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The egg parasitoids, *Trichogramma japonicum and Telenomus dignus*, seem to have doubtful impact on the regulation of rice yellow stem borer, *Scirpophaga incertulas* – It is time for a reality check

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Abstract

The egg parasitoids, *Trichogramma japonicum* and *Telenomus dignus*, generally record a high rate of parasitism of egg masses, often 100%, but critical studies in India revealed that these, either alone or in combination, parasitized only up to 60% of the eggs in an egg mass, allowing the remaining 40% to hatch and cause potential damage. It is so because they could parasitize only those eggs that are laid on the upper surface and cannot reach out and parasitize eggs laid at the bottom layer. As a result of this inherent limitation resulting in partial parasitism of egg masses, these parasitoids, either by way of natural parasitism or artificial releases even in high numbers, seem to have a doubtful impact on the regulation of rice yellow stem borer (YSB), *Scirpophaga incertulas*. *Tetrastichus schoenobii* is also a common parasitoid of YSB, but it appears very late in the field and remains active only for a short period which greatly reduces its importance unless manipulated as suggested. It is time for a reality check and to be pragmatic in our approach in utilizing these parasitoids.

Introduction

Three hymenopterans, *Telenomus dignus* (Gahan) (Scelionidae), *Trichogramma japonicum* Ashmead (Trichogrammatidae) and *Tetrastichus shoenobii* Ferriere (Eulophidae), have been found to be the most common egg parasitoids of the rice yellow stem borer (YSB), *Scirpophaga incertulas* (Walker) (Lepidoptera, Pyralidae), in India for decades. Detailed studies carried out in rice fields located in the campus of the Regional Research Station, University of Agricultural Sciences (Bangalore), V. C. Farm, Mandya (Karnataka), revealed that they parasitize the egg masses mostly alone, but also in combinations. Of the three, *T. dignus* alone accounted for 33.97 % parasitism of the 'egg masses' followed by 32.03 % by *T. shoenobii* and 8.03 % by *T. japonicum*. When a single egg mass was parasitized by more than one species, such combinations accounted for 11.2 % parasitism by *Telenomus* and *Trichogramma*, 4.5 % by *Telenomus* and *Tetrastichus*, 7.2 % by *Trichogramma* and *Tetrastichus*, and 3.05 % by *Telenomus*, *Trichogramma* and *Tetrastichus*. The overall parasitism of 'egg

masses' generally remained high, often 100 %, with an average of 81.3 %, giving an impression that these parasitoids contributed significantly towards the control of YSB. However, critical studies between the level of parasitism of the 'egg masses' and 'eggs in egg masses' revealed that the realities are contrary to this general belief and, therefore, it was advised not to use them, especially *T. japonicum* and *T. dignus*, in augmentative biological control (Manjunath, 1990). Despite, these parasitoids, *T. japonicum* continues to be recommended for mass releases for control of *S. incertulas*. The merit of this approach is discussed.

Parasitism of 'egg masses' vis-à-vis 'eggs in egg masses'

In the first place, it should be realized that there is a significant difference between the parasitism of 'egg masses' and 'individual eggs in egg masses.'

The yellow stem borer, *S. incertulas*, lays its eggs in masses. Studies on samples of more than hundred egg masses revealed that the number of eggs laid in an egg mass was up to 162 with an average of 46. These eggs are laid in layers one above the other and then fully covered with a protective mat of light brown hairs. Thus, an egg mass looks compact.

Critical studies revealed that both *Telenomus* and *Trichogramma* parasitized only up to 60% of the eggs in 'egg masses,' allowing the remaining 40 % to hatch and cause potential crop damage. It is so because they could parasitize only those eggs that are laid on the upper surface and cannot reach out and parasitize those eggs that are laid at the bottom layer, thereby resulting in partial parasitism. This inherent limitation greatly reduces their efficacy in controlling the stem borer. Further, even if an egg mass is not parasitized and all the eggs hatch, the natural survival rate of YSB larvae is very low, 5 to 10 %. It is indicated by the fact that the numbers of 'dead hearts' (in the vegetative stage) or 'whiteheads' (in the reproductive stage) encountered in infested spots in rice fields are hardly a few, otherwise, there should have been many more such affected plants. Such high mortality is because in the case of rice yellow stem borer, only one larva can successfully develop per tiller and, therefore, even if several larvae enter a plant, they die due to competition. Another factor is that upon hatching when the larvae try to disperse to the neighbouring plants, they become very vulnerable and are preyed upon by predators, especially spiders. Thus, with or without parasitization of egg masses, the early survival is very low. These factors have not been generally realized while assessing the efficacy of egg parasitoids.

In the case of *Tetrastictus*, its larvae being parasitoid-cum-predator, all the 'eggs' in an 'egg mass' were devoured, thus appearing to be very effective. Although seemingly so, the problem is that it appeared very late in the season almost coinciding with the panicle

initiation stage of the crop and thus, by the time it commenced its activity in the field, the pest would have already caused the damage thereby reducing its importance.

Discussion and conclusions

Having lived on the campus of Regional Research Station of UAS-B, V.C. Farm, Mandya, Karnataka, India surrounded by rice fields and spending a considerable amount of time in the fields for several years, closely studying various rice pests (yellow stem borer, brown plant hopper, leaf roller, caseworm, whorl maggot, etc.) biological control was of special interest. After making the above-mentioned detailed studies on the egg parasitoids in the fields and laboratory, it can be categorically stated: "Thus, considering their prevailing limitations, all the three species of parasitoids, *T. dignus*, *T. japonicum* and *T. schoenobii*, either alone or in combinations, do not play any significant role in controlling rice yellow stem borer in India. This aspect is overlooked as one is generally swayed by the high level of parasitism of 'egg masses' without realizing that parasitism of 'eggs in egg masses' is more critical. Therefore, mass-breeding and releasing of these egg parasitoids, especially *T. japonicum* and/or *T. dignus*, for management of *S. incertulas* does not serve the purpose" (Manjunath, 1990).

Despite these findings several decades ago, it is surprising that not only the practice of artificial releases of *T. japonicum* is recommended and continued, but also even success claimed with the control of YSB. In the last two to three decades, several studies were carried out on the egg parasitoids of YSB and papers published, both in India and other countries. Almost all of them concentrated on the parasitism of 'egg masses.' Sharmitha *et al.* (2020) stated "A maximum of 93.33 % of natural parasitism of the egg mass of yellow stem borer was observed, which managed the pest in the egg stage itself" although they also found that the parasitism of egg masses, either alone or in combinations, was partial. Their data also confirmed that the pattern of parasitism by these parasitoids was more or less similar to an earlier report (Manjunath, 1990) and that it has not changed over the last 3-4 decades. There have been several efforts in different parts of India wherein large-scale releases of *T. japonicum* were made ranging from 100,000 to 300,000 parasitoids/ha in one or more batches, and successful control of YSB has been claimed. Such conclusion was based indirectly upon the number of dead hearts or whiteheads found in the experimental fields and also yields obtained (Riba and Sarma, 2006, Karthikeyan *et al*, 2007, Murali Baskaran *et al.*, 2021, Deshpande *et al.*, 2023). Since these releases were made specifically to control the pest in its egg stage, data on the direct impact of parasitism on hatchability would have been more relevant and dependable as reduction in crop damage could have been due to other factors as well. In a study carried out in China, Tang *et al*. (2017) found that even after making large releases of

T. japonicum @ 50,000/ha, 100,000/ha and 200,000/ha, there was no increase in parasitism as "only a relatively small fraction of eggs was successfully parasitized. No clear conclusion could be drawn on the most efficient release rate as no significant differences were found among the three release rates." As explained, releases in any quantity would not make any impact. As stated, it makes a huge difference between the level of parasitism of 'egg masses' and 'parasitism of eggs in egg masses.' The researchers will have to bear this in mind while evaluating the parasitoids of egg masses, not only of YSB but also of other pests. It is time to be more practical in our approach towards such biological control.

As *T. schoenobii* can destroy all the 'eggs' in an 'egg mass' and it's only limitation being that it starts its activity late in the season, introduction of an exotic strain with prolonged period of activity may be worth exploring - Sri Lanka and Sarawak (Malaysia) could be the potential source (Manjunath, 2020). Another interesting area of research is that since *T. schoenobii* appears in rice field to coincide with the panicle initiation, to find out whether the crop at this stage produces any odour or kairomone that attracts this parasitoid. If so, it may be worthwhile, synthesizing this kairomone and applying it in the field when the crop is young to see whether it can trigger the early activity of *T. schoenobii.* Collaborative research would be helpful in such endeavours. For more data and other details, the references cited here and also the cross references mentioned therein may be consulted. The conclusion is that as per the prevailing conditions, the natural parasitism by, or artificial releases of *T. japonicum* and/or *T. dignus,* seem to have a doubtful impact on the regulation of the rice yellow stem borer owing to their inherent limitations. It is time for a reality check and to be pragmatic in our approach in this regard. The scope for improving the efficacy of *T. schoenobii* is thus indicated.

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