Rice Stem Borer, *Scirpophaga incertulas* (yellow rice stem borer) Sustainable Control Strategies in Asia

Insecticide Resistance Action Committee

www.irac-online.org

Introduction and Biological Background

The yellow stem borer (YSB), *Scirpophaga incertulas* (Walker), infests rice plants from the seedling stage through maturity. It is found in aquatic environments where there is continuous flooding. The yellow stem borer is regarded as monophagous with exclusive host specificity to rice. The number of generations in a year can vary from 2 to 6, depending on the ecological conditions and the availability of rice plants. The life cycle of the yellow stem borer consists of four stages: egg, larva, pupa and adult. The total duration of the life cycle (egg-adult) can vary between 32 to 45 days depending on temperature (Manikandan et al., 2013). Female moths lay eggs in masses of 100 to 200 eggs near the tip of leaf blades. Eggs hatch in 6 to 8 days under warm conditions. The larva is the damaging stage and undergoes six instars in 21 to 29 days. Pupation takes place inside the stem, usually in the lowest node of the plant or just above the water level. The pupal period lasts about 5 to 7.5 days depending on temperature (Manikandan et al., 2013). The female moth is larger than the male with forewings that are bright yellowish brown with a distinct black spot in the center. Moths are active at night; a female can lay up to three egg masses during her 6-to-10-day life span.

Damage Symptoms

Vegetative stage: The initial boring and feeding by larvae in the leaf sheath cause broad, longitudinal, whitish, discolored areas at feeding sites, but rarely result in wilting and drying of the leaf blades. About a week after hatching, larvae from leaf sheaths bore into the stem to feed on the inner surface of the stem walls. Such feeding detaches 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, turns brownish and dries off, while the lower leaves remain green and healthy. This condition is known as 'dead heart' and the affected tillers dry out without bearing panicles.

Reproductive stage: After panicle initiation, detachment of the growing plant parts from the base dries the panicles, which may not emerge. Panicles that have emerged do not produce grains. Affected panicles later become clearly visible in the fields. Empty panicles remain straight and are whitish in color and are called 'whiteheads'. Panicles are detached at the base after spikelet filling, resulting in shriveled grains. Damage by rice stem borer has been attributed to an average yield loss of 30 per cent (Krishnaiah and Varma, 2015).

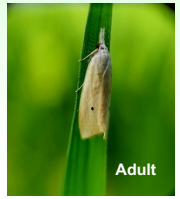
Photos courtesy of Corteva Agriscience™

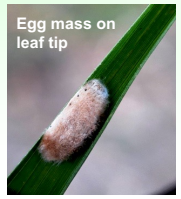
Stem Borer Management Using Insecticides

Yellow stem borer pest pressure can commonly reach economic thresholds that requires the use of insecticides to protect the rice crop. Options include systemic insecticides applied via seed treatment or as a granular formulation broadcasted into the water, as well as conventional foliar spray applications. One to two generations of YSB can occur during the vegetative stage starting in the nursery (for transplanted rice). Insecticide applications are timed to egg hatch and are made from nursery to 25 days after transplanting. Additional generations may occur during the reproductive stage (>45-55 days after transplanting) that also require protection.

Life Cycle: Adult lays eggs on leaf tips. Newly hatched larvae hang down with a silken thread and enters the stem at base, causing "Dead Heart", and/or "White ears", depending on when the damage occurs.

Photos courtesy of Corteva Agriscience™





Rice Stem Borer Spray Windows for Transplanted Rice

Phenology chart courtesy of Syngenta

Option A: Window rotations including Seed Treatment, Foliar or Granular Insecticides

Window 1	Window 2	Window 3
Nursery through ~15 days after trasnplant	>15-25 days after transplanting	>45-55 days after transplanting (panicle initiation)

Option B: Window rotations Only Foliar or granular Insecticide Applications

Window 1	Window 2
>15-25 days after transplanting	>45-55 days after transplanting (panicle initiation)

Rotate different MoA insecticides between windows of application. A MoA used in window 1 should not be used in window 2, similarly a MoA used in window 2 should not be used in window 3. Seed or water directed systemic insecticides might be stand-alone treatments early in the crop but under high pressure foliar sprays may be needed to reduce 1st generation damage. In this case all applications could be considered as window 1 treatments if targeting the same generation. Apply water directed systemic insecticides early in the pest generation to avoid residual control overlapping with the following generation.

Known Insecticide Resistance

There is very limited published literature documenting yellow stem borer resistance to insecticides (Mota-Sanchez, D. and J.C. Wise. 2023). However, it is widely known that overreliance on available insecticides have resulted in some loss of efficacy. The chemical classes and MoA insecticides listed on this table are registered for use in rice to control YSB in India (always check product label and local authorizations before use) as of this writing.

WD = Water directed
ST = Seed treatment

Application Type	IRAC Group MoA	Chemical class
WD	1A	Carbamate
WD	2B	Phenyl pyrazole
Foliar	3A	Pyrethroid
WD	4F	Pyridylidene
Foliar	5	Spinosyn
Foliar	6	Avermectin
Foliar / WD	14	Nereistoxin analogue
Foliar / WD / ST	28	Diamide
Foliar	28 + 3A	Diamide + Pyrethroid
Foliar / WD	28 + 4A	Diamide + Neonicotinoid
Foliar	30	Isoxazoline

Stem Borer Resistance Management

The following integrated Resistance Management (IRM) strategies will aid in preventing yellow stem borer from developing resistance to the currently effective insecticides used:

- Apply insecticides only when needed based on economic thresholds.
- Consult product labels or IRAC's website (www.irac-online.org) to determine the mode of action (MoA) of each product.
- Do not treat successive generations with products of the same MoA.
- Follow the "treatment windows" (TW) approach (see example on this poster).
- A TW is the period of residual activity with a single or sequential application of products with the same MoA. This TW should not exceed approximately 30 days (generally the length of one insect pest generation) but can be less, this can typically be accomplished by not exceeding two applications of products from the same MoA.
- Following this TW rotate to an approximate 30 day TW of effective insecticides with different MoAs if needed.
- Within a particular TW, insecticides with the same MoA may be applied more than one time, if the residual activity of the combined sequence of applications does not exceed the period of a single generation of the target pest (or approximately 30 days).
- Best practice for YSB is to avoid using the same MoA in two or more TW per crop cycle.
- In areas where 2-3 crops of rice are grown in a year in the same field, it is best practice to use products with a different MoA in the first TW of the subsequent crop versus what was applied in the last TW of previous crop.
- Use cultural practices such as ensuring transplants are free of egg masses, and short season varieties. Do not use excessive fertilization, plow in or flood stubble after harvest. Avoid staggered plantings.
- Usage of insecticides that have low impact on natural enemies can aid in biological control.

References:

Manikandan, N., J. S. Kennedy and V. Geethalakshm. 2013 Effect of elevated temperature on development time of rice yellow stem borer. Indian Journal of Science and Technology, Vol 6(12), 5563–5566.

Mota-Sanchez, D. and J.C. Wise. 2023. The Arthropod Pesticide Resistance Database. Michigan State University. On-line at: http://www.pesticideresistance.org

Krishnaiah, K. and Varma, NRG. 2015). Changing Insect Pest Scenario in the Rice Ecosystem - A National Perspective. Rice Knowledge Management Portal, pp. 28

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