Cost Effective In-Vitro Rearing of YSB using Natural Food Supplement

Mass rearing of YSB

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Abstract:- Scirpophaga incertulas W commonly known as Yellow Stem Borer (YSB), is a major insect pest of rice and causes a devastating effect on rice crop productivity. YSB specifically attacks at the young vegetative stage which leads to "dead heart" while the damage at reproductive stage results in "White Ear Head". Despite of its huge impact on agriculture sector across the globe no much molecular work was initiated due to difficulty in rearing. Hence in the given study, we aimed at developing a cost effective artificial YSB rearing system on natural diet. We designed our experimental model by using different naturally derived food sources (starch, sucrose and honey) as well as synthetic components (combination amylose and amylopectin). The findings of this study demonstrated that the YSB was successfully reared on natural starch, sucrose and synthetic starch under standard growth conditions. Establishment of such rearing method would definitely provide an instant source of different stages of YSB. These readily available stages of YSB can be deployed in studies involving optimization of bioassays, understanding lacunae of developmental studies and also in evaluating the effect of extrinsic factors. The outcome of this study will definitely leave a huge impact on developing an efficient pest management strategy against YSB.

Keywords: *Artificial Diet, Pest Management, Rearing, Rice, S. Incertulas, Starch, Yellow Stem Borer.*

I. INTRODUCTION

Yellow stem borer (YSB), *Scirpophaga incertulas* W. is a major insect pest of rice and its incidence in recent times was exponentially increasing day by day. Among 21 species of reported lepidopteran stem borers in rice, only eight species were prevalent in India [1]. The crop damage caused by rice stem borers was uniformly rising from 3 to 95 percent in India, while YSB alone itself causes loss upto 50-60%% by feeding on both vegetative and reproductive stages [2]. Due to its disastrous effect on crop yield YSB has occupied top most rank position and presumed as national pest in India [3].

Despite of several efforts in controlling YSB by chemical means, they were not quite effective in complete eradication although few chemical and biological control might exists [4]. Apart from the poor efficacy, the indiscriminate use of chemical pesticides made the situations even more worst by perturbing the balance of biodiversity. These have a negative effect on the natural enemies such as predators, egg parasitoids and entomopathogenic microorganisms [5-6]. Prolonged use of chemical pesticides also hastened the insecticide resistance, pest resurgence, secondary pest outbreak, environmental pollution and residue toxicity on human health [7-9].

In order to develop a sustainable crop protection strategy, comprehensive knowledge of climatic factors, geographical distribution, insect behavior, seasonal abundance etc., is mandatory. In the present study, we aimed at the establishment of a simple and reliable rearing protocol of YSB on an artificial diet by adapting natural and inexpensive resources. Our study would definitely serve as a platform for key research areas of YSB involving its developmental studies and control strategies.

II. MATERIALS AND METHODS

The experiment for mass rearing of YSB was carried out from 2020-2021, Kharif and rabi season in a cage set up at Growth chamber of Entomology Unit, SLN Biologicals Laboratory, Nizamabad, Telangana, India. The growth chamber was maintained under standard controlled conditions at 25ºC ± 2, RH 65 to 75% with a photoperiod of 12h light and 12h dark [10]. The YSB adults were collected from the rice fields and released onto the potted rice plants kept in a cage for oviposition. The leaves harboring egg mass were detached from plant and placed in glass tube containing wet cotton ball and plugged with dry cotton for proper aeration. The larvae generated from eggs were allowed to grow in a glass tube containing fresh stems immersed in standardised artificial diet with varying ingredients as food source (Starch, synthetic starch, 5% Sucrose, 5% honey and *cassava* starch). The stems were frequently replaced with fresh ones in order to avoid to decomposition. The larvae thus formed were left undisturbed from pupation stage to adult emergence. The mixed population of adult insects was again transferred to potted rice plants for oviposit and the cycle continued for 2 to 3 generations.

A. Statistical analysis

The data present in the given study are the mean values (±SE) of replicates conducted on different days and it was analyzed statistically by Oneway ANOVA (Holm-Sidak method) using SigmaPlot version 12.0.

III. RESULTS AND DISCUSSION

The principle objective of this study lies in the design of the cost-effective artificial rearing of YSB using a natural diet, we have chosen the four natural food diets (natural starch, sucrose, honey and starch derived from *Cassava* roots) and one synthetic media (amylose and amylopectin) which mimics its respective natural food (Table 1). The data presented in the given study revealed several key aspects pertaining to the rearing of YSB on different artificial diets.

S. No.	Ingredients	Quantity
1	Sucrose	5 g/l
2	Natural Starch	5 ml
3	Synthetic Starch[1]	5 ml
4	Cassava Starch	5 ml
5	Honey	5%

Table 1:- Different artificial diets and their quantities used for YSB rearing.
*Synthetic starch is a combination of amylose and amylopectin in the ratio of 1:3

In this study, we comprehensively demonstrated the life cycle of YSB with their respective duration between all the stages illustrated in Fig.1. Among all the above supplementations, 5% sucrose, natural starch and synthetic starch has resulted in the rearing of YSB successfully for three generations. Whereas 5% honey and starch derived from *Cassava* roots have failed to show any improvement and survival of YSB. Further, we have also recorded the survival fitness of all the stages of YSB on different artificial diets and the details were tabulated as Table 2. The survival rate of YSB on different individual diets was differing from each other, the number of egg clumps, instars and % of survival was recorded highest in Natural starch (Table 2).

The low cost and labor-saving rearing system enables the production of large quantities within a short period of time. The total duration of YSB life cycle was recorded to be 39-52 days which was quite short span compared to reported findings (**Fig. 1**) [11-12]. It was quite familiar that the success of any rearing method of monophagous insects depends on selection of its food for survival. Even in our study, YSB when fed on food diet derived from rice starch and artificial starch has survived successfully; while feeding with *Cassava* root starch and honey shown reluctance thereby perished. This non survivability of YSB larvae on starch derived from cassava and natural honey would strengthen its characteristic monophagous nature. Our data suggests that the duration of larval emergence from eggs was considerably lowest (5-6 days) compared to that of reported evidences which recorded minimum of 6 to 8 days [13-15].

S. No	Ingredients	Egg clumps	Instar	Survival rate
1	Sucrose	2 ± 1	80 ± 15	60
2	Natural Starch	3 ± 1	120 ± 22	85
3	Synthetic Starch	2 ± 1	112± 13	80
4	Cassava Starch	0	0	0
5	Honey	0	0	0

Table 2:- The mean ± SE values of YSB developmental stages and survival rate on different artificial diets.

The larval instars, are voracious feeders undergo 5 to 6 moultings and complete their span at a period of 21 to 28 days which was quite shorter than our case it was relatively quick than the previous reports [16]. The period of adult emergence from pupa varied from male to female, our findings demonstrated that the males emerged briskly than females which were in corroboration with Soundararajan (2021)[4].

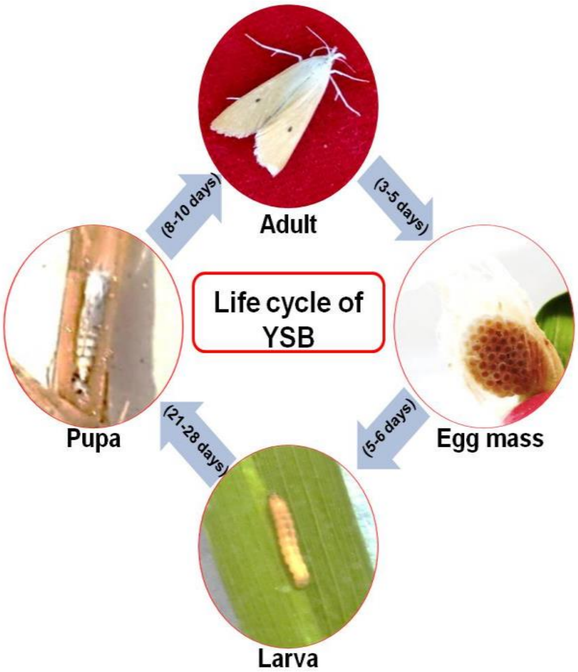

Fig 1:- The illustrative diagram of YSB lifecycle elucidates its developmental stages and life span.

IV. CONCLUSION

To conclude, our rearing method envisages on the specificity of YSB on rice derived natural food diet. This has become quite fundamental in designing the efficient, reproducible, reliable and cost effective YSB rearing method which can be useful for further studies on development and pest management strategies.

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REFERENCES

[1]. S. J. Reuolin, R. P. Soundararajan, P. Jeyaprakash, Field screening of wild introgressed rice lines for resistance to yellow stem borer, Scirpophaga incertulas W. E. J. Plant Breeding, 10(2):570-5, 2019.
[2]. D. Kattupalli, K. M. Barbadikar, V. Balija, S. Ballichatla, A. P. Padmakumari, S. Saxena, K. Gaikwad, S. Yerram, P. Kokku, M. S. Madhav, The draft genome of yellow stem borer, an agriculturally important pest, provides molecular insights into its biology, development and specificity towards rice for infestation. Insects, 12(6):563, 2021.
[3]. A. V. Nalla, D. Adiroubane, K. Kumar, S. Nadarajan, Field evaluation of rice accessions against Yellow Stem Borer, Scirpophaga incertulas wlk. IJRSAS, 6 (2):1-4, 2020.
[4]. R. P. Soundararajan, Mass culturing of rice yellow stem borer, Scirpophaga incertulas W.(Crambidae; Lepidoptera). JEZS, 8(3): 891-895, 2020.
[5]. K. Chakraborty, Effective Management of Scirpophaga incertulas Walker on rice crop during kharif season in West Bengal, India. Am-Eur J Agric Environ Sci., 12(9):1176-84, 2012.
[6]. M. M Rahaman, M. J. Stout. Comparative efficacies of next-generation insecticides against yellow stem borer and their effects on natural enemies in rice ecosystem. Rice Sci. 26(3):157-66, May 2019.
[7]. A. Janssen, P. C. van Rijn, Pesticides do not significantly reduce arthropod pest densities in the presence of natural enemies. Ecology letters, 24(9):2010-24, Sep 2021.
[8]. C. S. Straub, J. A. Faselt, E. S. Keyser, M. Traugott, Host plant resistance promotes a secondary pest population. Ecosphere. 11(3):e03073, Mar 2020.
[9]. S. Furihata, A. Kasai, K. Hidaka, M. Ikegami, H. Ohnishi, K. Goka, Ecological risks of insecticide contamination in water and sediment around off-farm irrigated rice paddy fields. Environ. Pollution, 251:628-38, Aug 2019.
[10]. A.P. Padmakumari, G. Katti, V. Sailaja, C. H. Padmavathi, V. J. Lakshmi, M. Prabhakar, Y. G. Prasad, Delineation of larval instars in field populations of rice yellow stem borer, Scirpophaga incertulas (Walk.). Oryza, 50:259-67, 2013.
[11]. Z. Islam, H. D. Catling, Biology and behaviour of rice yellow stem borer in deepwater rice, J. Plant Prot. in the Trop. 8(2):85-96, 1991.
[12]. R. Lal, Effect of sowing method of wheat after rice on the hibernating larvae of rice stem borers vis a-vis their management in Haryana. INDI. J. ENTO. 68(3):225, 2006.
[13]. D.K. Bora, D. Saharia, S. Hussain, Biology of yellow stem borer, Scirpophaga incertulas (Wlk.). Crop Res Hissar. 8:366-70, 1994.
[14]. B. S. Malhi, D. S. Brar, Biology of Yellow Stem Borer on Basmati Rice. J. Insect Sci. 11:127-9, 1998.
[15]. D. Panigrahi, S. Rajamani, Studies on the biology and reproductive behaviour of yellow stem borer, Scirpophaga incertulas Wlk. Oryza. 45(1):137-41, 2008.
[16]. B. Taylor, Scirpophaga incertulas (Walker)(Lepidoptera: Pyralidae) and deepwater rice—An integrated view. Crop Protection,15(7):649-55, Nov 1996.
[17]. C. R. Satpathi, K. Chakraborty, D. Shikari, P. Acharjee, Consequences of feeding by yellow stem borer (Scirpophaga incertulas Walk.) on rice cultivar Swarna mashuri (MTU 7029). World Appl. Sci. J. 17(4):532-9, 2012.