during their study. A cross was made taking KDML105 (cultivar which is susceptive) and MN62M (cultivar which is resistant to gall midge of rice). A novel genetic locus was obtained by using linkage study in a number of 144 F2 plants using SNP markers & F2:3 phenotype. A new resistance gene namely gm12 of rice gall midge was characterized on the chromosome 2 of rice in MN62M (a Thai rice landrace) [21]. They obtained DNA markers which can be used for marker assistant selection for developing cultivars having braod spectrum resistance rice gall midge. They also reported that the information on resistance genes give important knowledge in identifying rice gall midge biotypes in Southeast Asia and Thailand.

Marker-trait relationship of association for gall midge resistance has been reported [32]. A diverse population of rice was undertaken for the discovery of resistant genomic region or genes to gall midge Sahu et al. [32]. The marker, *gm3del3* was found to contribute the most genetic variation during their study. The damage brought about by gall midge is more common in India where growing of rice is commonly done such as the states of South and the North East India. For the development of resistant cultivar, resistant genes are needed to be characterized in the source population

Conclusion

The gall midge of rice plants is destructive pest and it causes a great loss in yield of rice. Many control measures are being employed for managing the rice gall midge. Some of the control measures are using insecticides and adopting of biological control. However, there is case of arising many biotypes. Therefore, establishment of varieties which are resistant to the different biotype is suggested for solving the biotype problems. Development of multiple resistant rice varieties should be encouraged. Identification of genes resistant rice gall midge will be helpful in developing promising multiple resistant rice varieties for the management of the pest maintaining the yield stability.

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