# Effect of stem damage by *Scirpophaga incertulas* (Wlk.) on yield of deep water rice

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## ABSTRACT

*Investigation on the effect of stem damage by* Scirpophaga incertulas (Wlk.) *the yellow stem borer on yield contributing characters of 27 deep water rice cultivars indicated that the percent reduction in panicle length, number of grains panicle*$^{-1}$*, 1000 grain weight and increase in the chaffy grain percent varied between 8.21 - 16.42, 7.83 - 16.99, 9.09 - 22.57 and 8.8 - 16.5 percent, respectively in plants with stem damage over the healthy ones. Percent reduction in the indices of various yield contributing characters was at higher levels in LPR-56-49, IR-4547-212, TC-6 and Bengdang Kumini. Percent yield reduction (PYR) was lowest in NDGR - 398 followed by NDGR-410, Jalnidhi, NDGR-421, Kariawa and TCA – 4, whereas yield reduction index (YRI) and percent yield loss due to stem damage were lowest in NDGR-398 followed by TCA-4, Jalanidhi, Kariawa, NDGR-410, NDGR-421 and in the higher range in Bengdang Kumini, LPR-5649 and IR-5533-56-1-12 and the highest in susceptible check Jalamagna. The percent yield loss due to 1% damaged stem varied between 0.224 - 0.438 with an average of 0.31 as compared with 0.50 in the susceptible check Jalamagna.*

***Key words:*** *Yellow stem borer, deep water rice, damaged stem, yield parameters*

The yellow stem borer (YSB), *Scirpophaga incertulas* (Wlk.) is the most destructive and widely occurring insect pest of rice that attacks all stages of the crop (Bandong and Litsinger, 2005). It is the most abundant stem borer in tropical lowland and deep water rice (Shepard *et al*, 1995) due to its adaptive characteristics for the aquatic environment (Catling, 1980). Severe yield loss is caused by this pest both by the production of white-heads and damaged but symptom less stems at reproductive stage in deep water rice (Catling, 1992). Due to the non-feasibility of using chemical pesticides and bio-agent in this fragile ecosystem, use of resistant varieties is the only alternative available for management of this pest in this ecosystem. The present investigation was therefore, undertaken to study the effect of stem damage on yield contributing characters and extent of grain yield loss in deep water cultivars.

## MATERIALS AND METHODS

Experiments were conducted in micro-ponds under controlled conditions at Central Rice Research Institute, Cuttack (CRRI) in the wet seasons of 2003 and 2004 with a set of 27 deep water cultivars resistant/ moderately resistant to yellow stem borer (Table 1) with a spacing of 30 x 20cm and inter varietal spacing of 60cm. These cultivars were obtained by evaluating 119 deep water cultivars under field condition in deep water ecosystem of Jagatsinghpur district, Orissa and in controlled condition at CRRI, Cuttack. Recommended agronomic practices were followed and water depth up to 120cm was maintainable throughout the period of study. Each tiller of the test entry along with the susceptible check was infested with two freshly emerged YSB larvae at booting stage for evaluating the effect of stem damage on yield parameters. The micro-ponds were covered with nylon mesh throughout the period of study to prevent further infestation from other sources. The micro-ponds measured 1.0 x 1.5 mtr and the experiment was completely randomised with five replications. The extent of stem damage by

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YSB was recorded by examining the tillers of 10 apparently healthy looking hills without any visible symptoms of damage from each accession selected randomly. The tillers of such hills were dissected at grain ripening stage (2 days before harvest} to study the extent of stem damage (DS). Yield parameters e.g. panicle length, number of grains panicle $^{-1}$; % chaffy grains, 1000 grain weight, and grain yield panicle$^{-1}$ were recorded from 10 panicles each of healthy and infested plants from each of the test entries including the susceptible check. Percent reduction/increase for each of the above traits was computed by the formulae (Mohanty, 1998) as indicated below:

## RESULTS AND DISCUSSION

The results of the present investigation indicated that there was considerable reduction in panicle length (8.21 - 16.42), number of grains panicle$^{-1}$ (7.83-16.99), 1000 grain weight (9.09-22.57) and increase in the percentage of chaffy grains (8.8-16.5) in plants with damaged stem as compared to healthy plants of the respective test cultivars (Table 1). However, the corresponding % reduction in panicle length, no. of grains panicle$^{-1}$, increase in percent chaffy grains, 1000 grain weight, and yield reduction index were 20.8, 26.28, 35.0, 37.21 and 33.18, respectively in the susceptible check Jalamagna. The yield reduction indices ranged from

$$\text{Percentage reduction of panicle length (A)} = \frac{\text{Mean panicle length in healthy plants} - \text{Mean panicle length in infested plant with DS}}{\text{Mean panicle length in healthy plants}} \times 100$$

$$\text{Percentage reduction of number of grains/panicle (B)} = \frac{\text{Mean number of grains}^{-1}\text{ in healthy plants} - \text{Mean number of panicle grains}^{-1}\text{ in infested plants}}{\text{Mean number of grains}^{-1}\text{ in healthy plants}} \times 100$$

$$\text{Percentage reduction of 1000 grain weight (C)} = \frac{\text{Mean weight of 1000 grains obtained from healthy plants} - \text{Mean weight of 1000 grains obtained from infested plants}}{\text{Mean weight of 1000 grains obtained from healthy plants}} \times 100$$

$$\text{Percentage increase of Chaffy grains (D)} = \frac{\text{Mean \% chaffy grains in panicles obtained from infested plants} - \text{Mean\% chaffy grains in panicle obtained from healthy plants}}{\text{Mean \% chaffy grains in panicles obtained from healthy plants}} \times 100$$

$$\text{Yield reduction index (YRI)} = \frac{A+B+C+D}{4}$$

$$\text{Percent yield reduction (PYR)} = \frac{\text{Mean grain yield Panicle}^{-1}\text{ obtained from healthy plants} - \text{Mean grain yield panicle}^{-1}\text{ obtained from infested plants}}{\text{Mean grain yield panicle}^{-1}\text{ obtained from healthy plants}} \times 100$$

$$\text{Percent yield loss due to stem damage} = \frac{\text{\% Damaged stem (DS)} \times \text{PYR}}{100}$$

**Table 1. Effect of stem damage by *Scirpophaga incertulas* (Wlk.) on yield contributing characters of deep water rice cultivars**

| Cultivar | Panicle length (cm) | | | No. of grains/panicle | | | (%) Chaffy grains | | | 1000 grain wt(g) | | | Grain yield/panicle (g) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Healthy | Infested | % reduction | Healthy | Infested | % reduction | Healthy | Infested | % increase | Healthy | Infested | % reduction | Healthy | Infested | % reduction |
| LPR-85 | 27.3 | 24.0 | 12.09 (20.35) | 166 | 144 | 13.25 (21.35) | 26.3 | 39.7 | 13.4 (21.47) | 25.8 | 22.1 | 14.34 (22.25) | 2.88 | 1.93 | 32.99 (35.06) |
| LPR-8 | 27.2 | 24.1 | 11.40 (19.73) | 178 | 158 | 11.24 (19.59) | 22.7 | 34.0 | 11.3 (19.64) | 27.0 | 23.9 | 11.48 (19.81) | 2.93 | 2.08 | 29.01 (32.63) |
| LPR-56-49 | 26.8 | 22.4 | 16.42 (23.90) | 153 | 127 | 16.99 (24.34) | 27.6 | 45.1 | 17.5 (24.73) | 24.4 | 20.1 | 17.62 (24.82) | 2.58 | 1.45 | 43.8 (41.44) |
| RDA-16-6 | 27.8 | 24.0 | 13.67 (21.70) | 165 | 142 | 13.94 (21.92) | 20.4 | 36.2 | 15.8 (23.42) | 28.1 | 23.8 | 15.30 (23.03) | 2.51 | 1.66 | 33.86 (35.58) |
| Kariawa | 28.0 | 26.3 | 8.21 (16.65) | 168 | 150 | 10.71 (19.10) | 20.1 | 30.4 | 10.3 (18.72) | 28.5 | 25.3 | 11.23 (19.58) | 2.65 | 1.97 | 26.79 (31.17) |
| NDGR-151 | 27.5 | 24.2 | 12.0 (20.27) | 151 | 129 | 14.57 (22.44) | 25.2 | 39.4 | 14.2 (22.14) | 25.3 | 21.7 | 14.23 (22.16) | 2.47 | 1.72 | 30.36 (33.44) |
| NDGR-421 | 28.2 | 25.5 | 9.57 (18.02) | 172 | 154 | 10.47 (18.88) | 18.5 | 29.7 | 11.2 (19.55) | 28.6 | 25.2 | 11.89 (20.17) | 2.77 | 2.05 | 25.99 (30.65) |
| TC-6 | 27.7 | 23.9 | 13.72 (21.74) | 164 | 138 | 15.85 (23.46) | 21.1 | 36.6 | 15.5 (23.18) | 27.8 | 23.6 | 15.11 (22.87) | 2.61 | 1.63 | 37.55 (37.79) |
| CN-579-363-3-1 | 27.6 | 24.9 | 9.78 (18.22) | 167 | 146 | 12.57 (20.77) | 21.8 | 32.3 | 10.5 (18.91) | 26.9 | 23.5 | 12.64 (20.83) | 2.50 | 7.79 | 28.4 (32.20) |
| IET-10003 | 28.3 | 24.8 | 12.37 (20.59) | 158 | 135 | 14.56 (22.43) | 24.3 | 37.7 | 13.4 (21.47) | 25.7 | 22.0 | 14.40 (22.30) | 2.52 | 1.73 | 31.35 (34.05) |
| IET-10084 | 27.9 | 24.8 | 11.11 (19.47) | 167 | 149 | 10.78 (19.17) | 23.1 | 34.7 | 11.6 (19.91) | 25.3 | 22.5 | 11.07 (19.43) | 2.48 | 1.80 | 27.42 (31.58) |
| IET-10027 | 28.1 | 24.5 | 12.81 (20.97) | 165 | 143 | 13.33 (21.41) | 21.9 | 35.3 | 13.4 (21.47) | 25.8 | 21.6 | 16.28 (23.80) | 2.56 | 1.73 | 32.42 (34.71) |
| IET-10029 | 27.7 | 24.1 | 13.0 (21.13) | 170 | 146 | 14.12 (22.07) | 24.5 | 39.5 | 15.0 (22.79) | 26.2 | 22.4 | 14.50 (22.38) | 2.60 | 7.87 | 28.08 (32.00) |
| Dayang | 27.8 | 24.4 | 12.23 (20.47) | 174 | 148 | 14.94 (22.74) | 24.1 | 38.3 | 14.2 (22.14) | 25.7 | 22.0 | 14.40 (22.30) | 2.51 | 1.70 | 32.27 (34.62) |
| IR-4547-2-1-2 | 28.0 | 23.7 | 15.36 (23.07) | 168 | 142 | 15.48 (23.17) | 23.3 | 39.4 | 16.1 (23.66) | 27.0 | 22.3 | 17.41 (24.66) | 5.68 | 1.66 | 39.55 (38.97) |
| IR-5533-14-1-1 | 28.2 | 25.0 | 11.35 (19.69) | 166 | 145 | 12.65 (20.83) | 23.6 | 35.2 | 11.6 (19.91) | 26.8 | 22.8 | 14.93 (22.73) | 2.66 | 1.93 | 27.49 (31.62) |
| IR-5533-56-1-12 | 27.2 | 23.1 | 15.07 (22.84) | 171 | 142 | 16.96 (24.32) | 24.2 | 40.7 | 16.5 (23.97) | 26.6 | 22.1 | 16.92 (24.29) | 2.65 | 1.82 | 31.32 (34.03) |

*Contd........*

| Cultivar | Panicle length (cm) | | | No. of grains/panicle | | | (%) Chaffy grains | | | 1000 grain wt(g) | | | Grain yield/panicle (g) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Healthy | Infested | % reduction | Healthy | Infested | % reduction | Healthy | Infested | % increase | Healthy | Infested | % reduction | Healthy | Infested | % reduction |
| Bengdang Kumini | 27.0 | 23.2 | 14.07 (22.03) | 161 | 136 | 15.53 (23.21) | 22.3 | 38.4 | 16.1 (23.66) | 25.7 | 19.9 | 22.57 (28.36) | 2.52 | 1.58 | 37.30 (37.64) |
| NDGR-410 | 28.5 | 26.1 | 8.42 (16.87) | 172 | 150 | 12.79 (20.95) | 21.7 | 31.3 | 9.6 (18.05) | 27.3 | 24.6 | 9.89 (18.33) | 2.74 | 2.05 | 25.18 (30.12) |
| NDGR-398 | 28.8 | 26.4 | 8.33 (16.78) | 175 | 161 | 8.0 (16.43) | 22.8 | 31.6 | 18.8 (25.70) | 27.5 | 25.0 | 9.09 (17.55) | 2.76 | 2.14 | 22.46 (28.29) |
| Baoyaz-177 | 27.5 | 24.4 | 11.27 (19.62) | 158 | 140 | 11.39 (19.72) | 22.4 | 33.9 | 11.5 (19.82) | 24.5 | 21.6 | 11.84 (20.13) | 2.39 | 1.73 | 27.62 (31.71) |
| Jalanidhi | 28.4 | 26.0 | 8.45 (16.90) | 162 | 146 | 9.88 (18.32) | 23.2 | 33.5 | 10.3 (18.72) | 25.1 | 22.8 | 11.16 (19.52) | 2.46 | 1.83 | 25.61 (30.40) |
| TCA-4 | 28.6 | 25.8 | 9.79 (18.23) | 166 | 153 | 7.83 (16.25) | 21.9 | 31.6 | 9.7 (18.15) | 26.4 | 23.7 | 10.23 (18.65) | 2.67 | 1.95 | 26.97 (31.29) |
| TCA-24 | 28.1 | 24.5 | 12.81 (20.97) | 164 | 141 | 14.02 (21.99) | 22.5 | 36.7 | 14.2 (22.14) | 25.2 | 21.8 | 13.49 (21.55) | 2.53 | 1.76 | 30.43 (33.48) |
| TCA-19 | 27.8 | 24.1 | 13.31 (21.40) | 160 | 136 | 15.0 (22.79) | 23.6 | 37.5 | 13.7 (21.72) | 25.3 | 21.7 | 15.02 (22.80) | 2.55 | 1.70 | 33.33 (35.26) |
| TCA-269 | 28.3 | 25.0 | 11.66 (19.97) | 167 | 145 | 13.17 (21.28) | 22.8 | 35.4 | 12.6 (20.79) | 26.1 | 22.6 | 13.41 (21.48) | 2.58 | 2.84 | 28.62 (32.34) |
| TCA-12 | 27.7 | 25.1 | 9.39 (17.84) | 167 | 151 | 9.58 (18.03) | 22.7 | 37.6 | 14.9 (22.71) | 25.7 | 21.9 | 14.79 (22.62) | 2.54 | 1.93 | 27.95 (31.92) |
| Jalamagna Susceptible check | 26.9 | 21.3 | 20.8 (27.13) | 156 | 115 | 26.28 (30.84) | 21.3 | 56.8 | 35.0 (36.27) | 25.8 | 16.2 | 37.21 (37.59) | 2.15 | 1.07 | 50.23 (45.13) |
| CD (P=0.05) | 0.744 | 0.749 | | 9.03 | 8.44 | | 0.875 | 0.781 | | 1.82 | 1.91 | | 0.744 | 0.749 | |

Figures in the parentheses are the means of Arcsin percentage

**Table 2. Extent of grain yield loss due to stem damage by yellow stem borer *Scirpophaga incertulas* (Wlk.) in deep water rice cultivars**

| Cultivars | % Damaged stem (DS) (%) | Percent yield reduction (PYR) | % yield loss due to DS | % yield loss due to 1% DS | Yield reduction index (YRI) |
|---|---|---|---|---|---|
| LPR-85 | 17.8 | 32.99 | 5.87 | 0.3297 | 13.27 |
| LPR-8 | 17.6 | 29.01 | 5.11 | 0.2901 | 11.36 |
| LPR-56-49 | 23.2 | 43.8 | 10.16 | 0.438 | 17.13 |
| RDA-16-6 | 23.8 | 33.86 | 8.06 | 0.3386 | 14.68 |
| Kariawa | 16.8 | 26.79 | 4.50 | 0.2679 | 10.11 |
| NDGR-151 | 21.1 | 30.36 | 6.41 | 0.3036 | 13.75 |
| NDGR-421 | 18.0 | 25.99 | 4.68 | 0.2599 | 10.78 |
| TC-6 | 21.8 | 37.55 | 8.19 | 0.3755 | 15.05 |
| CN-579-363-3-1 | 18.6 | 28.4 | 5.28 | 0.284 | 11.72 |
| IET-10003 | 20.0 | 31.35 | 6.27 | 0.3135 | 13.68 |
| IET-10084 | 17.5 | 27.42 | 4.80 | 0.2742 | 11.14 |
| IET-10027 | 18.8 | 32.42 | 6.09 | 0.3242 | 13.51 |
| IET-10029 | 25.0 | 28.08 | 7.02 | 0.2808 | 14.16 |
| Dayang | 20.1 | 32.27 | 6.49 | 0.3227 | 13.94 |
| IR-4547-2-1-2 | 22.2 | 39.55 | 8.78 | 0.3955 | 15.64 |
| IR-5533-14-1-1 | 20.1 | 27.44 | 5.52 | 0.2744 | 12.63 |
| IR-5533-56-1-12 | 29.6 | 31.32 | 9.27 | 0.3132 | 16.36 |
| Bengdang Kumini | 27.2 | 37.30 | 10.15 | 0.3730 | 16.61 |
| NDGR-410 | 18.0 | 25.18 | 4.53 | 0.2518 | 10.18 |
| NDR-398 | 17.8 | 22.46 | 4.00 | 0.2246 | 8.56 |
| Baoyaz-177 | 19.0 | 27.62 | 5.25 | 0.2762 | 11.50 |
| Jalanidhi | 17.4 | 25.61 | 4.46 | 0.2561 | 9.95 |
| TCA-4 | 16.5 | 26.97 | 4.45 | 0.2697 | 9.39 |
| TCA-24 | 20.3 | 30.43 | 6.18 | 0.3043 | 13.63 |
| TCA-19 | 21.1 | 33.33 | 7.03 | 0.3333 | 14.31 |
| TCA-269 | 19.8 | 28.62 | 5.67 | 0.2862 | 12.71 |
| TCA-12 | 19.4 | 27.95 | 5.42 | 0.2795 | 12.17 |
| Jalamagna (Susc. Check) | 41.7 | 50.23 | 20.95 | 0.5023 | 33.18 |
| Mean | - | - | 6.80 | 0.31 | 13.60 |

8.56% in NOGR-398 to 17.13% in LPR-5649 which indicated wide variation among the cultivars (Table 2). The percent yield reduction (PYR) ranged from 22.46 to 43.8 in different cultivars (Table 2). Extent of yield reduction depended upon the percentage of damaged stem that varied from 16.5 in TCA-4 to 29.6 in IR-5533-56-1-12 among the test cultivars compared to 41.7 in the susceptible check Jalmagna. The extent of yield loss due to each unit of damaged stem had wide variations. The percent yield loss ranged from 4.0 - 10.16 and extent of yield loss due to one percent of DS varied from 0.225-0.438 as compared with 0.502 in the susceptible check Jalamagna (Table 2). NDGR-398, Kariawa, NDGR-421, lET -10084, NDGR-410, Jalanidhi, l;CA-4, LPR-8 recorded low level of yield loss (4.00 - 5.11 %) due to stem damage as compared to other cultivars. These cultivars also exhibited lower percentage of yield loss 1 % damaged stem$^{-1}$ and the findings of this study established that on an average, one percent damaged stem resulted in 0.31% yield loss (Table 2). High levels of yield loss (8.06-10.16) were mainly due to high percentage of stem damage (21.8-29.6) in the cultivars like LPR-56-49, RDA - 16-6, TC-6, Bengdang Kumini and IR-5533-56-1-12. The yield loss due to stem damage could be attributed to the larval feeding resulting in reduction of translocation of nutrients to the developing panicles, thereby affecting panicle length, no. of grains panicle$^{-1}$, chaffy grain percent, 1000 grain weight and panicle weight. Similar type of observations were also obtained by earlier workers like Catling *et al.* (1987) and Islam (1991), Gupta *et al*. (1990), Catling and Islam (1979) and Pathak (1968) that stem damage in apparently healthy looking but damaged plants caused considerable yield loss depending on the varieties. The observations made in the present study also corroborate the findings of Islam (1990) who explained significant reduction in the number of filled grains, panicle weight and increase in grain sterility in three varieties viz. Chamara, Sodapankaish and Khama. So far as the relationship between extent of stem damage and grain yield loss is concerned, the observations made in the present study is more or less in conformity with the findings of Catling *et al*. (1987) and Senapati *et al.* (1994).

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