

MATERIALS AND METHODS

To study the growth, development and survivalship of sugarcane stem boring grubs

1. Under laboratory condition ($29.9 \pm 0.99^{\circ}\text{C}$ and $78.58 \pm 5.05\%$ RH)

Laboratory experiments were carried out at the Entomology and Zoology Division, Department of Agriculture. A stock of sugarcane stem boring grubs was collected from sugarcane fields at Chonburi province. The stock was in plastic boxes with pieces of sugarcane and soil, until pupation. The pupae were kept in plastic boxes until they were adults and copulation took place. After oviposition occurred in the soil, the eggs were collected for hatching in plastic boxes. The first instar of grubs were reared in plastic boxes, with dimension of 3 x 4 x 5 cm with soil and pieces of sugarcane, until they pupated. Fecundity, hatching percentage, number of instars, and duration of development were recorded.

2. Under field condition

A field studies was carried out at Chonburi province, during May 1990 to March 1992. The cane was planted in cement container 80 cm in diameter and 120 cm deep and the bottom of the

container was closed with cement 3 cm thick. Three containers were used. Then the first instar of the sugarcane stem boring grub, Dorysthenes bugueti Guerin were released into each container. There were 20 larvae per container in May 1990. At harvesting in time March 1991. The number of larvae, pupae and adult stage of the sugarcane stem boring grubs were recorded. The percentages of their survival in the field after one and two years were calculated.

To detect the distribution pattern and sequential sampling for
sugarcane stem boring grubs

1. Distribution pattern

A field study was conducted in Amphur Banbung, Chonburi province in 1989 and 1990. Eighteen sugarcane fields were selected (10 per cent in each affected area). All stools in each field were examined and counted to find the total number of stalks and infested stalks per stool as well as to find the total number of stools and infested stools per field. All this data was recorded, and the distribution pattern was calculated, using the Morisita Index (Morisita, 1959; Pools, 1974; Southwood, 1978).

$$I_a = \frac{\sum_{i=1}^N \frac{n_i(n_i-1)}{n(n-1)}}{N}$$

where N = the number of stools
 n_i = the number of individuals in the i^{th} stool
 n = the total number of individuals in all stool
 I_g = Morisita Index

The significance of the deviation from 1 is tested by the statistic F

$$F = \frac{I_g (n-1) + N-n}{N-1} \quad df = n-1$$

The Poisson distribution is given by the function (Pools, 1974).

$$P_x = \frac{a^x e^{-a}}{x!}$$

where P_x = The probability for (X) to occur
 X = The number of individuals per unit
 a = The mean number of individuals per unit
 e = The base of natural (Napierian) logarithms
 $x!$ = x factorial

The fit of the observed and expected frequency distribution may be tested by a Chi-square goodness of-fit test calculated as.

$$\chi^2 = \sum_{x=0}^N \frac{(O_x - E_x)^2}{E_x}$$

where O_x = The observed frequency of x

E_x = The expected frequency of x

N = The number of groups

The calculated Chi-square value is compared to a Chi-square table with $N-2$ degree of freedom. If the calculated Chi-square value is greater than a Chi-square table, it is concluded that the observed frequencies the Poisson distribution do not fit the expected frequencies.

2. Sequential sampling plan

Eighteen sugarcane fields at Chonburi province in the East of Thailand were selected between 1989 and 1990. All stools in each field were examined. The total number of stalks and infested stalks per stool, the total number of stools and infested stalks per field were recorded. The relationship between infested stalks and infested stools were statistically analyzed by using appropriate regression

model. The economic threshold (ET) would be estimated by regression equation to establish sequential sampling plan.

Sequential stop value terms are as follow (Legg et al., 1992)

$$LSV = SAMP * (ET - W_1 * SE)$$

$$USV = SAMP * (ET + W_2 * SE)$$

where LSV = Lower stop values

USV = Upper stop values

Samp = Sample number

ET = Economic threshold

SE = Standard error

W_1 and W_2 = the appropriate values of the width parameter

$$W_1 = 2.07874 + 0.12105 * \ln(\text{samp}) - 0.17096 * \ln(ET)$$

$$W_2 = 1.9199 + 0.19037 * \ln(\text{samp}) + 0.34179 * \ln(ET)$$

\ln = natural logarithms

Sequential sampling stop values were established by first setting type I (A) and type II (B) errors equal to 0.1. Type I errors occur when a grower sprays his sugarcane, when sugarcane stem

boring grubs populations are low or nonexistent (i.e., sprays unnecessarily). Type II errors occur when a grower does not spray his sugarcane when sugarcane stem boring grubs infestations are high (i.e., fails to spray).

To survey of the natural enemies of sugarcane stem boring grubs

A field experiment was conducted in Chonburi and Kanjana-buri provinces between April and December, 1990. The larvae of the sugarcane stem boring grubs were collected and reared in the laboratory. The species of natural enemies were identified.

To assess crop loss caused by sugarcane stem boring grubs

Crop loss is important for establishing ET and control treatment. Most studies on pest assessment correlate plant injury to pest density. This experiment was carried out under field condition by employing the following methods :-

1. Crop loss assessment by experiment

Field trials were carried out in Chonburi province between 1989 and 1991. Paired comparisons were made under chlordane 72 % EC, at a rate of 700 millilitre/rai treated and untreated with 8 replications. Both sugarcane varieties, F-156 and U-thong 1 were planted in plots size 7.8 x 8 metres with 2 metre borders, in

November, 1989. The spacing was 1.3 x 0.5 metre. Chlordane was applied at planting along the furrows and covered with soil 20 centimetres deep after application. When the cane was 2 months old, fertilizers formula 15-15-15 and 21-0-0 were applied at an actual rate of 30 and 50 kilograms per rai respectively, and weed control was carried out. The sugarcane stem boring grub infestation was assessed at harvest in April, 1990, and 1991 for both plant and 1st ratoon crops respectively. Yield of sugarcane in each plot was recorded and tested for the mean difference between the treated and untreated plots using paired t-test.

$$t = \frac{\bar{X}_1 - \bar{X}_2}{Sd}$$

where \bar{X}_1 = mean yield of the treated plots

\bar{X}_2 = mean yield of the untreated plots

Sd = standard error in the difference between the
two mean yields

n = the number of plots

Percentage reduction in potential yields was as follows :-

(Leclerg, 1971)

$$P = \frac{(\bar{X}_1 - \bar{X}_2)}{\bar{X}_1} \times 100$$

where P = percentage reduction

\bar{X}_1 = mean yield of the treated plots

\bar{X}_2 = mean yield of the untreated plots

2. A survey of crop loss assessment

A survey of crop loss was carried out to study the relationship between the number of sugarcane stem boring grub and yield of sugarcane, and relationship between the percentage of cane stalks infested by sugarcane stem boring grubs and the crop yield. Field studies were carried out in Chonburi between 1990 and 1991 using plant cane and ratoon cane. At harvest time, 150 stools per field of plant and ratoon cane were collected at random. The number of sugarcane stem boring grubs, the number of stalks affected and their stem injury were noted. The yield of each of these plants was also recorded. From the number of stalks per stool, the percentage of stalks injured in each stool was calculated and on this basis all the plants were grouped into ten categories at 10 per cent intervals.

In order to estimate the relationship of stalks damage and crop yield. A simple correlation was employed under field conditions. At harvesting time 100 sugarcane stools were collected at random and the number of sugarcane stem boring grubs, the number of stalks per stools and the number of injured stalks were counted.

The percentage of infested stalks was then calculated. A simple correlation coefficient(r) was calculated using Gomez's method (1984).

$$X_1 = \mathcal{A} + B_1X_2 + B_2X_3 + B_3X_4 + B_4X_4 + B_5X_5$$

where X_1 = yield loss per stool

X_2 = number of stalks per stool

X_3 = number of stalks injured per stool

X_4 = number of sugarcane stem boring grub per stool

X_5 = percentage infested stalks

$\mathcal{A}, B_1, B_2, B_3, B_4, B_5$ = constant

The value of r range from -1 to +1

To compare the efficiency of some insecticides in the control of sugarcane stem boring grubs

Field experiments were conducted in Chonburi province. There were 3 trials. Each trial consisted of a randomized complete block design with 4 replications and 6 treatments. The sugarcane was planted in plots size 7.8 x 8 metres, with 2 metre borders, with a spacing of 1.3 x 0.5 metre. Cane aged 2 months was fertilized with formula 15-15-15 and 21-0-0. The rates per rai were 30 and 50 kilograms respectively. The sugarcane varieties and insecticides were different in each trial.

1. Trial 1

The following insecticides were used as indicated at the given rates per rai : Chlordane 72 % EC 700 millilitre (one application only), endosulfan + BPMC 4.5 % G 5 kilograms, tefluthrin 5 % G 9.6 kilograms, terbufos 3 % G 9.6 kilograms and chlorpyrifos 20 % EC 1 litre each applied 3 times. The sugarcane, variety F156 was planted in November, 1989 and chlordane 72 % EC was applied on the setts in the furrows and covered with soil about 20 cm deep after application.

The following insecticides, endosulfan + BPMC, tefluthrin, terbufos and chlorpyrifos were applied 3, 4 and 5 months after planting or in May, August and September 1989. After harvesting, the weight, the number of stalks, the percentage of infested stools, the percentage of infested stalks and the commercial cane sugar (CCS) were recorded.

2. Trial 2

The treatments in this trial consisted of chlordane 72% EC at a rate of 700 millilitre per rai (one application only), endosulfan + BPMC 4.5 % G at rate of 3, 5 and 7 kilograms per rai and tefluthrin 0.5 % G at a rate of 9.6 kilograms per rai (three

applications). Sugarcane variety F140 was planted in the field and treated with insecticides the same was as in trial 1.

3. Trial 3

A field experiment was carried out using ratoon cane variety F156. Chlordane 72 % EC at a rate of 700 millilitre was applied once at planting. Endosulfan + BPMC 4.5 % G at a rate of 3, 5 and 7 kilograms per rai and tefluthrin 0.5 % G at a rate of 9.6 kilograms per rai were applied in May, August and September in 1991.

To evaluate the control of the sugarcane stem boring grub by pit fall traps

Field experiment were conducted at Chonburi and Prachuab Kerikhan provinces between March and May 1992. Four hundred and eighty pitfall traps per rai were laid in the rows and inter rows sugarcane in the field. Each row had 8 traps. The number of adult sugarcane stem boring grubs was counted at 10 day intervals, and they were separated into males and females.