ENT VI (813): ASSESSMENT OF YIELD LOSS CAUSED BY GINGER SHOOT BORER *DICHOCROCIS PUNCTIFERALIS* GUEN.

(1982 – 1984)

FINAL REPORT

CPCRI

Central Plantation Crops Research Institute
Regional Station, Calicut - 673 012, Kerala

CENTRAL PLANTATION CROPS RESEARCH INSTITUTE
KASARAGOD-670 124, KERALA

RPF-III
Project No. Ent.VI(813)
Date of start : 1982

Introduction

Ginger (Zingiber officinale Rosc.) is an important spice crop cultivated mainly for its culinary and medicinal values. Among the various pests that have been recorded to damage the crop in India, the shoot borer, Dichocrocis punctiferalis Guen. (Lepidoptera : Pyralidae) has been identified as the most destructive one. The caterpillars of the pest bore through into the pseudostems and feed on the inner core resulting in the formation of 'dead-hearts' or withered shoots. The present recommendation for the control of the pest includes spraying of malathion 0.1% at monthly intervals from July to October (Anon, 1983). However, no information is available either on the extent of crop loss caused at varying levels of infestation by the pest or on a suitable sampling procedure to estimate the level of infestation in the field, so that appropriate control measures could be undertaken taking into consideration the management costs. Hence, the project was initiated with the objective of estimating the loss caused to rhizome yield of ginger due to the infestation of shoot borer and to evolve a suitable sampling procedure to assess the level of infestation in a field for undertaking control measures.

11. Technical Programme

1. Collection of pupae and larvae for mass culturing.

2. Field experiments to estimate the yield in relation to pest infestation.
3. Artificial infestation at different levels to estimate the yield loss under caged conditions.

12. Materials and Methods

1. Mass culturing : The pupae and mature caterpillars of the shoot borer were collected from cardamom plants at Kalpetta (Wynad District) and also from turmeric plants at Peruvannamuzhi (Calicut District), Kerala. The affected pseudo-stems were brought to the laboratory and kept in cages and the emerging adults were collected and used for mass culturing.

2. Field experiments : The ginger cultivar 'Maran' was raised in 75 beds during 1982, 1983 and 1984 at the CPCRI Regional Station, Chelavoor, Calicut District. The seed rhizomes was sown at the rate of 25 g in each pit taken on raised beds of size 3 m x 1 m; each bed having 40 ginger plants. The sowing was undertaken during the last week of May during 1982 and 1983 and during the first week of June during 1984 depending on the receipt of pre-monsoon showers. All the recommended agronomic operations were carried out in the experimental fields excepting the plant protection measures.

The cumulative damage caused by the shoot borer on each clump was observed and recorded at monthly intervals from July to October. The weight of ginger rhizome in each clump was also recorded at the time of harvest during January/February.

The data collected were tabulated and statistically analysed.

Ginger plants were classified into different categories such as 0-5%, 6-15%, 16-25%, 26-35%, 36-45%, 46-55%, 56-65%, 66-75%, 76-85% & 86-100% according to the proportion of pseudostems damaged by the shoot borer and the yields of individual plants in these categories were tabulated for purposes of analysis. The data collected for 1982 and 1983 only could be used as the crop sown in 1984 was not harvested in view of the fact that an epidemic of bacterial wilt and soft rot diseases completely damaged the crop. An analysis of variance was done to evaluate the differences in the mean plant yield under different levels of damage for both the years. However, during 1983, the number of plants showing more than 35 per cent pseudostem damage was negligible. The mean yield per plant in the categories coming below 35 per cent damage was not statistically significant for both the years. Hence, a pooled analysis was done to evaluate the difference in the mean yield per plant under different levels of infestation and damage by the pest. The purpose of analysis was mainly to identify the level of damage beyond which a significant reduction in mean plant yield occurred. Such a level of damage was termed Critical Injury Level (CIL), to distinguish it from the conventional economic injury level.

a) <u>Critical Injury Level (CIL) for early crop stages</u>

The analysis of variance technique helped in identifying a CIL that corresponded to the final growth phase of the crop, i.e., in October. In order to facilitate control measures even at early stages of the crop during August and September, the CIL's were evaluated as follows: Let $\underline{a}$ be the number of pseudostems damaged by the pest in a plant and let $\underline{n}$ be the number of pseudostems available at an early stage of crop corresponding to August/September; let $\underline{ka}$ and $\underline{ln}$ be the corresponding numbers at the final stage of the crop, i.e., in October. Here $\underline{k}$ and $\underline{l}$, respectively, are the relative increase in the number of pseudostems damaged by the pest and relative increase in the number of pseudostems from August/September to October. As the CIL for October was fixed using the criterion that $\frac{ka}{l\,n} \geqslant 0.5$, the CIL for August or September could be evaluated using the relation that $\frac{a}{n} \geqslant 0.5 \left(\frac{l}{k} \right)$ using corresponding estimated values of $\underline{l}$ and $\underline{k}$ for these months.

For purposes of estimating $\underline{l}$ the data on total number of pseudostems per row of ten plants each were compiled and tabulated for August, September and October and the mean relative increase in number of pseudostems from August/September to October was calculated. For purpose of estimating $\underline{k}$, hundred random samples were selected for each month and the mean relative increase in number of pseudostems damaged from August/September to October was evaluated.

b) <u>Distribution pattern of plants with CIL</u>

In order to study the extent and the distribution pattern of plants with CIL in the field, the analysis was done as follows: In each row of ten plants, the number of plants showing CIL was counted and arranged in the form of a frequency table. The fitting of Poisson distribution was made and found adequate. As the number of plants with CIL was negligible in 1983, the analysis was done for August, September and October pertaining to 1982.

c) Economic Injury Level (EIL)

The EIL was evaluated in terms of number of plants with CIL for 3 m row of plants, taking into consideration the cost of spraying, the price of raw ginger and a profit factor of 1.5.

d) Sequential sampling plan

In order to arrive at a decision for the control of the pest based on the frequency of occurrence of plants with CIL, in any field of ginger, decision lines of the following form were evaluated:

$$D_1 = h_1 + bn$$

$$D_2 = h_2 + bn$$

When the distribution pattern of the plants with CIL follows a Poisson distribution, the values of h_1, h_2 and b would be:

$$b = \frac{m_2 - m_1}{\log_e(\frac{m_2}{m_1})}; \quad h_1 = -\log_e \frac{(1-\alpha)}{\beta} / \log_e (\frac{m_2}{m_1})$$

$$\text{and } h_2 = \log_e (\frac{1-\beta}{\alpha}) / \log_e (\frac{m_2}{m_1})$$

These parameters again depend on the allowable values of probabilities of committing an error of first kind i.e., α and second kind i.e., β and also on the allowable values of m_1 (the upper limit at which the number of plants with CIL/3 metre∠ and m_2 (the lower limit at which the number of plants with CIL/3 metre row would still be considered a high population). In the present study α and β were fixed as 0.1 and m_1 and m_2 were fixed at deviations of 1/5th of EIL on either side.

The probabilities of arriving at a correct decision at different values of number of plants with CIL/3 m row were evaluated as follows:

$$m = \frac{b \log_e x}{x - 1} \text{ and } L(m) = (x^{h_2} - 1) / (x^{h_2} - x^{h_1})$$

Where 'm' is the mean density of plants with CIL/3 metre row and L (m) is the probability of arriving at a correct decision. Successive values of L (m) and 'm' were obtained by substituting different values of $x > 0$ (Danielson and Berry, 1978). The expected number of rows to be sampled for various mean density of plants with CIL was derived using the equation:

$$E(n) = \frac{L(m)(h_1 - h_2) + h_2}{m - b},$$

Where E(n) is the average number of rows expected to be sampled.

3. Artificial infestation

The cultivar 'Maran' was raised in earthen pots of size 25 cm and maintained in field cages for studies on artificial

∠rows would still be considered a ~~high~~ low population infestation. A technique for artificial infestation was also standardised. The early instar caterpillars when placed inside the half-opened leaves of the plant were found to make their way into the pseudostem, while the later instar caterpillars had a tendency to come out of the leaves and make fresh holes near the collar region of the pseudostem.

During 1982 ginger plants in ten pots were inoculated with the second instar caterpillars of the shoot borer at the rate of one caterpillar per pot and another set of 10 pots were inoculated at the rate of two per pot. The number of pseudostems in the pots was recorded at the time of inoculation. Twenty pots without inoculation were maintained as control.

During 1983 ginger plants in 40 earthen pots were inoculated with graded population of the caterpillars and ten pots were maintained as control. The final infestation on ginger in pots was grouped into 0, 30, 60 and 100 per cent during 1982 and 1983.

Results and discussion

1. Mass culturing

Though mass culturing was attempted, sufficient numbers of caterpillars could not be obtained for artificial infestation studies as the adults laid only a very few eggs in captivity. Hence, field collected first instar caterpillars were used for the artificial infestation studies.

2. Field experiments

The incidence of shoot borer was high and uniform in 1982 and the plants could be classified into ten categories such as 0-5, 6-15, 16-25 etc. based on the percentage of pseudostems damage. However, in 1983, the number of plants with more than 35 per cent pseudostem damage was negligible. The mean yield per plant between the common categories of the two years did not differ significantly and the pooled analysis of variance which included 3914 plants indicated that the plants could be broadly grouped into two groups, viz., those with less than 50 per cent and the other with more than 50 per cent pseudostem damage. The group means differed significantly and it was evaluated that when the final cumulative damage of pseudostem per plant exceeded 50, there was a reduction of 38 g green ginger yield (Table 1). Hence, the CIL for a plant at final growth stage was fixed as 50 per cent pseudostem damage. The CIL's for a plant during August and September were evaluated as 60 per cent and 45 per cent, respectively.

The frequency distribution of plants with CIL was adequately described by Poisson distribution as revealed by the ratio of variance to mean and deviation χ^2 values. The ratios were 1.0, 1.3 and 1.3 for August, September and October, respectively and the deviation χ^2 were 0.5, 5.85 and 12.28 (Tables 2a, 2b and 2c).

Table 1. Mean yield of ginger (g per plant) under different levels of infestation by ginger shoot borer.*

Percentage of pseudostem damage	Mean yield per plant	Number of plants observed	Group means
0-5	178.84	640	178.5
6-15	209.98	741	
16-25	167.25	840	
26-35	162.87	546	
36-45	164.94	402	
46-55	148.21	304	140.8
56-65	145.95	179	
66-75	133.61	190	
76-85	131.62	34	
86-100	107.02	47	
Total	-	3914	-

*Pooled data for two years 1982-83 and 1983-84.

ANOVA	df	MSS	F
Between classes	9	222606.4	20.58**
Within classes	3904	10816.9	-
Less than 50 per cent versus more than 50 per cent damage	1	866200.0	80.07**

**Significant at 1% level.

Table 2a. Distribution pattern of plants with critical injury level (October)

k	Observed No. of rows with k plants	Expected No. of rows with k plants*
0	24	15
1	44	42
2	60	62
3	50	61
4	39	46
5	28	27
6	16	13
7	7	6
8	4	2
9	3	1

* $E(x_k) = \frac{N e^{-\mu} \mu^k}{k!}$; $\mu = 2.96$,

$\chi^2_{9.\text{df}} = 12.28$, $s^2/\mu = 1.3$

Table 2b. Distribution pattern of plants with critical injury level (September)

k	Observed No. of rows with k plants	Expected No. of rows with k plants*
0	78	65
1	86	92
2	55	68
3	32	33
4	15	12
5	4	4
6	3	1
7	2	0

* $E(x_k) = \frac{N e^{-\mu} \mu^k}{k!}$; $\mu = 1.47$; $\chi^2_{5\ df} = 5.85$, $s^2/\mu = 1.3$

Table 2c. Distribution pattern of plants with critical injury level (August)

k	Observed No. of rows with k plants	Expected No. of rows with k plants*
0	260	259
1	14	15
2	1	1

* $E(x_k) = \frac{N e^{-\mu} \mu^k}{k!}$

$\mu = 0.0582$

$s^2/\mu = 1.0$

The EIL was evaluated as 0.5 plants with CIL per row of 3 m length based on a profit factor of 1.5, spraying cost per ha of Rs. 460/- and the prevailing market price of green ginger @ Rs. 5/- per kg (Appendix-I).

The decision lines evaluated for purposes of sequential sampling in a field were:

$$D_1 = -5.36 + 0.5\ n \text{ (No spray line)}$$

$$D_2 = 5.36 + 0.5\ n \text{ (Spray line)}$$

The lines are presented in Fig. 1 and they clearly indicate the sampling involved and the relevant decision regarding control measures in any field of ginger. Fig. 2 furnishes the expected number (rows of 3 m each) to be sampled to arrive at a decision, for varying levels of mean density of plants with CIL per 3 m row.

3. <u>Artificial infestation</u>

In studies on artificial infestation under controlled condition, the average yield in the infestation groups of 0, 30, 60 and 100 per cent was 54.4, 43.0, 42.0 and 35.0 g during 1982 and 94.5, 77.0, 63.0 and 58.5 g green ginger respectively during 1983. As the ginger was grown under shaded condition, the yields of ginger in pots were very poor and the data were not statistically analysed. Yet there was a reduction in yield when compared to uninoculated control.

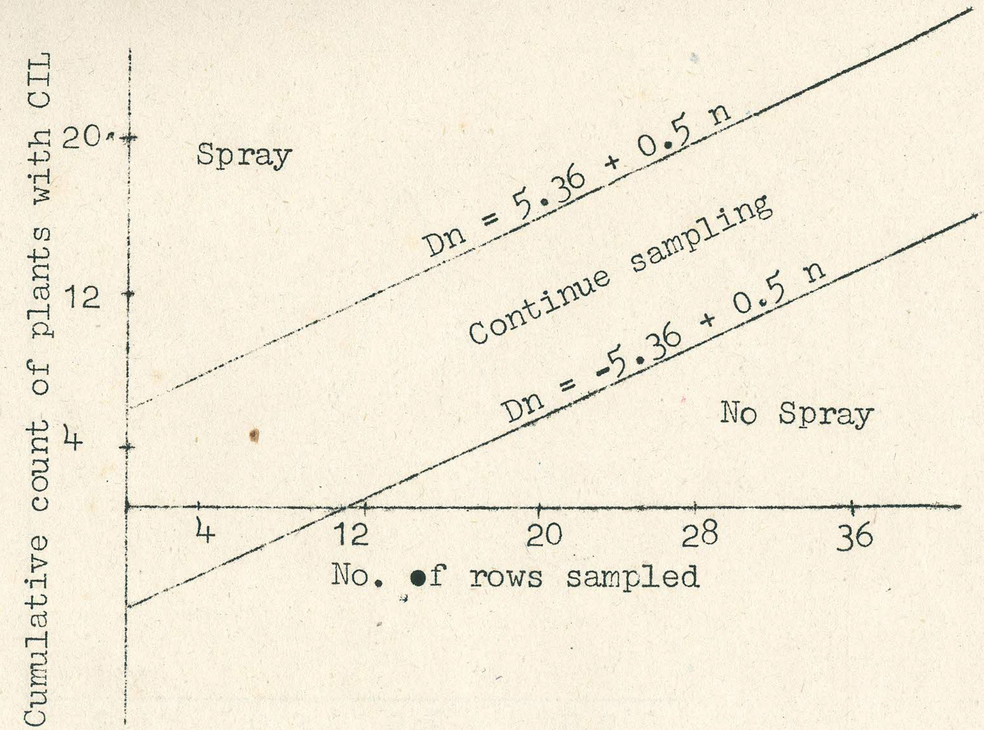
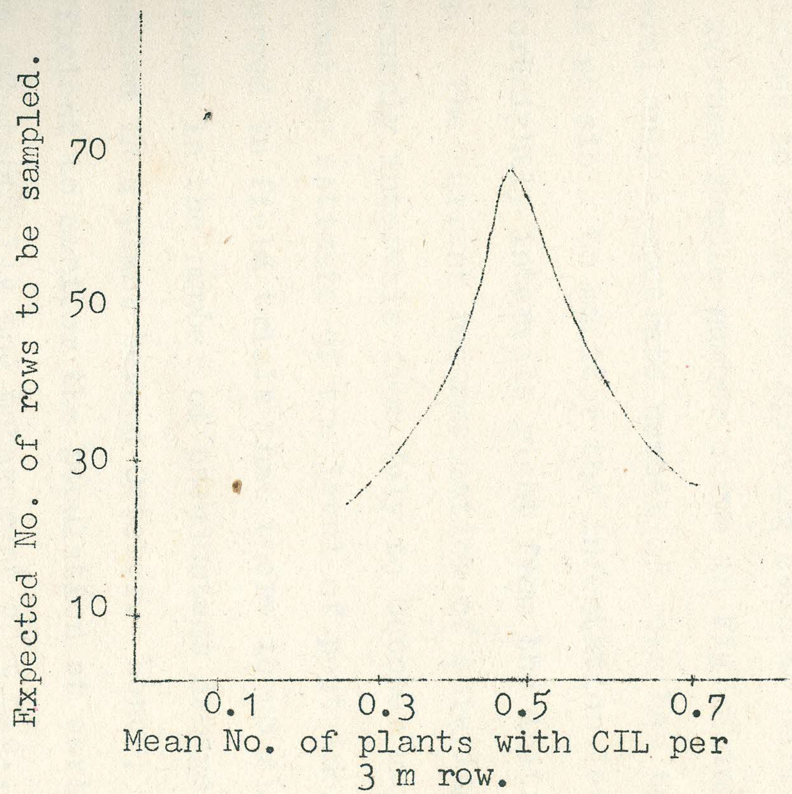


Fig. 1. Decision lines for the control of ginger shoot borer (*Dichocrocis punctiferalis* Guen.)

Fig. 2. The average sample number (ASN) curve for sequential sampling for ginger shoot borer.



Conclusions

The studies revealed that the incidence by the shoot borer caused reduction in the yield of ginger. The actual loss in yield comes to 38 g green ginger per clump when the cumulative pseudostem damage exceeded 50 per cent (Table 1). Thus the real loss comes to 1420 g ginger per bed having a stand of 40 clumps of ginger.

The present investigation is the first attempt in evolving a suitable sampling procedure to assess the infestation level in a field of ginger and for arriving at appropriate decisions to undertake spraying even at early stages of the crop. The average sample number curve in Fig. 2 indicates that in general only a moderate number of rows has to be sampled and hence it is possible to monitor the infestation level in a field even at fortnightly intervals right from the initial stages of the crop. The current recommendation of spraying of malathion 0.1% at monthly intervals from July to October may be uneconomical without an estimate of the level of pest incidence. It was also observed in field trials that there is no significant additional increase in the number of pseudostems damaged or pseudostem produced in a plant beyond October. Hence, it would be quite sufficient to monitor the population at early stages and thereby save substantially the management cost i.e., the cost of spraying.

ooOoo

SMChettiar :