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TITLE

Studies on control of yellow stem borer, Tryporyza incertulas, a serious pest of paddy, (part of a coordinated programme on the use of pest management with emphasis on rice insects)

FINAL REPORT FOR THE PERIOD

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FINAL REPORT

1. a) i) Contract No. : 2408/R1/RB

ii) Title of the Project : Studies on the control of yellow stem borer Tryporyza incertulas, serious pest of paddy (Part of a coordinated programme on the use of isotopes in pest management with emphasis on rice insects)

iii) Institute where research was carried out : Biology & Agriculture Division Bhabha Atomic Research Centre Trombay, Bombay - 400 085, India.

iv) Chief Scientific Investigator : Mr. G.W. Rahalkar

v) Time period covered : 15th July 1979 to 14th July, 1980 and 1st December, 1980 to 30th November, 1981.

b) Description of the research carried out : During the period under report investigations were carried out on the following:

1. Field survey for the relative abundance of the egg parasites of the Yellow Stem borer.
2. Development of procedures for the cultivation of paddy under laboratory conditions and rearing of the borer.
3. Laboratory rearing of Trichogramma japonicum and related studies.

1.1 Weekly collection of adult moths of yellow stem borer were made using 'Chinsurah tight Trap' (Banerjee and Basu 1956). A single light trap was set up in the rice field admeasuring about an acre. These collections were made from July 1979 to March 1980.

1.2 Egg masses of yellow stem borers were collected from the paddy fields. First collection of 39 egg masses was made on 24th October, 1979 when the monsoon fed crop was nearing earhead stage. A second batch of 135 egg masses was collected on 9th May, 1980 when the summer irrigated crop was also in earhead stage. Egg masses were kept individually in glass specimen tubes at 29 ± 1°C and 65-70% R.H. Emergence of parasites and/or host larvae were recorded daily. Representative specimens of emerging parasites from these egg masses were sent to the Commonwealth Institute of Entomology, London for identification.

2.1. For continuous rearing of the Yellow stem borer either on whole plants or on cut stem pieces, regular supply of rice plants was necessary. It was however difficult to obtain a large enough supply during summer months. To obviate this, an attempt was made to grow paddy under laboratory conditions and for ease of handling and optimum utilization of available space we attempted to grow rice plants in a nutrient medium. Paddy seeds, soaked in water for 48 hours were kept on nylon netting (20mesh

stretched over open end of a rectangular plastic containers (8.5 x 4.5 x 3.5 cm) filled with the medium (Fig. 1). To facilitate sprouting, soaked seeds were covered with wet towelling. The towelling was removed as soon as the roots penetrated through the mesh of the nylon cloth. Nutrient medium was replenished daily. Seedlings were kept under the hours of artificial light provided by 8 daylight florescent tubes of 40 watts each. Distance between the tubes and seedlings was about 90 cm. Among the various compositions of nutrient media tested, the one that supported growth of the plants is given in Table 1. With this medium the plants attained an average height of about 30 cm in 30 days. However, the stem girth was not comparable with that of field grown plants of the same age. When the plants were artificially infested with the neonate stem borer larvae, they failed to establish on these plants and develop, probably due to smaller diameter of the stems.

2.2. Further improvements in paddy cultivation were carried out using the nutrient medium described by Yoshida et al. (1976). Rice seedlings, 15-20 day old, were transplanted in plastic pots 11 x 22 x 20 cm containing 6 cm deep soil.

Twelve seedlings in groups of two were transplanted in each pot. Plants were irrigated with nutrient medium on alternate days. The plants were kept under artificial light described earlier. Rice plants thus grown also failed to support development of the borer larvae through repeated attempts.

2.3 Attempt was then made to rear the borer larvae on cut stem pieces. Three hundred newly hatched larvae were individually introduced into 5 cm long cut stem pieces (paddy variety TR-17) of 40-60 day old field grown plants. Infested stem pieces were covered with wet towelling and held at 29 ± 1°C. Larvae were reintroduced into fresh stem pieces, using progressively larger pieces, at 4 day intervals. Survival of the larvae was recorded at each food change.

It was observed that nearly 50 percent of the larvae died at the first food change and their survival progressively decreased; total mortality occurring at the end of 40 days (Table 2). Similar pattern was descernible in repeated attempts at rearing the borer on cut stem pieces. The cut stem pieces eventhough covered with moist towelling, lose moisture faster necessiating frequent food change. This and the disturbance associated with the frequent food change was primarily responsible

for larval mortality and retarded growth.

2.4 Improvements in larval survival and growth was achieved by using cut stem pieces with intact roots. Drying of the cut stem pieces could be considerably reduced by keeping the roots in contact with wet cotton wads kept at the bottom of the container (Fig. 2). Frequent food change was avoided by introducing fresh stem pieces into the containers at periodic intervals thereby allowing larvae to migrate to fresh food.

2.5. Several dietary formulations using ingredients listed in Table 3 were evaluated for their suitability to rear the stem borer larvae. Whenever used, the ingredients listed at 1-12 were autoclaved for 15 minutes at 15 lbs pressure. Bacto agar was added to the requisite quantity of water and similarly autoclaved. Hot agar solution was poured into a waring blender running at low speed and the required food ingredients were added first followed by vitamins and preservatives. The diet was blended for 3 min. while the blender was run at high speed, and poured while hot into requisite containers. Diets were presented to the larvae in various physical ferms like cubes, slants or packed in 5 mm diameter 3 cm long opague plastic tubes. Freshly hatched larvae

as well as those initially grown on rice stem pieces for 10,15 and 20 days were transferred on these diets either singly or in groups of 2-4.

3. Among the different egg parasites of the yellow stem bores Trichogramma japonicum plays an important role in the natural control of the borer. Nucleus culture of the parasite was obtained from the Indian station of the Commonwealth Institute of Biological Control, Bangalore, India, in the form of parasitized eggs of Corcyra cephalonica.

3.1. Although C. cephalonica is routinely used as an alternate host for laboratory rearing of this parasite, we observed that the parasite could be easily and efficiently reared on eggs of almond moth, Ephestia cautella. There were no significant differences in various developmental parameters of the parasites when eggs of both these host species were used (Table 4). Moreover, under choice conditions the parasite preferred Ephestia eggs over those of corcyra irrespective of the stock from which the parasite was drawn (Table 5). Ephestia eggs were therefore used in all the studies.

3.2. During rearing of the parasite in the laboratory, a major difficulty often experienced is that the host larvae emerging from the unparasitized eggs feed on the para-

sitized eggs in the absence of their natural food. To overcome this, the general practice is to store 6-8 hour old eggs for 24 hours at 0°C before use. The cold treatment permanently inhibits host larval development but the eggs still remain suitable for parasite development. An experiment was therefore carried out to evaluate the suitability of radiation killed eggs for rearing the parasite. Initially, lethal dose of gamma radiation was determined. Eggs collected over a period of 4 hours were irradiated with various doses of gamma radiation from Co^{60} source (dose rate 975 rads/Min) and their hatching was recorded. For total inhibition of hatching of 0-4 hr old eggs a dose of 5 Krad was required. Therefore, 0-4 hr old eggs were irradiated with 5 Krad and then exposed to mated parasite females. Groups of 100 eggs were given to 4 females each for parasitization till they died. For comparison, eggs killed with cold treatment were similarly exposed to female parasites. Total number of eggs parasitized and the parasites emerged was recorded.

3.3. As the basic objective of our study was to explore the feasibility of releasing sterile yellow stem borer females in the field at proper time to augment host

egg density for rapid multiplication of the indegenous parasite populations, we evaluated, as a first step, suitability of eggs laid by sterile Ephestia females. For this, freshly emerged females of Ephestia were irradiated with a predetermined sterilizing gamma radiation dose of 35 Krad, paired with males of the same age and allowed to oviposit. The eggs laid were collected and exposed to mated parasite females. Cold killed eggs were similarly used for comparison.

3.4. In order to see if the parasite could descriminate between eggs laid by sterile and normal females suitable experiments were performed. Twenty-five eggs laid by sterile females were spread randomly on individual gummed card pieces. Location of these eggs was marked by ink. Equal number of eggs laid by normal females but which were cold killed were then spread over these card pieces. Individual card pieces were then exposed to a single mated parasite female till the female died. Total number of eggs parasitized and their type were recorded.

1 C. Results obtained

1.1. Data on light trap collection of the borer showed peak collections in September and October and early December. It was also observed that there were 5 overlapping broods of the moth.

1.2 Only two parasite species viz. Telonomus rowanii Gahan and Tetrastichus schoenobii Ferrier were found to emerge from the egg masses collected on the two occasions. From the egg masses collected on 24.10.79 parasites only emerged from 31 egg masses, both parasites and host larvae from 6 and neither from the remaining 2. Out of the 135 egg masses collected on 9.5.80, parasites only emerged from 82, both parasites and host larvae from 10 and only host larvae from 19 (Table 6). Neither the parasites nor the host larvae emerged from the remaining egg masses. There was a distinct difference in the incidence of the two parasite species during two seasons. From the egg masses collected during the monsoon fed crop there was preponderance of T. rowanii (83.9%) whereas during the summer crop T. schoenobii emerged in large numbers (Table 7). Another interesting observation recorded on the parasite emergence from the egg masses collected from the summer crop was that out of the 92 egg masses from which parasites emerged nearly 34 egg masses yielded both the parasite species.

2.1 Rice plants grown on nutrient medium alone failed to support the larval development mainly due to the small girth of the plants.

2.2 Under improved method of cultivation reasonably good growth of plants could be obtained but it was still far from being satisfactory for the establishment of the stem borer larvae.

2.3 Repeated attempts at rearing of the borer larvae on cut stem pieces of the rice plants proved unsatisfactory as none of the larvae could reach the pupal stage.

2.4 Cut stem pieces with intact roots were comparatively suitable for rearing the borer larvae. When neonate larvae were reared on such stem pieces only 4 percent of them could reach adult stage. When 2-3 instar larvae from field collected rice plants were introduced on cut stem pieces with intact roots, about 30 percent reached the adult stage. However, in both these cases the emerging adults failed to oviposit even after confining them over caged potted rice plants.

2.5 None of the 10 artificial dietary compositions tested in any physical form proved useful in supporting larval development. The larvae whether newly hatched or initially grown on rice plants failed to establish on any of the diets.

3.2 Radiation killed eggs were found equally suitable to cold killed eggs for the development of the parasite (Table 8). There was no difference either in the

percent parasitization or successful development of the parasites.

3.3 When sterile eggs obtained from irradiated females (35 Krad) mated to normal males were offered to parasite females, they readily oviposited on the sterile eggs. Nearly 80 percent of the sterile eggs were parasitized as compared to 86 percent parasitization on cold killed eggs (Table 9). Percent parasite emergence from these two types of eggs was similarly comparable.

3.4 When the parasite female was given a choice between sterile eggs and cold killed eggs, she was unable to descriminate between the two types. Nearly 51 percent of the total eggs parasitized were the sterile eggs and 49 percent were cold treated normal eggs (Table 10).

1.d. Conclusions drawn

1. For the purpose of mass rearing of yellow stem borer larvae, growing of paddy plants under laboratory condition does not appear practically feasible.

2. Though the borer larvae could be reared upto adult stage on cut stem pieces with intact roots the yield is not satisfactory. Furthermore, reproduction of developing adults is affected probably due to some nutritional factors.

3. Neonate larvae as well as those grown for some time on natural host plant failed to establish themselves on any of the ten dietary compositions tested. It therefore appears that eventhough some of these diets contained natural host plant materials, some highly specific phagostimulants are most essential for initiation and sustenance of feeding activity. Physical consistancy of the diet is also thought to play an important role in this aspect.

4. Eggs of Ephestia cautella appear equally suitable, if not more, for the mass multiplication of Trichogramma japonicum in the Laboratory.

5. Gamma irradiation of host eggs with a lethal dose appears an equally efficient method to cold treatment and irradiated eggs are equally suitable for parasite development to cold killed eggs. Added advantage is that it cuts short the time required for cold treatment.

6. Eggs laid by sterilized Ephestia females are equally suitable for parasite development as compared to those laid by normal ones. Furthermore, T. japonicum females are unable to descriminate between these eggs.

1.(e) References:

1. Banerjee S.N. and Basu A.C. (1956)
"Chinsurah Light Trap"
Proc. Zool. Soc. Bengal 9(1):27-32.

2. Yoshida, S., Porno, D.A., Cocle, J.H. and Gomoz A.K. (1976)
"Routine procedure for growing rice plants in culture solution", Laboratory Manual for Physiological Studies of Rice IRRI Los Babos, Philippines.

1.(f) There was no departure from the level of activity envisaged in the contract. However, more detailed ecological investigations could have been carried out had the efforts of laboratory rearing of the borer been successful.

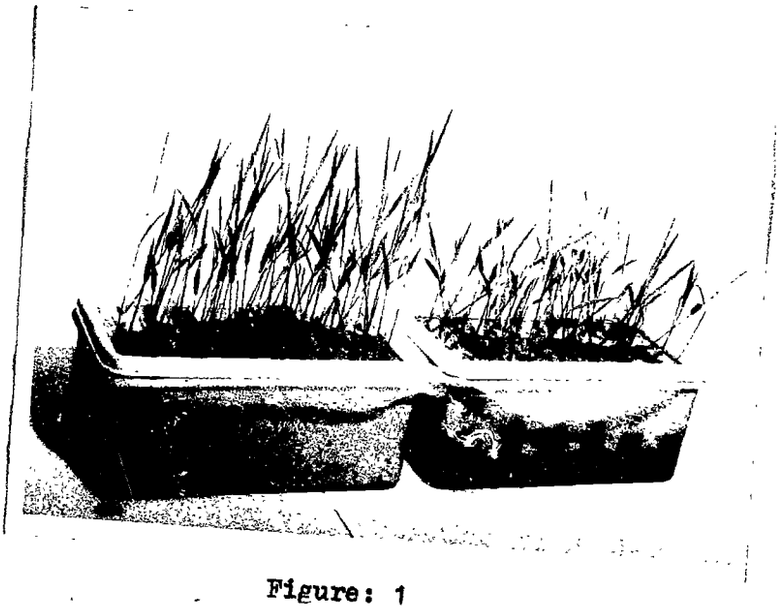

Figure: 1

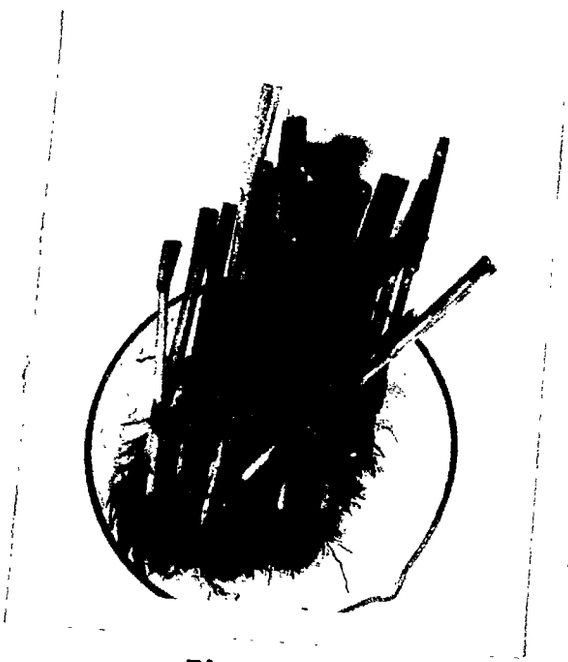

Figure: 2

Table 1 : Composition of the nutrient medium for growing paddy plants

Nutrient ingredient	Stock solution concentration	Quantity of the stock solution used to make 5 litres of the nutrient medium
Sodium dihydrogen phosphate ($NaH_2PO_4.2H_2O$)	5 g/100 ml	5.0 ml
Potassium Sulphate (K_2SO_4)	9.0 g/100 ml	5.0 ml
Calcium Chloride ($CaCl_2$)	11.10 g/100 ml	5.0 ml
Magnesium Sulphate ($MgSO_4.7H_2O$)	40.50 g/100 ml	5.0 ml
Sodium Molybdate	0.0047 g/100 ml	5.0 ml
Manganese Sulphate ($MnSO_4.4H_2O$)	0.40 g/Litre	28.0 ml
Borric Acid	0.40 g/L	23.0 ml
Zinc Sulphate ($ZnSO_4.7H_2O$)	0.10 g/L	14.50 ml
Copper Sulphate ($CuSO_4.5H_2O$)	0.10 g/L	12.0 ml
Ferric Citrate	4.0 g/100 ml	3.0 ml
Potassium Nitrate	28.9 g/100 ml	5.0 ml

Table 2 : Survival of yellow stem borer larvae on cut stem pieces (TR-17 variety)

Date	Larval survival (percent)
26.10.79	100.0
31.10.79	52.8
2.11.79	41.6
6.11.79	30.0
9.11.79	20.0
13.11.79	16.0
19.11.79	14.0
22.11.79	12.4
26.11.79	11.0
29.11.79	9.6
4.12.79	0.0

Table 3 : Composition of diets tested for rearing Tryporyza incertulas

Ingredients	Units	DIETS 1	2	3	4	5	6	7	8	9	10
1. Rice stem powder (Fresh)	Gms	3.80	-	3.50	3.50	-	-	-	-	-	10.00
2. Rice stem powder (Dry)	Gms	-	-	-	-	-	3.5	-	-	-	-
3. Germinated rice seed powder (Fresh)	Gms	3.80	2.0	-	-	-	-	-	-	-	-
4. Germinated rice seed powder (Dry)	Gms	-	-	3.5	1.7	1.7	1.7	1.7	1.7	-	-
5. Rice bran (crude, commercially milled)	Gms	-	-	-	-	-	-	-	-	5.0	5.0
6. Rice bran (defalted)	Gms	-	-	3.5	-	-	-	1.7	1.7	-	-
7. Wheat bran (crude, commercially milled)	Gms	-	-	-	-	-	-	1.7	-	-	-
8. Soybean flour	Gms	-	-	-	-	-	-	-	-	1.65	1.65
9. Milk powder	Gms	3.8	2.35	2.1	2.10	2.10	2.10	2.10	2.10	0.85	0.85
10. Sucrose	Gms	1.10	1.20	1.10	1.10	1.10	1.10	1.0	1.10	0.85	0.85
11. Glucose	Gms	2.30	1.20	1.10	1.10	1.10	1.10	1.10	1.10	0.85	0.85
12. Cellulose	Gms	3.40	2.0	1.75	1.75	1.75	1.75	1.75	1.75	-	-
13. Cholesterol	Gms	0.10	0.15	0.15	0.15	0.15	0.15	0.15	0.15	-	-
14. Honey	ml.	0.30	-	-	-	-	-	-	-	-	-
15. Linseed oil	ml	0.10	-	-	-	-	-	-	-	-	-
16. Rice bran oil	ml	0.10	0.10	-	-	-	-	-	-	-	-
17. Linoleic acid	ml	-	-	0.70	0.70	0.70	0.70	0.70	0.70		-
18. Wesson's salt mixture	Gms	0.70	0.75	0.70	0.70	0.70	0.70	0.70	0.70	0.85	0.85
19. KOH (4M)	ml	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
20. N.B.C. Vitamin mixture	Gms	0.70	0.80	0.70	0.70	0.70	0.70	0.70	0.70	-	-

Contd.....

21. Choline chloride	Gms	0.30	0.40	0.35	0.35	0.35	0.35	0.35	0.35	0.40	0.40
22. Ascorbic acid	Gms	0.20	-	-	-	-	-	-	-	0.25	0.25
23. Yeast	Gms	-	-	-	-	-	-	1.4	-	1.65	1.65
24. Methyl para hydroxy benzoate	Gms	0.10	-	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
25. Sorbic acid	Gms	-	-	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
26. 10% formal dehyde	ml	0.40	-	-	-	-	-	-	-	-	-
27. Bacto-Agar	Gms	1.9	1.6	2.1	2.1	2.1	2.1	2.1	2.1	1.7	1.7
28. Distilled water	ml	77.0	87.0	77.5	77.5	77.5	77.5	77.5	77.5	84.0	84.0

Table 4 : Comparative development of *T. japonicum* on *C. cephalonica* and *E. cautella*

Host eggs	Av. adult progeny per female	Mean developmental period (days)
Corcyra cephalonica	17.2	7.88
Ephestia cautella	16.4	7.77

Table 5 : Comparative preference by *Trichogramma japonicum* of eggs of *Ephestia cautella* and *Corcyra cephalonica* for parasitization under choice condition

Parents reared on	Percent eggs parasitized	
	Ephestia	*Corcyra*
Ephestia	60.33	39.67
Corcyra	61.21	38.79

Table 6 : Natural incidence of parasitism in yellow stem borer eggs

Date of collection	No. of egg masses collected	No. of egg masses showing			Parasite species
		Complete parasitization	Partial parasitization	No parasitization	
24.10.79	39	31	6	2	1. Telonomus rowanii Gahan (Fam. Ichneumonidae) 2. Tetrastichus schoenobii Ferriere (Fam. Eulophidae)
9.5.80	135	82	10	19*	

* From the remaining egg masses (24) neither host larvae nor parasites emerged.

Table 7 : Seasonal abundance of egg parasites of T. incertulas

Parasite species	Percent of total parasites	
	Monsoon crop	Summer crop
1. Tetrastichus schoenobii	15.4	83.9
2. Telonomus rowanii	83.1	16.7

Table 8 : Development of *T. japonicum* on eggs of *Ephestia cautella*

Host Egg Treatment	Total No. of eggs		No. of parasites emerged
	Used	Parasitised	
Gamma Irradiation (5 Krad)	400	248	229
24 hrs. storage at 0°C.	400	246	240

Table 9 : Development of T. japonicum on eggs laid by radiation sterilized Ephestia cautella females mated to normal males

	Sterile eggs	Cold treated normal eggs
Total No. of eggs		
Exposed	410	450
Parasitized	327	389
Total No. of adults parasites emerged	305	350

Table 10 : Comparative preference by Trichogramma japonicum of sterile and non sterile eggs of Ephestia cautella for parasitization under choice condition

Percent eggs parasitized	
Sterile eggs	Cold treated normal eggs
50.77	49.22

Summary

(Research Contract No. 2408/R1/RB)

Title	:	Studies on the Control of Yellow Stem Borer, Tryporyza incertulas, A Serious Pest of Paddy
Research Institute	:	Biology & Agriculture Division Bhabha Atomic Research Centre Trombay, Bombay 400 085, India
Chief Scientific Investigator	:	Mr. G.W. Rahalkar
Period of Contract	:	15th July 1979 to 14th July 1980 and 1st December 1980 to 30th November, 1981
Scientific Background and Scope of the Project	:	Egg parasitism is no doubt the chief biotic factor regulating paddy stem borer populations but at higher host densities. However, effective suppression of the borer through their natural enemies is not evident in practice. This is primarily due to the fact that whereas the borer undergoes only one screening by insecticide treatments given against the borer and/or other pests, the parasite complex faces two screenings;

one by the insecticide and then by the reduced host egg density. Attempts at inundative releases of parasites have been limited because of the complexities involved in their mass multiplication, as well as of their host species. Furthermore, long term rearing of egg parasites on their alternate laboratory host has been found to reduce their fitness to the environmental field conditions. Conservation and augmentation of natural enemies in situ would therefore be a better approach to biological control. Studies were therefore undertaken to evaluate the feasibility of releasing sterile yellow stem borer females into the field to increase host egg densities as these females would lay nonviable eggs.

Experimental method : (i) Paddy fields were surveyed for the natural incidence and seasonal abundance of egg parasitism in Yellow stem borer.

(ii) Attempts were made to grow rice plants under laboratory conditions on nutrient solutions or in pots irrigated with nutrient

solutions for rearing the larvae.

(iii) Attempts were made to rear Yellow stem borer larvae on cut stem pieces of field grown rice plants.

(iv) Several compositions of artificial diets were evaluated for rearing the stem borer larvae.

(v) Trichogramma japonicum, the natural egg parasite of the stem borer was reared in the laboratory using eggs of Corcyra cephalonica and Ephestia cautella as alternate host material.

(vi) Relative efficiency of gamma irradiation with lethal dose and cold treatment of Ephestia eggs to inhibit embryonic development was evaluated.

(vii) Suitability of radiation killed eggs or those laid by radiation sterilized host females for development of the parasite was evaluated.

Results obtained:

1. Light trap catches in rice fields indicated that there were 5 overlapping broods of the yellow stem borer and peak collections were in September-October and early December.

2. Only two parasite species, viz. Telonomus rowanii, and Tetrastichus schoenobii emerged from stem borer egg masses collected from rice fields. T. rowanii was predominant in monsoon crop and T. schoenobii in summer crop.

3. Yellow stem borer larvae could be reared on cut stem pieces of rice plants with roots intact but the emerging adults failed to oviposit. The borer larvae also failed to establish on several artificial diets tested.

4. Radiation killed eggs were equally suitable for the development of the parasite as compared to conventionally used Cold Killed eggs. The parasite could also develop on eggs laid by radiation sterilized females and was unable to discriminate between such eggs and the cold-killed normal ones.

Conclusions : Mass rearing of Yellow stem borer larvae on paddy plants grown under laboratory condition does not appear practically feasible.

Borer larvae reared on cut stem pieces with intact roots did not yield satisfactory adults as far as their reproductive behaviour was concerned.

Though some of the dietary compositions contained natural host material they failed to support the larval establishment. Probably some highly specific phagostimulants need to be incorporated in the diets.

T. japonicum could be reared on radiation killed Ephestia eggs. The female parasite was unable to discriminate between eggs laid by radiation sterilized host females and those laid by normal ones.