RESEARCH ON RHIZOME FLY
*Mimegralla coeruleifrons* MACQUART ON TURMERIC AND GINGER IN MAHARASHTRA

S. A. GHORPADE
S. S. JADHAV
and
D. S. AJRI

DEPARTMENT OF ENTOMOLOGY,
MAHATMA PHULE AGRICULTURAL UNIVERSITY
COLLEGE OF AGRICULTURE, KOLHAPUR-416 004.
MAHARASHTRA (INDIA)
REPORT
1977-1982

Research on rhizome fly, Mimegralla coeruleifrons Macquart on turmeric and ginger in Maharashtra.

( ICAR Ad-hoc Project )

PRINCIPAL INVESTIGATOR

Dr. D.S. Ajri,
Head,
Department of Entomology,
Mahatma Phule Agricultural University,
Rahuri. District : Ahmednagar.
PIN : 413 722.

RESEARCH WORKERS

Mr. S.A. Ghorpade,
Assistant Entomologist,

Mr. S.S. Jadhav,
Senior Research Assistant,
College of Agriculture,
Kolhapur - 416 004.

Mahatma Phule Agricultural University,
Rahuri. District : Ahmednagar.
PIN : 413 722.
Maharashtra (INDIA).
1. Introduction .......... 1-2
2. Project details and objectives .......... 3
3. Technical programme .......... 3
4. Detailed report - Experiments and results

Expt.1- Survey of rhizoma fly on turmeric and ginger in Maharashtra.
   a) Demarcation of endemic pockets .......... 4
   b) Estimation of losses in endemic creases .......... 5

Expt.2- Studies on the seasonal incidence and bionomics of rhizome fly on turmeric and ginger
   a) Seasonal incidence on turmeric .......... 6
   b) Seasonal incidence on ginger .......... 7
   c) Bionomics on turmeric and ginger .......... 8-12
   d) Natural enemies of rhizome fly .......... 13
   e) Carry over studies .......... 14-15

Expt.3- Effectiveness of some pesticides and oilseed cakes against rhizome rot malady.
   a) Preliminary pesticidal trial against rhizome rot malady of turmeric and ginger .......... 16-17
   b) Effectiveness of oilseed cakes against ratting malady in ginger .......... 18-19

Expt.4- Studies on the chemical control of rhizome fly infesting turmeric and ginger.
   a) Field evaluation of insecticides against rhizome fly on turmeric .......... 19-22
   b) Demonstration trial with 10% BHC dust against rhizome fly on turmeric .......... 22-23
   c) Efficacy of insecticides against rhizome fly on ginger .......... 23-25
   d) Studies on residues of phorate in ginger .......... 25

Expt.5- Screening of ginger and turmeric varieties for resistance to rhizome fly
   a) Field screening of ginger varieties .......... 26-27
   b) Field screening of turmeric varieties .......... 27-28
Expt. 6 - Investigations into the role of rhizome fly, fungi and nematodes in causing rhizome rot malady of turmeric and ginger. 28-31

Expt. 7 - Survey of insect pests other than rhizome fly and nematodes associated with turmeric and ginger
a) Pest complex of turmeric and ginger and their natural enemies 32-35
b) Survey of plant parasitic nematodes 35-36

Expt. 8 - Studies on efficacy of insecticides against tingid bugs, S. typhica on turmeric 36-37

Expt. 9 - Studies on efficacy of insecticides as seed dressers against scales, A. hartii infesting ginger rhizomes in storage 37-38

5. Summary 39-41
6. Schedule for integrated management of rhizome fly 42
7. Reference tables 1 to 22 43-68
3. List of publications 70-71
9. Suggestions for future research 71-72
10. Acknowledgements 72
11. Meteorological data 73-74
"2. Survey questionnaire-Appendix I 75-77
"3. References 78
<table>
<thead>
<tr>
<th>Table</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Incidence of rhizome fly on turmeric and ginger crops in Maharashtra State</td>
<td>43</td>
</tr>
<tr>
<td>2. Losses caused by rhizome fly in endemic areas of Maharashtra State</td>
<td>44</td>
</tr>
<tr>
<td>3. Seasonal incidence of rhizome fly, <em>M. coeruleifrons</em> on turmeric</td>
<td>45-46</td>
</tr>
<tr>
<td>4. Seasonal incidence of rhizome fly, <em>M. coeruleifrons</em> on ginger (Nagthane, Dist. Satara)</td>
<td>47-48</td>
</tr>
<tr>
<td>5. Durations of various stages of rhizome fly, <em>M. coeruleifrons</em> on turmeric and ginger</td>
<td>49</td>
</tr>
<tr>
<td>6. Natural parasitism of pupae of <em>M. coeruleifrons</em> by <em>Trichopria</em> sp.</td>
<td>50</td>
</tr>
<tr>
<td>7. Emergence of rhizome flies from seed material of turmeric</td>
<td>51</td>
</tr>
<tr>
<td>8. Effect of various pesticides in controlling rhizome rot malady of turmeric and ginger</td>
<td>52-53</td>
</tr>
<tr>
<td>9. Effect of different oilseed cakes against rhizome rot malady of ginger</td>
<td>54</td>
</tr>
<tr>
<td>10. Efficacy of different insecticides tested during 1979-80 to 1981-82 against rhizome fly on turmeric</td>
<td>55</td>
</tr>
<tr>
<td>11. Efficacy of different insecticides tested during 1979-00 to 1981-82 against rhizome fly on turmeric (Pooled data)</td>
<td>56</td>
</tr>
<tr>
<td>12. Economics of insecticides tested during 1979-80 to 1981-82 against rhizome fly on turmeric</td>
<td>57</td>
</tr>
<tr>
<td>13. Efficacy of insecticides against rhizome fly, <em>M. coeruleifrons</em> on ginger</td>
<td>58</td>
</tr>
<tr>
<td>14. Percentage of affected shoots by <em>M. coeruleifrons</em> in different ginger varieties (1978-79)</td>
<td>59</td>
</tr>
<tr>
<td>15. Reaction of turmeric varieties to rhizome fly, <em>M. coeruleifrons</em> (1979-80)</td>
<td>60</td>
</tr>
<tr>
<td>17. Incidence of rhizome rot in turmeric and ginger</td>
<td>62</td>
</tr>
</tbody>
</table>
### Table 2

<table>
<thead>
<tr>
<th>Table</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>B. The insect pests affecting turmeric and ginger crops in Maharashtra</td>
<td>63-64</td>
</tr>
<tr>
<td>19. Plant Parasitic Nematodes associated with turmeric and ginger in Maharashtra</td>
<td>65</td>
</tr>
<tr>
<td>20. Percentage occurrence of different plant parasitic and free living nematodes</td>
<td>66</td>
</tr>
<tr>
<td>21. Efficacy of insecticides against tingial bugs, S. typica infesting turmeric</td>
<td>67</td>
</tr>
<tr>
<td>22. Efficacy of insecticides against scale insects, A. hartii infesting stored ginger rhizomes</td>
<td>68</td>
</tr>
</tbody>
</table>
LIST OF PLATES

Plate-I: Map of Maharashtra State showing area under turmeric and ginger crops and endemic pockets of rhizome fly.

Plate-II: Seasonal incidence of *M. coerulifrons* on turmeric.

Plate-III: Seasonal incidence of *M. coerulifrons* on ginger.

Plate-IV A: Egg of *M. coerulifrons*.

Plate-IV B: First instar maggot of *M. coerulifrons*.

Plate-V A: Male and female of *M. coerulifrons*.

Plate-V B: Stages in the life cycle of *M. coerulifrons* and damaged turmeric rhizome.

Plate-VI A: Turmeric and ginger plants raised in earthen pots for studies on bionomics.

Plate-VI B: A typical damage by *M. coerulifrons* in turmeric.
INTRODUCTION

India is a major producer of turmeric and ginger spices in the world and earns vital foreign exchange through their export. The area under these crops and their production in 1978-79 were 62000 and 34300 hectares and 1,46,800 and 67,200 tons (dry) respectively (George and Velappan, 1980). In Maharashtra, the cultivation of these crops is fairly wide spread covering 5800 and 600 hectares respectively (Anonymous 1977). Sangli, Satara, Nanded, Parbhani, Solapur, Bhir and Chandrapur are the important turmeric growing districts of the State, while ginger is mainly grown in Satara district.

In recent years, several pests have developed association with these crops. Amongst them, rhizome fly, *Mimagralla coeruleifrons* Macquart (Micropezidae) has become a serious menace to the cultivation of both these crops causing considerable economic losses particularly in Sangli and Satara districts of the State. Its infestation leads to rotting of turmeric and ginger rhizomes. The rhizome rot malady is more common during the rainy months. The acreage under these crops is dwindling fast since no effective and economical control measures are known.

Prior to the inception of this scheme, role of rhizome fly maggots in causing the rotting of rhizomes was not known. It was a controversial issue as to whether the maggots damage the rhizomes first leading to entry of rotting organisms or they enter the rhizome which have been rendered rotten by the pathogens. Hence, it was necessary to study the exact role of rhizome fly maggots and the associated organisms in the malady.

A perusal of review of literature shows that the work on Micropezidae presented by Berg (1947), Henning (1952), Steyskal (1952 and 1964) and Wallace (1969) provides considerable information on the taxonomy and systematics of *M. coeruleifrons* and *Calobota sp.* found associated with rotten ginger rhizomes. However, the basic information on biology and habits of this pest was not precisely known. Earlier, the incidence of this pest on turmeric and ginger crops was recorded by Dhoble (1975), David and Kumaraswami (1982) and
air (1980) in India. Jacob (1980) has recently reported this past to be associated with the soft rot disease affected rhizomes of ginger in Kerala. A schedule of insecticidal applications for the control of the pest infesting turmeric crop has been recommended by the Department of Agriculture, Maharashtra State (Anonymous, 1977).

In view of the seriousness of the problem the Indian Council of Agricultural Research sanctioned an adhoc project entitled Research on rhizome fly on turmeric and ginger in Maharashtra during 1977-82 to the Mahatma Phule Agricultural University, Rahuri. A comprehensive research programme aimed at finding out the information on bionomics, seasonal incidence, area infested and extent of infestation, role of different agencies in the rotting malady, varieties of turmeric and ginger resistant to the malady and chemical control of malady was undertaken. The information on these aspects provides a firm foundation for formulating an integrated schedule of operations for management of the malady in general and rhizome fly in particular and thus save the losses to these crops.
1. Project Title: Research on rhizome fly (Mimegrella caeruleifrons M) on turmeric and ginger in Maharashtra.


4. Date of termination: 8-10-1982.

5. Name of Institute: Mahatma Phule Agricultural University, Rahuri-413 722.

b) Division/Dept/Section: Department of Entomology.

c) Location of work: College of Agriculture, Kolhapur-46004.

6. Technical Personnel employed:

<table>
<thead>
<tr>
<th>Name with designation</th>
<th>Date of joining</th>
<th>Date of leaving</th>
<th>Total months spent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mr. S.A. Ghopade</td>
<td>1-10-1970</td>
<td>6-10-1970</td>
<td>40</td>
</tr>
<tr>
<td>Asstt. Entomologist</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mr. S.S. Jadhav</td>
<td>18-11-1970</td>
<td>8-10-1982</td>
<td>47</td>
</tr>
<tr>
<td>Sr. Res. Asstt.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mr. V.S. Teli</td>
<td>9-11-1977</td>
<td>30-9-1970</td>
<td>11</td>
</tr>
<tr>
<td>Asstt. Entomologist</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

7. Total outlay: Rs. 1,00,580-00

Share of ICAR: 100%
Share of participating agency: Nil

8. Total amount spent: Rs. 1,09,096.11

Share of ICAR: 100%
Share of participating agency: Nil

9. Objectives and how far these have been achieved:

Objectives: To study the bionomics of rhizome fly on turmeric and ginger and evolve suitable measures for its control.

Achievements: The details of bionomics of rhizome fly were worked out and control measures with satisfactory results were found out.

10. Approved Technical Programme:

i) Survey of the turmeric and ginger growing areas of the state to demarcate endemic areas.

ii) Studies on the seasonal incidence and bionomics.
iii) To find out measures for integrated pest management and formulate suitable schedule of operations.

iv) Studies on varietal resistance in turmeric and ginger to the attack of rhizome fly.

v) Investigations on the role played by rhizome fly in causing the soft rot disease.

vi) Investigations on control of other pests of turmeric and ginger like Dichoc ros is punctiferalis, Udaspes folus etc.

1. Detailed report:

Expt. 1- Survey of rhizome fly on turmeric and ginger growing crops in Maharashtra.

a) Demarcation of endemic pockets:

During 1970-79, Survey of turmeric and ginger growing areas for rhizome fly incidence was carried out in Sangli and Satara districts only whereas in 1979-80 it was extended to selected villages of Chandrapur, Wardha, Aurangabad, Nandur, Bhir, Parbhani and Solapur districts.

Methodology: Before the surveys, the information on village wise acreage under turmeric and ginger crops was obtained from the Assistant Director (Cash crops) of each district (Plate-I). The sample villages were selected at random from a list of villages growing these crops. As far as possible the villages having maximum acreage were selected for visits. To collect the information on infestation by rhizome fly, three selected fields at different locations were visited in each village during the growing season of crops in December-January. The stage/s of the pest observed in fields were noted. Ten plants selected at random showing symptoms of damage were uprooted and their rhizomes were cut open to ascertain the infestation of the pest and stage/s found therein were noted. The observations recorded on incidence of the pest are presented in Table 1, while the questionnaire used to collect the information during surveys is given in Appendix-I.

Results: Observations recorded during 1978-79 and 1979-80 on the incidence of the rhizome fly revealed that the pest was prevalent in all the places visited in Sangli and Satara districts
Plate - I

MAP OF MAHARASHTRA STATE SHOWING AREA UNDER TURMERIC AND GINGER C.OPS AND ENDEMIC POCKETS FOR RHIZOME FLY

District Head-Quarters

--- District Boundary

Endemic pockets

+ Turmeric area in hectares

* Ginger area in hectares
of the Maharashtra State (Table 1). It appeared to have assumed a status of serious pest on turmeric crop in Sangli district and ginger crop in Satara district. In Parbhani, Nanded, Bhir, Solapur and Aurangabad districts, the incidence of rhizome fly was recorded for the first time on turmeric and ginger crops. However, the intensity of infestation was rather low in these areas. The incidence of the pest was observed in Chandrapur and Wardha districts. Mostly larval and pupal stages of the pest were encountered in the rhizomes examined at the time of surveys.

Conclusions: It could be concluded from the present surveys that rhizome fly was endemic on turmeric and ginger in Sangli and Satara districts of Maharashtra State and the problem was observed to be quite serious. The pest might assume serious proportions on these crops in Parbhani, Nanded, Bhir and Solapur districts of the state under favourable conditions.

b) Estimation of losses caused by rhizome fly in endemic areas.

During 1979-80, the field survey at harvest was carried out in turmeric and ginger growing tracts of Sangli and Satara districts to estimate the losses in yield caused due to damage by the rhizome fly. Methodology: Five sample villages each from Sangli and Satara districts containing considerable area under turmeric and ginger crops respectively were selected to collect the information on losses caused due to damage by rhizome fly. The observations on yield of healthy rhizomes and infested rhizomes were recorded at harvest in two fields at different locations from an area of 10 x 10 m. The per cent loss in yield was worked out on weight basis. The data are presented in Table 2.

Results: It was found that in the villages selected for study, the loss in yields of turmeric due to infestation of rhizome fly ranged between 15.63 to 32.26 per cent with an average of 25.35 per cent whereas in ginger the losses varied from 17.26 to 44.12 per cent with an average of 30.62 per cent.

Conclusions: The data collected during the survey revealed that the incidence of rhizome fly caused reduction to the extent of 25.35 per...
Studies on the seasonal incidence and *bionomics* of rhizome fly on turmeric and ginger.

a) **Seasonal incidence on turmeric:**

During 1979-80 to 1981-82, observations on the seasonal incidence of rhizome fly on turmeric crop were recorded in cultivation fields at Chinchani (Mangrul), Karve and Digraj in Sangli district. These are the endemic areas of the pest in Sangli district.

**Methodology:** A field of turmeric was selected to determine the time of appearance of the pest and its maximum activity in the season. In each field, four plots (5x5m) were taken at random and periodical observations on the population of flies were recorded throughout the season. Since the adults are not active flyers, visual observations were made in open vegetation on the abundance of flies. The visual counts of the adults resting only on the leaves and also the number of affected shoots in each plot were taken at fortnightly intervals starting from germination till the harvest of the crop. The observations were always taken in morning hours for half an hour in each plot. The infestation of the pest was ascertained by dissecting rhizomes of plants with affected shoots and observing for the stages of the pest therein. Meteorological records were obtained from the Agricultural School located in the endemic areas at Digraj in Sangli district.

**Results:** The observations on the seasonal abundance of rhizome fly in endemic pockets (Table-3) indicated that the activity of the pest started in the second fortnight of July in turmeric fields i.e. nearly two months after planting. The flies remained active in fields during the period from August to October which coincides with the rhizome formation stage of the crop. However, yellowing of leaves of affected shoots and infestation of rhizomes were noticed in the second fortnight of August. The maximum population of pest and infested rhizomes were noticed in September and October respectively. From November onwards, the activity of pest in fields started declining. The flies were totally absent in fields from December onwards. Good rains after planting (150 to 250 mm) followed by intermittent rains with cloudy weather and temperatures ranging.
per cent prevailing during August to October seemed to favour the activity of the pest. The positive correlations between population of the pest (adults) and precipitation received as well as precipitation and per cent infested rhizomes have been observed. The relation between incidence of the pest and rainfall is depicted graphically in Plate-II. The various stages of the pest observed in fields from August onwards indicated overlapping generations. 

Conclusions: The incidence of rhizomafly on turmeric started in the second fortnight of July and was maximum during August to October.

b) Seasonal incidence on ginger:

Observations on the seasonal incidence of rhizome fly on ginger were recorded in endemic areas during 1979-80 to 1981-82 on cultivator's field at Nagthana in Satara district.

Methodology: Same as given above for recording observations on turmeric crop. Meteorological data were obtained from the Agricultural School located in endemic areas at Borgoon in Satara district.

Results: It could be seen from the observations presented in Table-4 that the activity of pest started in the first fortnight of July in ginger fields i.e. nearly one and half months after planting. The pest was more active in fields during August and September which coincides with the finger set formation stage of the crop. The infestation of rhizomes started in the last week of July and increased to its maximum during August and September. In selected beds, the incidence of pest was observed in patches. In general, the infestation of the pest was relatively more in waterlogged places in beds. Intermittent rains with cloudy weather and high temperatures (above 32°C) and relative humidity (above 70%) prevailing in September increased the activity of the pest and seemed to favour its multiplication in the season. The relation between incidence of the pest and rainfall are depicted graphically in Plate-III. Examination of infested rhizomes revealed the presence of upto 50 maggots in a single rhizome. No flies were observed in ginger fields from December onwards. However, the maggots and
pupae did exist in the infested rhizomes from December onwards till the harvest of crops. This indicated the possibilities of the pest hibernating in larval and pupal stages in infested rhizomes.

Conclusions: The incidence of rhizome fly started in early fortnight of July in ginger fields and reached its peak in September as evidenced by yellowing of affected shoots and infested rhizomes.

c) Bionomics of rhizome fly on Turmeric and Ginger:

The life history of rhizome fly, _M. coeruluisfons_ was studied on turmeric and ginger crops separately in the laboratory during 1970-1981. The observations recorded on the durations of different stages in the life cycle of the pest are presented in Table-5, whereas the figures of different stages of the pest are depicted in Plates-IV and V.

Methodology: The flies were collected from the fields and confined in glass jars (15x10 cm) for egg laying. The maggots were reared on turmeric and ginger rhizomes separately. Observations on mating behaviour, oviposition and longevity of flies were recorded by releasing newly emerged five pairs of flies in wire cages (100x100x60 cm) having potted plants. For observations on egg laying, freshly mated female flies were confined in glass jars (15x10 cm) having 5 cm layer of moist soil at the bottom and covered with muslin cloth at top. An aqueous 10 per cent honey solution was provided in the cages and glass jars as food for flies. After oviposition eggs were removed by soft camel hair brush and placed on a piece of turmeric leaf which was then kept in a petridish lined with wet blotting paper to study the incubation period and percentage of hatching. The maggots were reared on pieces of turmeric and ginger rhizomes separately in petridish (9 cm dia). For recording the number and durations of instars, the maggots were taken out of the food material and were examined at every alternate day following hatching under the high power of stereo zoom binocular microscope. The morphological features of the maggots were also noted. This procedure involved frequent disturbance to the developing stages. Therefore, another undisturbed series was run simultaneously every
Plate-II. Seasonal incidence of M. coeruleifrons on turmeric (Average of three years data)

- Infested rhizomes (%)
- Av. No. of flies
- Rainfall (mm)

For % infested rhizomes/25 sq.m. 25 20 15 10 5 0
Av. No. of flies/25 sq.m. 30 25 20 15 10 5 0
Rainfall (mm) 120 100 80 60 40 20 0

July Aug Sept Oct Nov Dec
time to record the entire life cycle. The same procedure was followed to know the pupation, pupal period and emergence of the flies.

Results:

1) Nature of damage and hosts: Observations made on artificially infested plants in potted conditions in laboratory indicated that rhizome fly maggots are primarily responsible for damage to turmeric and ginger rhizomes.

i) Nature of damage: The tiny and active maggots soon after hatching migrated through soil layers to the plants. The maggots entered the plants mostly at the collar region and later bored into the rhizomes and fed on the inner contents by tunneling through it. The aerial ports of the attacked rhizomes showed yellowing and drying up of leaves which started from the lower older leaves. The complete drying up of leaves including main shoot was seen afterwards. In pots where many eggs were released, the resulting maggots bored together into rhizomes resulting in complete riddling of the tissues and poor formation of finger sets. In such cases the maggots destroyed the rhizomes completely (Plate-VI-B).

The infestation of rhizome fly in fields was observed in patches and damage was relatively less in light and well drained soils. Although the maggots of the pest were primarily responsible for damage to the rhizomes the infestation was observed to lead to the secondary infection by pathogenic fungi and plant parasitic nematodes. The association of fungi like Fusarium sp., Sclerotium sp. and less frequently by Pythium sp. and plant parasitic nematodes belonging to genera like *Meloidogyne*, *Helicotylenchus*, *Tylenchus*, and *Dorylaimids* was generally observed in field infested rhizomes.

ii) Host range: The pest has been observed to feed and breed on turmeric, *Curcuma longa* and ginger, *Zingiber officinale* Rosa in nature.

iii) Spread of the pest: The pest was observed to migrate through flight as well as through movement of the infested rhizomes from one place to another.
Life history:

Copulation: The flies copulate freely both in field and also in laboratory. Under caged conditions, mating of flies was observed to take place 6 days after the emergence. The copulation was frequently noticed throughout the day without any marked preference for a particular period during the day time. The male and female flies mate several times during their life time. The male was very active at copulation. It stimulated female for many rapid movements. Stimulation lasted for 2 to 3 minutes after which mounting followed. Male sits on the back of female which then adjusted her abdomen by straightening and bringing it in close opposition with the male organs. The duration of copulation varied from 40 to 45 seconds and rarely upto 60 seconds. In fields, mating of flies was usually observed on the upper leaf surface.

Oviposition: The females laid eggs nearly 9 to 10 days after mating. Oviposition took place during night hours. A fertilized female laid 76 to 150 eggs with an average of 130 eggs. The oviposition period varied from 1 to 3 days. The death of flies occurred within 2 to 3 days after oviposition.

Habit and location of egg laying: After locating a suitable place the female laid eggs in soil at a depth of about 5 mm with the help of a short ovipositor. Eggs were also laid on the surface of soil. Usually eggs were 1 - 10, but sometimes also in batches of 2 to 10. In fields, eggs were found in the vicinity of plants on soil surface, in soil cracks and under small lumps of soil.

Egg: The freshly laid egg is small, white and oblong tapering at either ends (plate IV-A). It measures 0.79 mm in length and 0.22 in width. The surface is sculptured with parallel longitudinal stripes. The colour of the eggs becomes yellowish towards hatching.

Incubation period: The incubation period varied from 2 to 5 days.

Hatching: The maggots come out of the egg shell by rupturing the anterior end of egg. The hatching of eggs ranged from 0 to 97 per cent in laboratory. The unhatched eggs shrank and turned dull creamy white in colour.
A. Egg of *M. coeruleifrons* (magnified 135 times)

B. Vixst instrar larva of *M. coeruleifrons* (magnified 100 times)
First instar: The freshly emerged maggot is tiny, apodous, colourless and translucent (Plate IV-B). Body is cylindrical without distinct segments, broader at the posterior end and gradually tapering to a narrow point anteriorly. The larva measures on an average 0.63 mm in length and 0.15 mm in width at the broadest part of the body. Soon after hatching the larva is active in movement and has subterranean habitat. The duration of this instar was 3 to 7 days in turmeric and 3 to 5 days in ginger.

Second instar: It is characterised by the appearance of a pair of reddish brown posterior spiracles on the blunt end of the last abdominal segment. The maggot is white, nearly cylindrical and tapering anteriorly with twelve visible body segments. Two semicircular flaps or oral lobes are present anterior to the mouth orifice on the first body segment. Spinulose areas occupy the ventral anterior part of each abdominal segment and are used for locomotion. The larva measures 4.00 mm in length and 1.1 mm in width. This instar lasted for 3 to 6 days in turmeric and 4 to 5 days in ginger.

Third and final instar: Fully grown maggot is creamy white in colour and apodous. It is almost similar to second instar maggot in appearance, except that the cephalic flaps and posterior spiracular pair present on the last abdominal segment are much thicker, dark and relatively bigger. The body is twelve segmented. Spinulose areas on ventral surface of each abdominal segments are much fleshy, blunt and directed backwards. A pair of fan shaped anterior spiracles is present on the first thoracic segment. This instar measures 9.00 mm in length and 1.17 mm in width. Duration of this instar ranged between 3 to 13 days in turmeric and 6 to 10 days in ginger.

The total larval period occupied 13 to 25 days in turmeric and 15 to 23 days in ginger.

Pupation: Pupation took place inside the infested rhizomes usually at the end of the larval tunnel.
**Pupa** : The pupa is enclosed in a dark brown elongated puparium. The posterior spiracles are similar to those of maggots but are more heavily sclerotized. The pupa of female in general is larger in size than that of male. It measured on an average 0.2 mm in length and 1.2 mm in breadth. The colour of pupa changes from brown to black at the time of emergence of flies. Pupal period varied from 5 to 15 days in turmeric and 5 to 10 days in ginger.

**Emergence** : The adult emerges by rupturing the puparium along a circular suture on thoracic segments. The posterior half of puparium usually remains loosely attached to its body.

**Adult** (Plate V-A) : On emergence the flies are light dusky in colour. The wings are present in small folds in the thoracic segment. Within half an hour after emergence the wings are straightened and body becomes dark blackish in colour. The tarsi of fore-legs are white in colour. The body is blackish with a pair of transparent wings having three light ashy spots. The last abdominal segments of female are modified into a short ovipositor.

Under caged conditions in laboratory the longevity was observed to be almost same in both sexes when fed with 10 per cent honey solution. The body length of male and female flies varied from 3 to 14 mm and 13 to 16 mm respectively. The wing expansion of flies varied from 13 to 16 mm.

**Activity and habits** : The flies were found to be active throughout the day. However, maximum activity of the flies was observed during morning and evening hours of the day. During these periods several flies could be seen on leaves while in the remaining hours of the day they were found to rest on the lowermost leaves and rarely on the surface of soil. The flies have the habit of holding the fore-legs straight out in front of the head like antennae. In nature, the flies are also found sitting and walking on the leaves of grasses on the bunds in the morning hours.

**Sex ratio** : The sex ratio of female and male flies was 1:1 approximately.
ft* Mala and female of *M. coeruleifrons*
(Male at left and female at right)

B. Life stages of *M. coeruleifrons*
   a) Eggs  b) Maggot  c) Pupa
   d) Adult female *fly*  e) Infested *turmeric rhizome*
In nature, a larval-pupal endo-parasite Trichopria sp. (Diptera: Hymenoptera) was observed to parasitise late instar maggots of rhizome fly. Average parasitization to the extent of 30.2, 26.5 and 15.0 per cent under field conditions was recorded during 1970, 1979 and 1980 respectively.

In 1970 and 1979, efforts were made to study the seasonal occurrence of Ichopria sp. and M. coeruleifrons in endemic pockets of this pest. The pupae were collected from ginger fields at fortnightly intervals starting from August onwards till the crop was harvested in December. The percentage of parasitism was worked out. The data on percentage parasitism, temperatures, humidity and rainfall are presented in Table-5.

The parasite appeared in the last week of August and remained active till the crop was harvested in December. Parasitism reached its peak in the month of October which might be due to the availability of maximum host larvae in October. As many as 13 to 19 individuals emerged from a single pupa indicating that the parasite was gregarious.

Carry over of the pest: Efforts were made during 1979-80 and 1981-82 to study the sources of infestation and carry over of the pest through seed rhizomes, alternate host plant and soil.

Through alternate hosts: The planting of bulbs of tuber crops viz., Gladiolus, Cannia dica and Colocasia antiquorum was done during 1979-80 in 3 mm rows in endemic areas at Chinchani, Dist. Sangli near to the turmeric fields to study the possibility of their acting as alternate hosts. However, no infestation of rhizome fly was observed on any of these crops. No presence of any stage of the pest was noticed in the stray plants observed in harvested fields of turmeric in off season.

Through soil: For knowing the carry over of the rhizome fly through immature stages in soil after harvest of crop and prior to planting of other crop, samples of soil
from five randomly selected places were examined during 1979-00 for the presence of stage/a of pest. A stages of pest were found. Efforts were also made to study the emergence of rhizome flies through the harvested fields of turmeric and ginger by placing 16 mesh nylon fly proof nets (3 x 1x 1m) in such fields prior to planting. But no emergence of flies was observed. However, in ratoon ginger fields, where the crop was covered with nylon nets (4 x 1 m), the emergence of rhizome flies was noticed in the month of August. This observation indicated that rhizome fly was carried over through ratoon ginger fields.

Through seed rhizomes: For studying the carry over through seed rhizomes, a survey was undertaken at the time of harvesting and planting of both these crops in Sangli and Satara districts during 1979-00. Maggots and pupae of rhizome fly were encountered in the infested seed rhizomes examined at harvest as well as at planting. Studies were, therefore, undertaken during 1981-02 at the Turmeric Research Station, Digraj (Dist-Sangli) to know the carry over of the pest through turmeric seed rhizomes.

Methodology: Seed rhizomes of turmeric (50 kg) were collected at harvest in April, 1981. These rhizomes were equally divided into two lots and were stored in pits (1 x 1 x 0.5 m in size) per the storage practices followed by the local cultivators. Both the lots were covered with 16 mesh nylon fly-proof nets. Weekly observations on the emergence of flies and meteorological data were recorded. At each observation, rhizome flies emerged were counted and removed. The observations were continued till no emergence was observed. The number of flies emerged from each lot along with temperatures and rainfall is given in Table-7. In another experiment, four cages of nylon fly proof nets (3 x 1 x 1 m in size) were fixed in turmeric fields at different places at Digraj (Dist. Sangli), immediately after planting of turmeric rhizomes i.e. on 13th July 1981 so as to observe the emergence of rhizome flies in planted fields. The record of number of flies emerging in each net and meteorological data at weekly interval was maintained.
A. Turmeric and ginger plants raised in earthen pots for studies on bionomics of rhizome fly.

B. A typical damage by M. coeruleifrons in Turmeric. Infested plant at left and healthy plant at right.
Results: It is evident from the data on the emergence of flies through stored turmeric seed rhizomes (Table-7) that the emergence of rhizome flies started in the second week of May, 1981. The reason for emergence appeared to be wetting of seed rhizomes due to rainfall of 53.5 mm received in the last week of April, 1981. The emergence of flies continued up to the second week of August. No definite correlation could be observed between emergence of flies and weather conditions such as temperature and rainfall in the season. The data collected on rhizome flies emerging in fields indicate that after receipt of 45 mm precipitation after planting, the rhizome flies emerged in the freshly planted crop (Table-7). The emergence of flies started nearly 17 days after planting and continued up to the first week of September. The observations indicated that rhizome fly was carried through diapausing maggots and pupae present in the infested seed rhizomes of turmeric.

Conclusions: The studies on bionomics of rhizome fly, M. coerulescens in laboratory indicated that the pest completed its life cycle within 40 to 62 days on turmeric and 35 to 47 days on ginger. The female deposited eggs in soil at a depth of 5 mm. Significant female laid from 76 to 150 eggs. The incubation period varied from 2 to 5 days. Three larval instars were observed. The durations of first, second and third instars were 3 to 7 days and 3 to 13 days in turmeric and 2 to 3, 3 to 5 and 6 to 7 days in ginger respectively. The total larval period ranged between 13 to 25 days in case of turmeric and 15 to 23 days in ginger. The pupal period lasted for 5 to 15 days in turmeric and 9 to 10 days in ginger. The sex ratio was approximately 1:1. The longevity of adult was almost same in both the sexes. A parasite, Trichogramma sp. was recorded to parasitize the late larval instar. The maggots and pupae in infested seed rhizomes used for planting and stages present in ginger ratoon fields appeared to be responsible for carry over of the pest from one season to another.

Expt. 3: Effectiveness of some pesticides and oilseed cakes against rhizome rot malady.

a) Preliminary pesticidal trial against rhizome rot malady
tf/itn a view to finding out suitable pesticides for the control of rhizome rot malady of turmeric and ginger, different insecticides, fungicides and nematicides were tested under field conditions in kharif season of 1970-79 at Chinchani-Mangrul (Sangli) on turmeric and on ginger at Nagthane (Satara). There were thirty siht pesticides and control (untreated). The pesticides were tried in the form of seed dressers, dusts, granules, drenches and foliar sprays.

Methodology:

Experimental details:

Design of layout: Randomized block
Replications: Three
Treatments: 39 (As given in Table-0).
Variety:
  Turmeric - Rajapuri
  Ginger - Local
Plot size:
  Gross - 3.5 x 2.5 m
  Net - 3.0 x 2.0 m
Location:
  Turmeric - Chinchani (Sangli)
  Ginger - Nagthane (Satara)
Date of planting/harvesting:
  Turmeric - 25-5-70 to 19-3-79
  Ginger - 23-5-70/ 5-11-70

Method of application/recording observation:

Seed treatment: The preplanting seed treatment by dipping the seed rhizomes in the required emulsions of different pesticides was given for 10 minutes half an hour before planting.

Sprays: The pesticidal sprays were given with high volume knapsack sprayer. First spraying of pesticides was given 45 days after the date of planting. Remaining three sprayings were given at an interval of 15 days.

Soil application: First and second soil applications of dust and granular formulations of insecticides were given 45 and 75 days after the date of planting respectively. The dust were broadcasted and thoroughly mixed in soil, whereas granules were applied near the base of the plants,
Drenching: First and second soil drenchings of different pesticides were given 45 days and 75 days after planting around the base of plants.

Whorl applications: The pesticidal granules were applied in the leaf whorls, first at 45 days after the date of planting and second, third and forth at intervals of 15 days thereafter.

At harvest, the weight of healthy and infested rhizomes per plot were recorded separately and percentage of infested rhizomes on weight basis was worked out. The percentages were transformed to arcsin angles and the data were statistically analysed. The yields of healthy rhizomes were also recorded.

Results: From the data presented in Table-0 it could be seen that the differences in incidence of rhizome rot malady in both turmeric and ginger due to treatments were significant. In respect of yield of healthy rhizomes, however, the differences were significant in ginger only. Considering the incidence of malady in turmeric and ginger and yield of ginger, treatments from sr.No.6 to 15 consisting of seed treatment with either agallo 0.2% or BHC 0.4% followed by soil application with insecticides like 5% phorate, quinalphos, carbaryl and carbofuran and treatments at sr.No. 35, 36 and 30 were the most promising and significantly reduced the incidence of rhizome rot malady.

Conclusions: The treatment consisting of seed dressing with either 0.4% BHC 50 wp or 0.2% agallo followed by soil applications of insecticides like BHC, phorate, quinalphos, carbaryl and carbofuran; seed dressing with 0.2% agallo followed by whorl application of endosulfan granules; seed dressing with 0.4% BHC followed by whorl application of carbaryl granules and soil application of diazinon granules followed by application of diazinon spray, were the most promising against rhizome rot malady of turmeric and ginger.

Based on the results of this preliminary pesticidal trial, field experiments with promising insecticides were planned and conducted in the subsequent years.
A field experiment was conducted during 1970-79 in an endemic area on cultivators' field at Nagthane in Satara district to find out the effectiveness of different oilseed cakes in minimising the losses due to rhizome rot malady in ginger. Seven oilseed cakes viz., neem fruit (*Azadirachta indica* Juss), cotton seed (*Gossypium* sp.), Karanj (*Pongamia glabra* vent), groundnut (*Arachis hypogaea* Linn.), neem seed (*A. indica*), mahua (*Madhuca latifolia* Roxb) and Kusum (*Carthamus tinctarius* L.) were tested.

**Methodology**

**Experimental details:**
- **Design of layout:** Randomized block
- **Replications:** Three
- **Treatments:** Eight including control (As in Table-9)
- **Variety:** Local
- **Plot size:** Gross: 3.5 x 2.5 m
  - Net: 3.0 x 2.0 m
- **Location:** Nagthane, Dist.Satara
- **Date of planting:** 23-5-1970
- **Method of planting:** Flat beds
- **Spacing:** 15 x 15 cm
- **Date of harvesting:** 5-11-1970

**Method of application/recording observation:**

A single application of oilseed cakes was made at planting at the rate of 2.5 tons/ha. The different cakes were broadcasted in the field and mixed thoroughly in soil in each plot. The effectiveness of different cakes was assessed by taking into account the affected shoots and rotten rhizomes. The total number of shoots and affected ones were counted at fortnightly intervals starting from germination in each treatment and percentage of affected shoots was worked out. Similarly, the yield of rotten and healthy rhizome was recorded separately in each treatment at harvest and percentage of rotten rhizomes was calculated on weight.
basis. The yield data of healthy rhizomes was statistically analysed. The presence of dipteran maggots, fungi and plant parasitic nematodes was ascertained in randomly selected rotten rhizomes from each treatment in laboratory.

Results: It is evident from Table-9 that all the cakes were significantly more effective in reducing the percentage of affected shoots of ginger over control. Of the seven cakes tested, minimum percentages of affected shoots (24.12%) were recorded in plots treated with neem fruit cake. It was, however, at par with rest of the cakes except those of mahua and Kusum. All the cakes also proved significantly superior to control in reducing the rotting of rhizome. The cotton seed cake followed by neem fruit cake were the most promising ones recording less than 17.0 per cent rotten rhizomes as against 53.09 per cent in untreated control. However, these cakes were at par with rest of the oilseed cakes as judged from per cent rotten rhizomes. Considering the yield of healthy rhizomes cotton seed, karanj and neem fruit cakes appeared to be the most promising treatments. The lower incidence of rhizome rot malady in different oil seed cakes might be due to their repellent action against insect and nematodes and inhibitory action against micro-organisms which however, needs confirmation. In the laboratory study, the fungi of Fusarium and Alternaria were associated with rotten rhizomes and Eumerus pulcherium Brunetti were found to be associated with rotten rhizomes.

Conclusions: Out of seven oilseed cakes tested the neem fruit, cotton seed and Karanj cakes were promising in reducing the incidence of rhizome rot malady of ginger and gave increased yields of healthy rhizomes.

Expt.4: Studies on the chemical control of rhizome fly infesting turmeric and ginger.

a) Field evaluation of insecticides against rhizome fly on turmeric.

Field trials were conducted during 1979-80 to 1981-82 to evaluate the effectiveness and economics of promising insecticides
The rhizome fly on turmeric in endemic areas of Sangli district, there were 14 insecticidal treatments and a control (untreated) during 1979-00 and 1900-01, whereas in 1901-02 there were 11 insecticidal treatments and a control.

**Methodology:**

<table>
<thead>
<tr>
<th>Experimental details</th>
<th>1979-00</th>
<th>1980-01</th>
<th>1981-02</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design of layout</td>
<td>R.B.D.</td>
<td>R.B.D.</td>
<td>R43.D.</td>
</tr>
<tr>
<td>Replications</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Treatments</td>
<td>t5</td>
<td>15</td>
<td>12</td>
</tr>
<tr>
<td>Variety</td>
<td>Rajapur</td>
<td>Rajapur</td>
<td>Rajapur</td>
</tr>
<tr>
<td>Plot size</td>
<td>Cross</td>
<td>0.0 x 7.0 m</td>
<td>4.0 x 3.0 m</td>
</tr>
<tr>
<td></td>
<td>Net</td>
<td>7.7 x 6.5 m</td>
<td>3.5 x 2.7 m</td>
</tr>
<tr>
<td>Location</td>
<td>Chinchani</td>
<td>Karve</td>
<td>Digraj</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(Sangli)</td>
</tr>
<tr>
<td>Spacing</td>
<td>22 x 15 cm</td>
<td>22 x 15 cm</td>
<td>30 x 15 cm</td>
</tr>
<tr>
<td>Date of planting</td>
<td>11.5.79</td>
<td>22.5.00</td>
<td>0.6.01</td>
</tr>
<tr>
<td>Method of planting</td>
<td>ridges &amp; furrows</td>
<td>ridges &amp; furrows</td>
<td>ridges &amp; furrows</td>
</tr>
<tr>
<td>Date of harvesting</td>
<td>27.2.00 to 6.3.00</td>
<td>25.2.01 to 3.3.02</td>
<td>20.2.01 to 4.3.02</td>
</tr>
</tbody>
</table>

**Insecticidal applications**

- **I.** 22.7.79 - 19.7.00 - 12.8.01
- **II.** 1.1-9.79 - 10.0.00 - 4.8.01
- **III.** 7.11.79 - 10.9.00 - 3.11.01

**Method of application/recording observation**

A pre-planting treatment of dipping the seed rhizomes in the suspension of 0.4 per cent DHC 50 wp plus a mercurial compound (copper 6%) at 0.025 per cent for 10 minutes just half an hour before planting was given to all the treatments including control. Taking into account the seasonal incidence of the pest in fields, three soil applications of insecticides were given at an interval of 30 days commencing from 45 days after planting. The insecticides in the form
of granules and dusts were applied to the base by broadcasting at the bases of plants. This operation was followed by a light irrigation if no rains were received after application.

To assess the comparative effectiveness of these insecticides against the pest, the percentages of infestation on weight basis were determined at the time of harvest by recording yields of healthy and infested rhizomes separately in each plot. The analysis of the pooled data for three seasons for common treatments was carried out. The yield of healthy rhizomes were also recorded. Ten infested rhizomes selected at random from each plot were cut open at harvest for ascertaining the infestation of rhizome fly.

Results: The data on efficacy of insecticides tested during 1979-00 to 1901-02 are presented in Table-10.

During 1979-00, it was found that all the insecticidal treatments were significantly superior to control in reducing the infestation of rhizome fly. The treatment with DDT 10% dust recorded only 0.97% of infested rhizomes, but it was at par with rest of insecticidal treatments except carbofuran 3G and quinalphos 1.5% dust. The differences in yields of healthy rhizomes were, however, non-significant.

During 1900-01, the results showed that all the insecticidal treatments significantly reduced the rhizome fly infestation as compared to untreated control. The treatment with soil application of bromophos 5G recorded only 2.47% infested rhizomes, however, it was at par with rest of the insecticidal treatments except quinalphos 1.5% dust. No significant differences were observed in yields of healthy rhizomes due to the treatments.

During 1901-02, it was observed that all the insecticidal treatments were significantly superior to control in reducing the infestation of rhizome fly. The treatment with aldicarb 10G and bromophos 5G recorded less than 3.0% infested rhizomes. The treatment with aldicarb 10G was the most promising and recorded significantly higher yields of healthy rhizomes i.e. 194.43 q/ha.

The perusal of three years pooled data presented in Table-11 revealed that all the insecticidal treatments were effective...
in reducing the rhizome fly infestation as compared to untreated control. Among the insecticides tested, bromophos 5G was superior to other treatments and gave the lowest percentage of infested rhizomes of less than 3.0 per cent. It was, however, at par with quinalphos 5G, aldicarb 10G, phorate 10G, DHC 10D and carbaryl 10D. Quinalphos 1.5D was observed to be the least effective. With reference to yield of healthy rhizomes, the plots treated with aldicarb 10G yielded 224.31 q/ha healthy rhizomes as compared to 47.70 q/ha in control. However, it did not differ significantly from rest of the insecticidal treatment except quinalphos 1.5% dust.

Among the various insecticides tested, the cost of DHC 10% dust was minimum (Rs. 361.00/ha) followed by bromophos 5G (Rs. 1000.00/ha) and quinalphos 5G (Rs. 1225.00/ha). The maximum net return of (Rs. 5710.00/ha) over control was obtained by aldicarb 10G treatment (Table-12). However, on the basis of return per rupee investment treatment with DHC 10% dust was most promising giving return of Rs. 0.93.

Conclusions: The results of the insecticidal trials conducted during 1979-80 to 1981-82 against rhizome fly on turmeric showed that three soil applications of bromophos 5G, quinalphos 5G, aldicarb 10G and, phorate 10G @ 20 kg/ha per application were highly effective in reducing infestation of the pest and also economical. b. Demonstration trial with 10% BHC dust against rhizome fly on turmeric.

Methodology: A turmeric field of 25 x 20 m and 50 x 50 m was selected for the experiment during 1980-81 and 1981-82 respectively. Half the area of this plot was treated with BHC 10% dust and the remaining half was kept as control. The planting of turmeric was done on 22-5-1980 and 0-6-1981 during respective years. The preplanting seed treatment by dipping seed rhizomes for 10 minutes in the suspension of 0.4% BHC 50 wp plus 0.025% emisan 6% was given just half an hour before planting. This treatment was common for both treated and untreated plots. Three soil applications of 10% 3HC dust @ 70 kg/ha per application were made on half plot (treated) with intervals of 30 days starting from 45 days after the date of planting were given i.e. on 19-7-80,
3-10-01 during 1901-02. The harvesting of plots was carried out on 25-3-01 and 4-3-02 during respective years. A random sample of 20 kg and 50 kg harvested rhizomes were taken from each treated and untreated plots during 1900-01 and 1901-02 respectively. The weights of infested rhizomes were recorded and the percentage of infested rhizomes was worked cut on weight basis.

Results: The observations recorded showed that 10% 3HC treated plots had only 0.5% and 2.9% infested rhizomes as against 21.8% and 11.1% in the untreated plots during 1900-01 and 1901-02 respectively.

Conclusions: Three applications of 3HC 1C... dust an soil surface around plants @ 70 kg/ha per application given at monthly interval starting from 45 days after planting reduced the infestation of rhizome fly on turmeric.

c) Field efficacy of different insecticides against rhizome fly on ginger.

Field experiments were conducted during 1901 and 1902 in endemic areas of the pest in Satara district to evaluate the efficacy of eleven insecticidal treatments against rhizome fly infesting ginger.

Methodology

Experimental details:

<table>
<thead>
<tr>
<th>Design of layout</th>
<th>Randomized block</th>
</tr>
</thead>
<tbody>
<tr>
<td>Replications</td>
<td>Three</td>
</tr>
<tr>
<td>Treatments</td>
<td>12 including control (As given in Table-13)</td>
</tr>
<tr>
<td>Variety</td>
<td>Local</td>
</tr>
<tr>
<td>Location</td>
<td>Nagthana, Dist. Satara</td>
</tr>
<tr>
<td>Plot size</td>
<td>Gross - 4.5 x 2.5 m</td>
</tr>
<tr>
<td></td>
<td>Net - 4.0 x 2.0 m</td>
</tr>
<tr>
<td>Spacing</td>
<td>15 x 15 cm</td>
</tr>
<tr>
<td>Method of planting</td>
<td>Flat beds</td>
</tr>
<tr>
<td>Date of planting</td>
<td>23.5.1901 and 29.5.1902</td>
</tr>
<tr>
<td>during respective years</td>
<td></td>
</tr>
<tr>
<td>Insecticidal applications</td>
<td>1901  1902</td>
</tr>
<tr>
<td></td>
<td>I. 5.0.01  30.6.02</td>
</tr>
<tr>
<td></td>
<td>II. 1.9.01  1.0.02</td>
</tr>
</tbody>
</table>
A preplanting treatment of dipping the ginger sets for 10 minutes in suspension of 0.4% BHC 50 wp plus 0.025% omisan 6% just half an hour before planting was given and this treatment was common for all the treatment plots including control. Taking into account the seasonal incidence of the pest, three soil applications of insecticides were given at intervals of 30 days commencing from nearly two months after planting during 1901 and a month after planting in 1902. The insecticides in the form of granules and dusts were applied to the soil by broadcasting at the bases of plants. This operation was followed by a light irrigation if no rains were received after application.

To assess the comparative effectiveness of the insecticides, the percentages of infestation as evidenced by affected shoots was determined by counting healthy and affected shoots of ginger in each treatment at intervals of 15 days starting from germination. At each observation, ten affected shoots were uprooted at random from each plot and their rhizomes were examined for rhizome fly damage. In all eight observations were recorded in the season. The analysis of the pooled data for two seasons was carried out.

Results: It could be seen from Table-13 that during 1901-02 phorate 10G and bromophos 5G recorded less than 2.1% percent affected shoots and were most effective insecticides in reducing the infestation of rhizome fly on ginger, while in 1902-03 quinalphos 5G and bromophos 5G were the best insecticidal treatments in keeping the pest under check.

The analysis of data for two seasons presented in Table-13 showed that all the insecticidal treatments were effective in reducing the rhizome fly infestation compared with control. Among the insecticides tested, bromophos 5G and quinalphos 5G at 1.0 kg a.i./ha per application gave the lowest percentage of affected shoots of less than 4.0 per cent.

Conclusions: Results of insecticidal trials during 1901-02 and 1902-03 against rhizome fly on ginger indicated that three applications of bromophos 5G at 1.0 kg a.i. ha per application...
given at monthly interval starting from 45 days after planting were the most effective in reducing the pest infestation followed by quinalphes 5G and phorate 10G as judged from percentage of affected shoots.

d) Studies on residues of phorate in ginger.

Methodology:
Application of phorate 10% granules @ 2.0 kg a.i./ha in application was one of the treatments from the experiment during 1981-82 on chemical control of rhizome fly on ginger. The rhizomes from treated and untreated plots from this experiment were harvested on 27-1-1982. The level of phorate residues in the rhizomes was determined by the spectrophotometric method described by Gotz and Watts (1964).

Results: The results of residue analysis are presented in Table below.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Residues in samples (ppm)</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I</td>
<td>II</td>
</tr>
<tr>
<td>Untreated</td>
<td>0.004</td>
<td>ND</td>
</tr>
<tr>
<td>Phorate 10G</td>
<td>0.226</td>
<td>0.760</td>
</tr>
</tbody>
</table>

ND = Not detectable

It could be seen from the Table above that the level of residues in the ginger rhizomes from the plot treated with phorate granules @ 2.0 kg a.i./ha per application ranged from 0.129 to 0.760 ppm with an average of 0.374 ppm. This level of residue is quite less than the tolerance limit of 0.5 ppm fixed by EPA for other vegetables. The two samples from untreated plot showed residues to the extent of 0.077 to 0.094 ppm. This might be due to transport of pesticide from treated plot through irrigation water.

Conclusions: The level of residues of phorate 10G in ginger rhizomes ranged from 0.129 to 0.760 ppm with an average of 0.374 ppm which is well below the tolerance limit of 0.5 ppm.
During kharif 1970, screening of ginger cultivars was undertaken under natural infestation of rhizome fly for evaluating their performance in endemic areas of the pest in Satara district.

**Methodology**

**Experimental details:**

- **Design of layout**: Randomized block
- **Replications**: Two
- **Varieties**: Thirty (as given in Table-14)
- **Source**: Horticultural Research Station, Ambalavayal, Kerala.
- **Plot size**: Gross: 3.5 x 2.5 m.
  Net: 3.0 x 2.0 m.
- **Location**: Nagthana, Dist. Satara.
- **Spacing**: 15 x 15 cm
- **Method of planting**: Flat beds.
- **Date of planting**: 25-5-1970.
- **Date of harvest**: 5-11-1970

**Recording observations**: Observations on affected shoots and healthy shoots were recorded at 15 days intervals starting from germination till the harvest of crop. The infestation of rhizome fly in each variety was ascertained by dissecting randomly selected rhizomes of affected shoots and observing for the stages of the pest found therein. The percentages of affected shoots in different varieties were worked out and transformed to arc-cosine angles. The data were analysed statistically.

**Results**: The data in Table-14 indicated that all the thirty cultivars of ginger tested were susceptible to the rhizome fly. However, variety Nadirs was most promising recording 9.41% affected dead shoots. Poona (local) was the next promising cultivar with 4.92% incidence of the pest, but it was at par with Thodupuzha, th Andrews, Tura, Arippa and Thinladium. Bajpai variety recorded the highest percentage of dead shoots (47.16%) and was observed to be highly susceptible to the pest.
Conclusions: In the field screening with thirty varieties of ginger for their reaction to rhizome fly Madia was the least susceptible variety recording only 9.4% affected dead shoots.

b) Field screening of turmeric varieties to rhizome fly resistance.

Field evaluation of turmeric varieties was undertaken during 1970-79 to 1981-02 in endemic areas of rhizome fly on cultivators' field in Sangli district.

Methodology

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>Chinchani (Sangli)</td>
<td>Chinchani (Sangli)</td>
<td>Karve Digraj (Sangli)</td>
<td>Digraj (Sangli)</td>
</tr>
<tr>
<td>Replications</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Varieties</td>
<td>20</td>
<td>9</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Source</td>
<td>Turmeric Research Station</td>
<td>Turmeric Research Station</td>
<td>Digraj (Sangli)</td>
<td>Digraj (Sangli)</td>
</tr>
<tr>
<td>Ambalwadyal Digraj</td>
<td>(Kerala)</td>
<td>(Sangli)</td>
<td>(Sangli)</td>
<td>(Sangli)</td>
</tr>
<tr>
<td>Plot size</td>
<td>Two rows of 3 m</td>
<td>Two rows of 3 m</td>
<td>Two rows Gress 1.5 x 2.5 m</td>
<td>Two rows Gress 1.5 x 2.5 m</td>
</tr>
<tr>
<td>Date of planting</td>
<td>25.5.7a</td>
<td>11.5.79</td>
<td>22.5.00</td>
<td>25.6.01</td>
</tr>
<tr>
<td>Date of harvesting</td>
<td>10.3.79</td>
<td>27.2.00</td>
<td>25.2.01</td>
<td>24.2.01</td>
</tr>
</tbody>
</table>

Method of recording observation

At harvest, observations on the weights of infested rhizomes and healthy rhizomes were recorded separately in each variety and percentages of infested rhizomes were worked out on weight basis. The data were statistically analysed after transforming percentages into arcsin angles. The infestation of M. coeruloleifrons was ascertained by dissecting ten randomly selected infested rhizomes in each variety.

Results:

The results are presented in Table-15 and 16. During 1970-79, out of 20 varieties tested, Sugandhum and Duggirala
10% infested rhizomes. The varieties Kasturi tanuk, Von timilla, Nandyal type, Kuchipudi, Armur and G.I. puram-I were observed to be moderately susceptible. The rest of the varieties were highly susceptible to rhizome fly infestation under natural field conditions. Wynad local was found to be the most susceptible variety recording 41.90 pur cant infested rhizomes.

In 1979-80 out of 9 varieties tasted, Tekurpeta was observed to be the least susceptible recording only 1.92% infested rhizomes while Sugandhum, Duggirala, Waigaon and Kasturi varieties recorded less than 5% infested rhizomes and were at par with Tekurpeta. The average percentage of damaged rhizomes in local Rajapuri variety was the highest (19.22%).

During 1980-81 and 1981-82, Amongst the nine turmeric varieties tested at Karve and Digraj (Dist. Sangli), Waigaon and Kasturi varieties appeared to be the least susceptible to the attack of rhizome fly, whereas Rajapuri locally grown variety was highly susceptible to the pest. The yield of healthy rhizomes in both those varieties were also comparable with that of Rajapuri (chock).

Conclusions: The screening of promising varieties of turmeric under natural infestation of rhizome fly showed that none of the varieties was completely resistant to the pest. However, Waigaon, Kasturi, Sugandhum, Duggirala and Tekurpeta were less susceptible to rhizome fly and also recorded higher yields of healthy rhizomes compared to Rajapuri, a locally cultivated variety. It was worth noting that Rajapuri (chock) showed the highest susceptibility to rhizome fly during all the three years under study.

Expt. 6: Investigations into role of rhizome fly maggots, fungi and plant parasitic nematodes in rhizome rot malady of turmeric and ginger.

It is observed that both turmeric and ginger crops in fields suffer considerable losses due to rotting malady. A constant association of rhizome fly maggots, pathogenic fungi and plant parasitic nematodes was found with rotted rhizomes. The exact role played by these agents in causing the malady of
rotting of turmeric and ginger rhizomes is not known. Studies
were, therefore, undertaken in the laboratory during 1979-00, 1980-01
and 1982-03. Amongst the isolated diseases from field collected
rotten rhizomes, *Pythium* fungi was the most predominant species
during 1979-00, whereas *Sclerotium* and *Fusarium* were predominant in
1980-01 and 1982-03 respectively. The predominant species of fungi
was included in the trials during respective years. Introduction of
plant parasitic nematodes, obtained from field collected rhizome
and soil samples was, however, made during 1979-00 only.

Methodology:

Experimental details:

- Design of layout: Pot culture experiment with R.B.D. with three replications.
- Variety: Turmeric-Rajapuri
  Ginger-Local
- Location: Entomology Section, College of Agriculture, Kolhapur.
- Date of planting: 21.6.1979/27.2.1980
  harvesting: 5.6.1980/10.3.1981
  6.7.1982/22.2.1983
- Details of treatment - As given in Table-17

Each treatment consisted of a set of three earthen pots (15 cm dia). The treatment combinations during 1979-00 consisted of
inoculation of cultures of rhizome fly maggots, *Pythium* fungus and
plant parasitic nematodes in potted plants alone as well as
in combination with each other, whereas during 1980-01 and 1982-03
the cultures of *Sclerotium* and *Fusarium* fungi were used respectively
in place of *Pythium*. The pots were filled with soil sterilized in
autoclave. Healthy rhizomes of turmeric and ginger, surface
sterilized with mercuric chloride solution (1:1000) and then washed
thoroughly with distilled water, were planted in the earthen pots.
A set of pots filled with sterilized soil and soil from endemic
area without inoculation of any cultures and planted with healthy
rhizomes constituted controls. A preplanting seed treatment with
0.4% BHC 50 wp and 0.25% agallol suspension given for 10 minutes.
just half an hour before planting was an additional treatment during 1979-00. The pots were watered every alternate day following introduction of cultures.

Before experimentation the cultures of all the three agents involved were maintained in the laboratory. For development of pathogenic fungi cultures, the rotten rhizomes of turmeric and ginger were collected from fields. The culture of most predominant fungus was isolated on PDA media during respective years under study. During 1979-00 and 1902-03, the cultures of fungi obtained on PDA media were mixed in sterilized soil and covered with sterilized gunny bags for 21 days to make the soil sick. The earth pot were filled with such fungi sick soil treatmentwise. In 1900-01, however, the culture of fungus was inoculated in the potted plants.

The mass culture of rhizome fly was maintained in the laboratory. The eggs obtained were sterilized by passing through a solution of 5 per cont chloramine in 70% alcohol. In each treatment, 25 freshly emerged maggots were released in potted plants. To obtain plant parasitic nematodes, the soil and root samples of turmeric and ginger were collected from field in endemic areas and nematodes were extracted by sieving and decanting method using series of sieves viz., 20, 60, 100, 200 and 350 mesh. The population of nematode species complex per 250 ml soil extract was counted and released in each treatment. The nematode species complex released consisted of Helicotylenchus sp (750), Tylenchus sp (250), Telenchophrynchus sp (500), Xiphinema sp (250) and saprozoic nematodes (1250). The introduction of cultures was done on 3.9.1979 and 4.9.1902 during respective years.

The observations on symptoms on leaves and rhizomes of infested plants were recorded at weekly intervals starting from inoculation of cultures and are presented in Table-17.

**Results:** During 1979-00, the rotting of ginger rhizomes was observed in treatments with Pythium and nematodes, Pythium and rhizome fly maggots combinations and also in potted plants with soil from endemic area irrespective of seed treatment with 0.4% BHC or 0.25% agallool while in turmeric it was noticed in
treatments with soil from endemic areas and plants inoculated with rhizome fly maggots alone obtained from unsterilized eggs. The rhizomes of turmeric attacked by rhizome fly were partly consumed by the maggots and yellowing of leaves was observed in such plants 12 to 15 days after release of maggots. Also, the finger set formation of attacked rhizomes was adversely affected. The results indicated that in turmeric rhizome fly maggots were responsible for damage to rhizomes, whereas in ginger Pythium fungus in combination with nematodes and rhizome fly maggots played important role in causing rotting of rhizomes. In case of plants grown in pots containing soil from endemic areas it was observed that Pythium spores and plant parasitic nematodes present in soil could cause the rotting of rhizomes. Positive cultures of Pythium and nematodes were re-isolated from such rhizomes.

During 1900-01, the observations recorded indicated that both rhizome fly maggots obtained from unsterilized eggs and Sclerotium fungus alone as well as in combination were capable of damaging turmeric and ginger rhizomes. The infested rhizomes yielded Sclerotium on re-isolation. However, in 1902-03, the results showed that rhizome fly maggots alone could cause damage to turmeric and ginger rhizomes. No rotting was observed in rhizomes inoculated with Fusarium fungus alone.

Conclusions: The trials conducted during 1979-80, 1980-81 and 1982-83 to know the role played by causal agents in rotting of turmeric and ginger rhizomes indicated that rhizome fly, M. coeruloiferens maggots alone played major role and were primarily responsible for damage to rhizomes of both these crops, whereas pathogenic fungi viz., Pythium, Sclerotium and Fusarium and plant parasitic nematodes were of secondary importance aiding in rotting.

Expt. 7: Survey of insect pests other than rhizome fly and Plant Parasitic Nematodes associated with turmeric and ginger crops in Maharashtra.
The survey was carried out in turmeric and ginger growing tract comprising Digrej (Sangli), Nagthane (Satara) and around Kolhapur in cultivators' fields during the years 1900 and 1901. The observations on the incidence of pest complex of both these crops were made periodically and their intensity in the season was noted. All the species of insects collected were got identified from the Director, Commonwealth Institute of Entomology, British Museum, London except the snails which were identified by the Zoological Survey of India, Calcutta. A list of pests found infesting turmeric and ginger crops is given in Table-10.

Results: It is evident from Table-10 that besides rhizome fly, *M. coeruleifrons* there are 13 different pests infesting turmeric and ginger crops. The principal pests attacking turmeric were rhizome fly, *Mimogralla coeruleifrons* Macquart; tinnin bug *Stephanitis typica* Distant; lunate fly, *Eumerus pulcherium* Brunetti; and leaf roller, *Drosophila folius*, whereas in ginger rhizome fly, *M. coeruleifrons* and lunate fly, *E. pulcherium* were the most common in fields. Rhizome fly, *M. coeruleifrons* was present at all the localities under observation and the maggots were observed parasitised by *Trichopria sp.* (Hymenoptera). The intensity of ingid bugs and leaf roller on turmeric was moderate in October. In storage, scale insects, *Aspidiotella hartii* Okil as found to be quite serious pest on turmeric and ginger rhizomes effecting sprouting of rhizomes. A hymenopteron parasite, *A. modestus* (Encyrtidae) was found parasitising to the extent of 00 to 90% in scales in laboratory. The cured sets of turmeric in laboratory were heavily attacked by Cigarette beetle, *L.serricornis* and this pest was also observed parasitised by *A. calandrae* (Hymenoptera) in storage. Two species of mely bugs, *Rhizopus sp.* and *Planococccoides* were recorded for the first time in the country. These adversely affected the sprouting of infested rhizomes. Besides, several species of unidentified mites
were found to be associated with rotten rhizomes of turmeric and ginger in all the places under survey. The incidence of *P. indicus*, *H. serata*, other dipteran maggots and snails, *Opeas gracile* was negligible.

The preliminary observations recorded on the biology of mealy bugs, tingid bugs and leaf roller are briefly described here. Mealy bugs (*Rhizoeaeus* sp.): In July 1981, the stored seed rhizomes of turmeric collected from the Turmeric Research Station, Digraj (Dist-Sangli) were found infested with *Rhizoeaeus* sp. This appears to be a new record in India. The nymphs and adult bugs were abundant on basal parts of germinating buds and beneath the scaly leaves on rhizomes. The sprouting of infested seed rhizomes was adversely affected. The morphological features of the species indicated that the adult female is wingless, slightly elongate and milky white in colour with distinct segmentation. It measures 3.2 mm in length and 2.1 mm in width. A pair of antennae is present and legs are well developed. The body is covered with a cottony white wax. The adult male is delicate, brownish yellow and active. It possesses a pair of transparent wings. A female laid between 95 to 162 eggs with an average of 120. Eggs are ellipsoidal, covered by loose cottony wax, small, and whitish in appearance. On an average the egg measures 0.21 x 0.12 mm in size. Freshly hatched nymph is ovate and milky white with a short pair of antennae. It measured 0.20 mm in length and 0.11 mm in width. The nymphs and adult bugs remain concealed beneath turmeric haulms and suck the sap. As a result of feeding, tender buds turn brownish in colour and lose their vigour. The sprouting is adversely affected in severe cases.

Tingid bugs: In September 1981, a moderate incidence of tingid bug, *S. typica* was observed on turmeric crop around Kolhapur. The preliminary observations recorded on the life history of this pest indicated that a female inserts eggs in leaflets on the lower surface. There are five nymphal instars during a period of about 16 days. The durations of different nymphal instars are given in Table below.
Table - Duration of nymphal instars of *S. typica*.

<table>
<thead>
<tr>
<th>Instar</th>
<th>Duration in days</th>
<th>Average (10 observations)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Range</td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>2-3</td>
<td>2.4</td>
</tr>
<tr>
<td>II</td>
<td>3-5</td>
<td>3.5</td>
</tr>
<tr>
<td>III</td>
<td>2-3</td>
<td>2.2</td>
</tr>
<tr>
<td>IV</td>
<td>4-5</td>
<td>4.4</td>
</tr>
<tr>
<td>V</td>
<td>2-5</td>
<td>3.1</td>
</tr>
<tr>
<td>Total</td>
<td>13-2-1</td>
<td>15.6</td>
</tr>
</tbody>
</table>

The nymphs are gregarious in habit and always remain in colonies on lower surface of leaves. The nymphs and adults suck the sap causing characteristic white spots on the surface of leaves. Ultimately, the infested leaves turn yellowish in colour and margins get curled up.

**Leaf roller:**

The incidence of leaf roller, *U. fulus* was recorded on turmeric and ginger crops during September-October, 1981 in the season. Preliminary studies were undertaken to study the biology of this pest on turmeric. The observations recorded showed that the total duration from egg to adult was 25.4 days. The incubation period ranged from 3 to 4 days. The larva passed through five instars. The full-grown larva is greenish in colour, stout and has black head. The duration of larval instars are given in Table below:

Table: Duration of life stages of *U. fulus* on turmeric.

| Incubation Period (days) | Larval instars (days) Total Pupal period duration from egg to adult(days) |
|--------------------------|--------------------------|-------------------------------------------------|
| Range                    | 3-4 2-3 2-3 2-4 2-5 3-6 11-22 6-7 20-33 |
| Average                  | 3.6 2.2 2.2 3.4 3.6 1.6 15.4 6.4 25.4 |
The caterpillars make a fresh leaf fold at each instar end and feed from within. The full-grown larva pupates in the leaf fold enveloped within a white waxy fluff. The pupal period lasts for 6-7 days. The s. upper butterfly is violet, black with white spots on wings.

Conclusions: Besides M. coeruleifrons, U. fc'ae, A. hartii, E. pulcheriai, and other diptaran maggots and unidentified mites infest turmeric and ginger crops in the field. In addition, turmeric also suffers from the attack of S. typica, P. indicus, H. serrata, H. juricorne, Rhizoecus sp, planococcoides sp., and O. gracile (snails). The intensity of rhizome fly was heavy while that of tingid bugs and leaf roller on turmeric was moderate. The mealy bugs infesting stored turmeric seed rhizomes have been recorded for the first time as new pest in Maharashtra State.

b) Survey of plant parasitic nematodes associated with turmeric and ginger in Maharashtra.

A survey of turmeric and ginger growing areas was undertaken during 1970-79 and 1979-80 to know the plant parasitic nematodes associated with these crops.

Methodology: Soil and rhizome samples were collected at random from different localities. The nematodes were extracted by sieving and decanting method using series of sieves viz; no.60, 100, 200 and 350 mesh. The nematodes thus recovered were killed by gentle heat and fixed in 5% formalin. The roots were stained in acid fuchsin with lactophenol. A list of identified nematodes is presented in Table-19.

Results: It could be seen from Table-19 that eleven different species of plant parasitic nematodes and some free living nematodes were recovered during the surveys in the state. As many as ten species were recorded on turmeric and seven on ginger. In turmeric H. Cylindrochir, Xiphinema, Meloidogyne and Tylanehorhynebus were found to be commonly associated. Amongst these, species belonging to H. Cylindrochir and Meloidogyne genera were the most predominant with an average density of population of 422 and 261 per 250ml of soil respectively. However, in ginger, species belonging to genera
Dorylaimillus was more predominant and was found to be commonly associated with the rhizomes. This species had maximum density of population of 454 per 250 ml of soil in a locality in Satara district. Helicotylenchus, Meloidogyne, Telenchus, Mononchida, Paratylenchus and Rotylenchus were less predominant with low density of population. It is interesting to note from Table-20 that Dorylaimillus sp. which was not observed on turmeric was the most predominant species on ginger. While Xiphinema, Boleodorus, Tylenchoryynchus and Nesiura were not observed on ginger rhizomes.

Conclusions: Eleven different species of plant parasitic nematodes were found to be associated with turmeric and ginger rhizomes in Maharashtra State. Helicotylenchus sp and Meloidogyne sp. in turmeric and, Dorylaimillus sp. in ginger were the most predominant.

Expt.-8: Studies on the efficacy of some insecticides against tingid bug, Stephanitis typica Distant infesting turmeric.

A field experiment was conducted during 1982-83 to find out the most effective insecticides for the control of tingid bugs S. typica infesting turmeric crop.

Methodology:

Experimental details:

Design of layout: Randomized block
Replications: Three
Treatments: 14 including control (As given in Table-21)
Variety: Rajapuri
Plot size: 5.0 x 4.0
Spacing: 22 x 22 cm
Location: Agril. College Farm, Kolhapur.
Date of planting: 11.5.1982
Date of spraying: 14.9.1982
Stage of pest: 2nd to 4th nymphal instar
Date of harvesting: 26.1.1983
Method of application and recording observation:

A single application of insecticides was given with a high volume knapsack sprayer when sufficient population of pest was observed. For assessing the efficacy of the insecticides, the population of tingid bug nymphs (2nd to 4th instar) was recorded prior to and 43 hours and 96 hours after treatment on three taro plants for each treatment and three leaves on each plant. The percent mortality of bugs due to insecticidal treatments was worked out. The data was analysed statistically after transforming percentages into arc-sin values.

Results: The results of the trial indicated that all the insecticidal treatments were superior to control in reducing the population of tingid bugs (Table 21). Amongst the treatments, monocrotophos (Monokem), phosphamidon (Dimecron), and methyl demeton (Metasystox) at 0.02 per cent were more effective recording 100% mortality of the pest at 96 hours after application. The treatments with malathion and bromophos ethyl at 0.02% recorded the minimum reduction of tingid bug population.

Conclusions: Treatments with 0.02% monocrotophos (Monokem), phosphamidon (Dimecron) or methyl demeton (Metasystox) spray were the most effective against tingid bugs on turmeric.

Expt.9: Studies on the efficacy of insecticides as seed dressers against scales, Aspidiella hartii against ginger in storage.

During 1982-83, a trial was laid out to find out the most effective insecticides/scales, A. hartii attacking stored ginger rhizomes in laboratory.

Methodology:

Experimental details:

Design of layout: Randomized block
Replications: Three
Treatments: 0 including control (Table 22)
Variety: Local
Location: College of Agriculture, Kolhapur.
Method of application/recording observation: To coat the ginger seed sets with different insecticides in the form of wettable powders, weighed quantities of heavey scale infested rhizomes were placed in a round plastic containers. Then slurry of insecticides was added to this. For uniform coating, the container was thoroughly shaken for 10 minutes. Similarly, emulsions of desired concentrations of insecticides were prepared in plastic containers and to this weighed quantity of scale infested ginger sets were added and kept 11 minutes. After seed treatment the sets were kept in petridishes treatmentwise in laboratory.

The observations on mortality of scales due to different treatments were recorded on 2nd, 4th 6th and 15th day after seed dressing. For determining the mortality, a treated set of ginger rhizome was taken and 20 scales were removed and state of scales (dead or alive) was ascertained by removing them and viewing under binocular microscope. In this way, replicationwise mortality percentages in different treatments were worked out. The data were subjected to statistical analysis after transforming into arc-sin angles.

Results: The data presented in Table 22 revealed that all the insecticidal treatments were superior to control in reducing the scale population. Seed treatments with Oncol, Landrin and isofenphos were more effective in controlling scales followed by other treatments. The seed dressing with BHC 50 wp at 0.4% recorded the least per cent reduction of scale insects. The percentage reduction in scales showed an increasing trend with time and was maximum at 15 days after seed dressing in all the treatments.

Conclusions: Seed treatment with Oncol 50wp at 25 gm/kg, Landrin 50wp at 12 gm/kg or isofenphos 40 SD at 40 gm/kg seed sets of ginger proved to be effective in controlling scales, *S. auritii* infesting stored ginger rhizomes.
The survey of turmeric and ginger growing areas of Maharashtra State showed that rhizome fly was quite serious on turmeric in Sangli district and on ginger in Satara district. The incidence of the pest was also recorded on both these crops in tracts of Parbhani, Nanded, and Solapur and Aurangabad districts of Maharashtra State. The data collected from surveys for estimation of losses caused by rhizome fly in endemic areas of Sangli and Satara districts revealed that the incidence of pest caused reduction in yields of turmeric and ginger to the extent of 25% and 31% respectively.

Observations recorded on the seasonal occurrence of rhizome fly in endemic pockets of Sangli and Satara districts indicated that the incidence of the pest on turmeric started in the second fortnight of July i.e. nearly two months after planting and was found maximum during the period between August to October, whereas in ginger fields it started in first fortnight of July and reached peak in September as evidenced by yellowing of affected shoots and infested rhizomes.

Studies on the biology of rhizome fly, M. coralloides, in laboratory indicated that the pest completed its life cycle within 40 to 65 days in turmeric and 35 to 47 days in ginger. A female deposited from 76 to 150 eggs in soil at a depth of 5mm. The incubation period varied from 2 to 5 days. Three larval instars were observed. The maggots were observed to be responsible for complete damage to rhizomes by feeding. The total larval period ranged between 13 to 25 days in turmeric and 15 to 23 days in ginger. The pupation took place in larval tunnel and the pupal period lasted for 5 to 15 days in turmeric and ginger respectively. The sex ratio was 1:1 approximately. The longevity of adult flies was almost same in both the sexes in laboratory. A hymenopteron parasite, Trichopria sp. was collected from its pupae. The hibernating maggots and pupae in infested seed rhizomes appeared to be responsible for carry over of the pest in turmeric.
while ratoon ginger fields were primarily responsible for early over of the pest from one season to another.

The results of the insecticidal trials conducted for three seasons against rhizome fly on turmeric revealed that the treatment consisting of seed dipping in the suspension of 0.4% BHC 50 wp plus 0.025% emosan 6% for 10 minutes just half an hour before planting followed by three soil applications of bromophos (5G) at the rate of 1.0 kg a.i./ha per application given at 30 days intervals starting from 45 days after planting date was highly effective in reducing the infestation of rhizome fly. Quinolphos 5G, phorate 10G, BHC 10% and carbaryl 10% dusts were the next promising treatments. Application of 3HC 10% dust on soil was found to be the most economical treatment in controlling rhizome fly.

The efficacy of insecticides tested against rhizome fly on ginger showed that the treatment consisting of seed dipping in the suspension of 0.4% BHC 50 wp plus 0.025% emosan 6% for 10 minutes just half an hour before planting followed by soil application of bromophos 5G at 1.0 kg a.i./ha, three times at intervals of 30 days commencing from one and half months after planting was the best in controlling the pest. Quinolphos 5G at 1.0 kg a.i./ha per application and phorate 10 G at 2.0 kg a.i./ha per application were the next best treatments. The level of residues of phorate in ginger rhizomes at harvest was 0.374 ppm when estimated by spectrophotometer described by Getz and Watts (1964) which is below tolerance limit of 0.5 ppm. Considerable reduction in incidence of rhizome rot malady of ginger was also found in leucom fruit, cotton seed and karanj cake treated plots at the rate of 2.5 tons/ha applied at planting.

Screening of 20 ginger types for resistance to rhizome fly under fairly heavy field infestation showed that 'Nadia' and 'Poona' types were the least susceptible to its attack. Field screening of turmeric varieties under fairly heavy natural infestation of rhizome fly, showed that varieties 'Waigoen' and 'Kasturi' followed by 'Duggirala', 'Sugandhum' and 'Tekurpeta' were less susceptible, whereas 'Rajapuri' a locally grown variety
Studies on causes on rhizome rot malady in turmeric and ginger revealed that rhizome fly was primarily responsible for damage to turmeric rhizomes while *Pythium*, *Fusarium* and nematodes were secondary in importance. During 1980-81, it was however, found that both rhizome fly and *Sclerotium* fungus alone as well as in combination played primary role in rotting malady of turmeric and ginger rhizomes.

The surveys conducted in Sangli, Satara and Kolhapur districts for the incidence of pests attacking turmeric and ginger crops indicated that besides rhizome fly, *M. coerulescens* there were several other pests. The intensity of *M. coerulescens* was heavy in all the places surveyed while moderate incidence of *S. typica* and *U. foles* was recorded on turmeric crop during the period between September to October. The intensity of scales, *A. harti* was more in stored rhizomes of both the crops. Minor incidence of *P. indicus*, *E. pulcherium* and *S. sorata* was recorded. The population of unidentified mites was heavy in field collected rotten rhizomes of turmeric and ginger, whereas cured turmeric setts were found infested heavily by *L. serricaepe*.

The field surveys of plant parasitic nematodes associated with turmeric and ginger undertaken during 1970-79 and 1979-80 in Maharashtra indicated that *Helicotylenchus* and *Meloidogyne* genera were commonly associated with turmeric rhizomes, while *Meloidogyne* and *Dorylaimidae* were more predominant with ginger rhizomes. Eleven species of plant parasitic nematodes were recovered in turmeric and ginger during the surveys.

It has been found from the efficacy of 13 different insecticides tested against tingid bugs, *S. typica* infesting turmeric that monocrotophos (Monok-m) 0.02%, phosphamidon (Dimecron) 0.02% or methy demeton (Methoxyf) at 0.02% concentration controlled 100% population of the pest 96 hours after spray. In the experiment on efficacy of seven different insecticides as seed dressers against scales, *A. hartii*, infesting ginger rhizomes it was observed that seed treatment with Oncol 50 sp at 25 gm/kg was the most effective in reducing pest population.
Based on the research findings, an integrated programme for the management of rhizome fly, *M. coerulophrans* infesting turmeric and ginger crops has been formulated as indicated below:

1. Select light and well-drained fields for planting of both turmeric and ginger crops.
2. Destroy the infested seed rhizomes before planting to prevent breeding of the pest in the season. Use only healthy seed rhizomes for planting.
3. Dip the seed rhizomes for 10 minutes in a suspension of 0.4% BHC 50WP plus, 0.025% oomison 6% (Mercurial compound) just half an hour before planting to give protection from stages of post surface infection against fungal diseases.
4. Avoid flooding and water stagnation in fields in August to October. Remove the excess water from fields.
5. Avoid interculturing operations like weeding during August to October to prevent injury to plants and rhizomes.
6. Inspect the fields regularly and remove the affected plants along with their rhizomes as soon as attack is seen and destroy them to prevent further multiplication of the pest in the season.
7. Give soil applications of bromophos 5% or quinalphos 5% or phorate 10% granules at 20 kg/ha or BHC 10% dust at 70 kg/ha 45 days after planting. The second and third applications of insecticide should be given at intervals of 30 days in August and September. Apply granules or dust near the base of plants, cover with soil and give light irrigation if no rains are received after application.
8. Use resistant varieties like 'Waigaoon' and 'Kasturi' of turmeric and 'Nadia' of ginger for planting particularly in endemic areas.
9. Deep ploughing soon after harvesting of crops should be undertaken to expose the hibernating stages of the pest. Also collect and destroy all the infested rhizomes at harvest to eliminate stages of pests therein.
10. In places where rhizome fly is endemic ratooning should be avoided and harvesting of crop must be done before the next season commences. This will prevent carry over of the pest to the next season.
11. Follow proper crop rotations of crops to check the continuous breeding of the pest.
Table 1. Incidence of rhizome fly on turmeric and ginger crops in Maharashtra State.

<table>
<thead>
<tr>
<th>District</th>
<th>Area (ha)</th>
<th>Turmeric</th>
<th>Ginger</th>
<th>Endemic pockets (Village)</th>
<th>Stage of pest found</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1978-79</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1979-80</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sangli</td>
<td>1067.00</td>
<td>14.00</td>
<td></td>
<td>Borgaon, Takari, Dudhazri, Alsund, Ghanwad, Pare, Chinchani (Mangrul), Karanje, Savlaj, Anjani, Malangaon, Manerajuri, Digraj and K' Mahankal.</td>
<td>Kushi, Chinchani, Savlaj, Larvae and Pupae, Daphalapur, Karve, Pare and Digraj.</td>
</tr>
<tr>
<td>Parbhani</td>
<td>1032.00</td>
<td>Nil</td>
<td></td>
<td>Not surveyed</td>
<td>Basamat Larvae, Pupae and flies.</td>
</tr>
<tr>
<td>Nanded</td>
<td>609.00</td>
<td>Nil</td>
<td></td>
<td>Not surveyed</td>
<td>Malagaon Pupae and flies Nil</td>
</tr>
<tr>
<td>Chandrapur*</td>
<td>434.41</td>
<td>Nil</td>
<td></td>
<td>Not surveyed</td>
<td>Nil Nil</td>
</tr>
<tr>
<td>Wardha *</td>
<td>30.00</td>
<td>Nil</td>
<td></td>
<td>Not surveyed</td>
<td>Nil Nil</td>
</tr>
<tr>
<td>Bhir</td>
<td>145.76</td>
<td>8.36</td>
<td></td>
<td>Not surveyed</td>
<td>Bhir Pupae and flies Larvae.</td>
</tr>
<tr>
<td>Aurangabad</td>
<td>Nil</td>
<td>40.00</td>
<td></td>
<td>Not surveyed</td>
<td>Khirdi and Khultabad Larvae.</td>
</tr>
<tr>
<td>Solapur</td>
<td>Not available</td>
<td>Not available</td>
<td>Not surveyed</td>
<td>Barshí</td>
<td>Larvae and Pupae</td>
</tr>
</tbody>
</table>

(Source: Asstt. Director (Cash crops) of respective districts)

* Places visited were Sumthana, Chinchorodi and Chimur in Chandrapur district and Waigaon and Hinganghat in Wardha district.
Table 2. Losses caused by rhizome fly in endemic areas of Maharashtra State

<table>
<thead>
<tr>
<th>District</th>
<th>Block</th>
<th>Village</th>
<th>Turmeric</th>
<th>Healthy (kg/100 Sq.m.area)</th>
<th>Infested (kg/100 Sq.m.area)</th>
<th>Loss in yield (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sangli</td>
<td>Khanapur</td>
<td>Chinchani</td>
<td>147.0</td>
<td>70.0</td>
<td>32.26</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tasgaon</td>
<td>Savalaj</td>
<td>150.0</td>
<td>68.0</td>
<td>31.19</td>
<td></td>
</tr>
<tr>
<td></td>
<td>K'Mahankal</td>
<td>Kuchi</td>
<td>189.0</td>
<td>68.0</td>
<td>26.46</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mira</td>
<td>Digraj</td>
<td>130.0</td>
<td>35.0</td>
<td>21.21</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Jat</td>
<td>Dhaphalapur</td>
<td>259.0</td>
<td>48.0</td>
<td>15.63</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Average</td>
<td>175.0</td>
<td>57.8</td>
<td>25.35</td>
<td></td>
</tr>
<tr>
<td>Satara</td>
<td></td>
<td>Borgaon</td>
<td>38.0</td>
<td>30.0</td>
<td>44.12</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Karad</td>
<td>Pol</td>
<td>49.0</td>
<td>27.0</td>
<td>35.53</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Satara</td>
<td>Pedali</td>
<td>71.0</td>
<td>31.0</td>
<td>30.39</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Satara</td>
<td>Nagthane</td>
<td>68.0</td>
<td>23.0</td>
<td>25.27</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Patan</td>
<td>Tarale</td>
<td>69.0</td>
<td>15.0</td>
<td>17.86</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Average</td>
<td>59.0</td>
<td>25.2</td>
<td>30.62</td>
<td></td>
</tr>
</tbody>
</table>
Table 3: Seasonal incidence of rhizome fly, *M. coeruleifrons* on turmeric

<table>
<thead>
<tr>
<th>Month</th>
<th>Date of Observation</th>
<th>Av. No. of flies/25 Sq.m. area</th>
<th>Av. per cent infested rhizomes/25 Sq.m. area</th>
<th>Date of Observation</th>
<th>Av. No. of flies/25 Sq.m. area</th>
<th>Av. per cent infested rhizomes/25 Sq.m. area</th>
</tr>
</thead>
<tbody>
<tr>
<td>June</td>
<td>02.06.79</td>
<td>0.0</td>
<td>0.0</td>
<td>05.06.80</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>21.06.79</td>
<td>0.0</td>
<td>0.0</td>
<td>23.06.80</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>July</td>
<td>16.07.79</td>
<td>1.0</td>
<td>0.0</td>
<td>12.07.80</td>
<td>2.5</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>28.07.79</td>
<td>7.2</td>
<td>0.0</td>
<td>20.07.80</td>
<td>8.0</td>
<td>0.0</td>
</tr>
<tr>
<td>August</td>
<td>17.08.79</td>
<td>11.0</td>
<td>17.0</td>
<td>16.08.80</td>
<td>16.0</td>
<td>7.5</td>
</tr>
<tr>
<td></td>
<td>28.08.79</td>
<td>15.5</td>
<td>30.0</td>
<td>19.08.80</td>
<td>12.0</td>
<td>1.5</td>
</tr>
<tr>
<td>September</td>
<td>11.09.79</td>
<td>12.2</td>
<td>35.0</td>
<td>09.09.80</td>
<td>10.0</td>
<td>22.5</td>
</tr>
<tr>
<td></td>
<td>26.09.79</td>
<td>8.5</td>
<td>30.0</td>
<td>18.09.80</td>
<td>7.5</td>
<td>25.0</td>
</tr>
<tr>
<td>October</td>
<td>15.10.79</td>
<td>15.7</td>
<td>25.0</td>
<td>07.10.80</td>
<td>4.7</td>
<td>25.0</td>
</tr>
<tr>
<td></td>
<td>26.10.79</td>
<td>8.2</td>
<td>35.0</td>
<td>16.10.80</td>
<td>4.0</td>
<td>32.5</td>
</tr>
<tr>
<td>November</td>
<td>07.11.79</td>
<td>1.7</td>
<td>15.0</td>
<td>02.11.80</td>
<td>0.5</td>
<td>10.0</td>
</tr>
<tr>
<td></td>
<td>22.11.79</td>
<td>2.0</td>
<td>10.0</td>
<td>18.11.80</td>
<td>0.0</td>
<td>5.0</td>
</tr>
<tr>
<td>December</td>
<td>05.12.79</td>
<td>0.0</td>
<td>2.0</td>
<td>05.12.80</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>27.12.79</td>
<td>1.0</td>
<td>10.0</td>
<td>22.12.80</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>January</td>
<td>15.01.80</td>
<td>0.0</td>
<td>0.0</td>
<td>04.01.81</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>02.02.80</td>
<td>0.0</td>
<td>0.0</td>
<td>28.01.81</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>February</td>
<td></td>
<td>0.0</td>
<td>0.0</td>
<td>05.02.81</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>25.02.81</td>
<td>0.0</td>
<td>0.0</td>
<td>25.02.81</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

Date of planting: 08.05.1979
Date of harvesting: 02.02.1980

Date of planting: 1980
Date of harvesting: 02.02.1980
<table>
<thead>
<tr>
<th>Month</th>
<th>Date of observation</th>
<th>Avg. No. of flies/25 Sq.m. area</th>
<th>Av. per cent infested rhizomes/25 Sq.m. area</th>
<th>No. of flies/25 Sq.m. area</th>
<th>Per cent infested rhizomes/25 Sq.m. area</th>
<th>Av. Rainfall (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>June</td>
<td>08.06.81</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>76.3</td>
</tr>
<tr>
<td></td>
<td>26.06.81</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>35.0</td>
</tr>
<tr>
<td></td>
<td>10.07.81</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>37.0</td>
</tr>
<tr>
<td></td>
<td>22.07.81</td>
<td>0.5</td>
<td>0.0</td>
<td>5.2</td>
<td>0.0</td>
<td>45.7</td>
</tr>
<tr>
<td>July</td>
<td>05.08.81</td>
<td>2.3</td>
<td>0.0</td>
<td>9.8</td>
<td>8.2</td>
<td>71.7</td>
</tr>
<tr>
<td></td>
<td>25.08.81</td>
<td>5.5</td>
<td>10.0</td>
<td>11.0</td>
<td>18.3</td>
<td>37.7</td>
</tr>
<tr>
<td>August</td>
<td>04.09.81</td>
<td>20.0</td>
<td>32.5</td>
<td>14.1</td>
<td>30.0</td>
<td>110.5</td>
</tr>
<tr>
<td></td>
<td>22.09.81</td>
<td>15.3</td>
<td>35.0</td>
<td>10.4</td>
<td>30.0</td>
<td>103.7</td>
</tr>
<tr>
<td>September</td>
<td>03.10.81</td>
<td>7.5</td>
<td>30.0</td>
<td>9.3</td>
<td>20.0</td>
<td>19.7</td>
</tr>
<tr>
<td></td>
<td>19.10.81</td>
<td>5.0</td>
<td>1.25</td>
<td>5.7</td>
<td>26.7</td>
<td>5.5</td>
</tr>
<tr>
<td>October</td>
<td>05.11.81</td>
<td>1.0</td>
<td>0.0</td>
<td>1.1</td>
<td>8.3</td>
<td>8.3</td>
</tr>
<tr>
<td></td>
<td>24.11.81</td>
<td>0.5</td>
<td>0.0</td>
<td>0.8</td>
<td>5.0</td>
<td>16.3</td>
</tr>
<tr>
<td>November</td>
<td>07.12.81</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.7</td>
<td>4.8</td>
</tr>
<tr>
<td>December</td>
<td>27.12.81</td>
<td>0.0</td>
<td>0.0</td>
<td>0.3</td>
<td>3.3</td>
<td>0.0</td>
</tr>
<tr>
<td>January</td>
<td>15.01.82</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>31.01.82</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>—</td>
</tr>
<tr>
<td>February</td>
<td>04.02.82</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>—</td>
</tr>
</tbody>
</table>

Date of planting: 08/06/81
Date of harvesting: 04/02/82
Table 4: Seasonal incidence of rhizome fly, *M. coerulogironis* in ginger (Nagthane, Dist. Satara)

<table>
<thead>
<tr>
<th>Month</th>
<th>Date of observation</th>
<th>1278-80</th>
<th>Av. No. of flies/25 Sq.m.area.</th>
<th>Av. per cent infested rhizomes/25 Sq.m.area</th>
<th>Date of observation</th>
<th>1980-81</th>
<th>Av. No. of flies/25 Sq.m.area.</th>
<th>Av. per cent infested rhizomes/25 Sq.m.area</th>
</tr>
</thead>
<tbody>
<tr>
<td>May</td>
<td>15.05.79</td>
<td>0.0</td>
<td>0.0</td>
<td>08.05.80</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>21.05.79</td>
<td>0.0</td>
<td>0.0</td>
<td>19.05.80</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>June</td>
<td>12.06.79</td>
<td>0.0</td>
<td>0.0</td>
<td>04.06.80</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>21.06.79</td>
<td>0.0</td>
<td>0.0</td>
<td>20.06.80</td>
<td>0.5</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>July</td>
<td>03.07.79</td>
<td>1.5</td>
<td>0.0</td>
<td>12.07.80</td>
<td>3.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>26.07.79</td>
<td>5.0</td>
<td>0.0</td>
<td>21.07.80</td>
<td>5.7</td>
<td>0.0</td>
<td>1.8</td>
<td>25.0</td>
</tr>
<tr>
<td>August</td>
<td>10.00.79</td>
<td>12.7</td>
<td>10.0</td>
<td>06.08.80</td>
<td>10.0</td>
<td>0.0</td>
<td>30.0</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>30.08.79</td>
<td>12.5</td>
<td>20.0</td>
<td>18.08.80</td>
<td>11.7</td>
<td>0.0</td>
<td>35.0</td>
<td>0.0</td>
</tr>
<tr>
<td>September</td>
<td>12.09.79</td>
<td>14.2</td>
<td>35.0</td>
<td>11.08.80</td>
<td>3.2</td>
<td>0.0</td>
<td>10.0</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>25.09.79</td>
<td>15.5</td>
<td>37.0</td>
<td>24.09.80</td>
<td>4.8</td>
<td>0.0</td>
<td>15.0</td>
<td>0.0</td>
</tr>
<tr>
<td>October</td>
<td>04.10.79</td>
<td>10.2</td>
<td>27.0</td>
<td>13.10.80</td>
<td>4.8</td>
<td>0.0</td>
<td>10.0</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>19.10.79</td>
<td>5.7</td>
<td>12.0</td>
<td>25.10.80</td>
<td>0.5</td>
<td>0.0</td>
<td>35.0</td>
<td>0.0</td>
</tr>
<tr>
<td>November</td>
<td>02.11.79</td>
<td>2.0</td>
<td>10.0</td>
<td>17.11.80</td>
<td>0.0</td>
<td>0.0</td>
<td>10.0</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>27.11.79</td>
<td>0.5</td>
<td>0.0</td>
<td>29.11.80</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>December</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Date of planting 15.05.1979
Date of harvesting 27.11.1979
Date of planting 08.05.1980
Date of harvesting 10.12.1980
<table>
<thead>
<tr>
<th>Month</th>
<th>Date of observation</th>
<th>1981-82 Av. No. of flies/25 Sq.m.area.</th>
<th>Av. per cent infested rhizomes/25 Sq.m.area.</th>
<th>Pooled G mean per cent infested rhizomes/25 Sq.m.area.</th>
<th>Average Rainfall (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>May</td>
<td>13.05.81</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>22.05.81</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>June</td>
<td>04.06.81</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>58.3</td>
</tr>
<tr>
<td></td>
<td>19.06.81</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>81.5</td>
</tr>
<tr>
<td>July</td>
<td>07.07.81</td>
<td>0.0</td>
<td>0.0</td>
<td>142.8</td>
<td>68.0</td>
</tr>
<tr>
<td></td>
<td>24.07.81</td>
<td>0.0</td>
<td>0.0</td>
<td>3.3</td>
<td></td>
</tr>
<tr>
<td>August</td>
<td>05.08.81</td>
<td>1.3</td>
<td>9.0</td>
<td>36.7</td>
<td>43.8</td>
</tr>
<tr>
<td></td>
<td>31.08.81</td>
<td>3.0</td>
<td>9.1</td>
<td>36.7</td>
<td></td>
</tr>
<tr>
<td>September</td>
<td>13.09.81</td>
<td>4.5</td>
<td>15.0</td>
<td>36.7</td>
<td>43.8</td>
</tr>
<tr>
<td></td>
<td>24.09.81</td>
<td>2.5</td>
<td>7.3</td>
<td></td>
<td>125.8</td>
</tr>
<tr>
<td>October</td>
<td>01.10.81</td>
<td>1.5</td>
<td>20.0</td>
<td>19.0</td>
<td>41.0</td>
</tr>
<tr>
<td></td>
<td>15.10.81</td>
<td>1.3</td>
<td>4.2</td>
<td>7.3</td>
<td>9.3</td>
</tr>
<tr>
<td>November</td>
<td>03.11.81</td>
<td>1.0</td>
<td>10.0</td>
<td>3.3</td>
<td>13.0</td>
</tr>
<tr>
<td></td>
<td>30.11.81</td>
<td>1.0</td>
<td>2.5</td>
<td>3.3</td>
<td>29.1</td>
</tr>
<tr>
<td>December</td>
<td>05.12.81</td>
<td>0.5</td>
<td>0.0</td>
<td>3.3</td>
<td>13.0</td>
</tr>
<tr>
<td></td>
<td>29.12.81</td>
<td>0.0</td>
<td>0.0</td>
<td>3.3</td>
<td>2.3</td>
</tr>
</tbody>
</table>

Date of planting 13.05.1981
Data of harvesting 27.01.1982
Table 5: Durations of various stages of thri2ome fly, M. concavata, from tomato and ginger

<table>
<thead>
<tr>
<th>Generation</th>
<th>Date of egg laying</th>
<th>No. of eggs</th>
<th>Hatching (%)</th>
<th>Egg stage</th>
<th>Duration of larval instars in days</th>
<th>Total larval period in days</th>
<th>Date of adult emergence</th>
<th>Total period of adults from egg to adult in days</th>
<th>Longevity of adults (days)</th>
<th>Sex Ratio M:F</th>
<th>Total Life span in days</th>
</tr>
</thead>
<tbody>
<tr>
<td>RHEERIC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aug-Sept, 28.70</td>
<td>25</td>
<td>91.7</td>
<td>3.2</td>
<td>-</td>
<td>-</td>
<td>16.0</td>
<td>13.5</td>
<td>5-9-70 to 33.1</td>
<td>16.7</td>
<td>19.0</td>
<td>1:1.3</td>
</tr>
<tr>
<td>1970</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sept-Oct, 9.70</td>
<td>25</td>
<td>33.5</td>
<td>3.5</td>
<td>-</td>
<td>-</td>
<td>14.0</td>
<td>1.22</td>
<td>10.10-10.10</td>
<td>29.3</td>
<td>17.1</td>
<td>21.3</td>
</tr>
<tr>
<td>1970</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aug-Sept, 30.0.79</td>
<td>25</td>
<td>79.0</td>
<td>3.0</td>
<td>-</td>
<td>-</td>
<td>24.1</td>
<td>1.12</td>
<td>2.10-9.9</td>
<td>37.3</td>
<td>9.0</td>
<td>10.0</td>
</tr>
<tr>
<td>1970</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aug-Sept, 21.0.00 &amp; 23</td>
<td>90.6</td>
<td>2.6</td>
<td>5.7</td>
<td>4.0</td>
<td>4.0</td>
<td>15.3</td>
<td>9.7</td>
<td>15.9-21.0</td>
<td>27.6</td>
<td>15.0</td>
<td>10.4</td>
</tr>
<tr>
<td>1979</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aug-Sept, 12.10 &amp; 23</td>
<td>91.2</td>
<td>2.9</td>
<td>3.5</td>
<td>3.6</td>
<td>11.9</td>
<td>20.2</td>
<td>7.9</td>
<td>5.10-11.0</td>
<td>31.0</td>
<td>9.6</td>
<td>13.0</td>
</tr>
<tr>
<td>1981</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RHEERIC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aug-Sept, 28.70</td>
<td>25</td>
<td>91.7</td>
<td>3.2</td>
<td>-</td>
<td>-</td>
<td>16.0</td>
<td>13.5</td>
<td>5-9-70 to 33.1</td>
<td>16.7</td>
<td>19.0</td>
<td>1:1.3</td>
</tr>
<tr>
<td>1979</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sept-Oct, 9.70</td>
<td>25</td>
<td>33.5</td>
<td>3.5</td>
<td>-</td>
<td>-</td>
<td>14.0</td>
<td>1.22</td>
<td>10.10-10.10</td>
<td>29.3</td>
<td>17.1</td>
<td>21.3</td>
</tr>
<tr>
<td>1979</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aug-Sept, 30.0.79</td>
<td>25</td>
<td>79.0</td>
<td>3.0</td>
<td>-</td>
<td>-</td>
<td>24.1</td>
<td>1.12</td>
<td>2.10-9.9</td>
<td>37.3</td>
<td>9.0</td>
<td>10.0</td>
</tr>
<tr>
<td>1979</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aug-Sept, 21.0.00 &amp; 23</td>
<td>90.6</td>
<td>2.6</td>
<td>5.7</td>
<td>4.0</td>
<td>4.0</td>
<td>15.3</td>
<td>9.7</td>
<td>15.9-21.0</td>
<td>27.6</td>
<td>15.0</td>
<td>10.4</td>
</tr>
<tr>
<td>1980</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aug-Sept, 12.10 &amp; 23</td>
<td>91.2</td>
<td>2.9</td>
<td>3.5</td>
<td>3.6</td>
<td>11.9</td>
<td>20.2</td>
<td>7.9</td>
<td>5.10-11.0</td>
<td>31.0</td>
<td>9.6</td>
<td>13.0</td>
</tr>
<tr>
<td>1981</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figures in parentheses are range values.

<table>
<thead>
<tr>
<th>Year</th>
<th>Period</th>
<th>Yea Temp. (°C)</th>
<th>Min.</th>
<th>Max.</th>
<th>Relative humidity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1978</td>
<td>2.0-70</td>
<td>15.10-70</td>
<td>22.0</td>
<td>20.0</td>
<td>80-85</td>
</tr>
<tr>
<td>1979</td>
<td>30.8-79</td>
<td>10.10-79</td>
<td>23.0</td>
<td>29.5</td>
<td>62-00</td>
</tr>
<tr>
<td>1980</td>
<td>21.8-80</td>
<td>24.9-80</td>
<td>23.0-</td>
<td>20.5</td>
<td>65-87</td>
</tr>
<tr>
<td>1981</td>
<td>26.0-01</td>
<td>10.10-01</td>
<td>22.0</td>
<td>20.0</td>
<td>59-06</td>
</tr>
</tbody>
</table>
Table 6: Natural parasitism of pupae of *M. coerulescens* by *Trichopria* sp.

<table>
<thead>
<tr>
<th>Date of collection</th>
<th>1978</th>
<th>1979</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Met. week</td>
<td>No. of pupae collected</td>
</tr>
<tr>
<td>4.6.78</td>
<td>32</td>
<td>45</td>
</tr>
<tr>
<td>5.8.78</td>
<td>34</td>
<td>75</td>
</tr>
<tr>
<td>5.9.70</td>
<td>37</td>
<td>57</td>
</tr>
<tr>
<td>3.9.78</td>
<td>39</td>
<td>125</td>
</tr>
<tr>
<td>2.10.78</td>
<td>41</td>
<td>150</td>
</tr>
<tr>
<td>7.10.78</td>
<td>43</td>
<td>100</td>
</tr>
<tr>
<td>1.11.78</td>
<td>45</td>
<td>140</td>
</tr>
<tr>
<td>5.11.78</td>
<td>47</td>
<td>70</td>
</tr>
<tr>
<td>1.12.78</td>
<td>50</td>
<td>75</td>
</tr>
<tr>
<td>.12.78</td>
<td>52</td>
<td>50</td>
</tr>
</tbody>
</table>

**Total** 895  271  **Av. 30.2**  

**Total** 1011  269  **Av. 26.5**

Meteorological data during 1978 was not recorded.
Table 7: Emergence of rhizome flies from seed material of turmeric

<table>
<thead>
<tr>
<th>Date of observation</th>
<th>Stored seed rhizomes</th>
<th>Planted rhizomes in fields</th>
<th>Weekly temp. (°C)</th>
<th>Total weekly rainfall (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I</td>
<td>II</td>
<td>Total</td>
<td>I</td>
</tr>
<tr>
<td>20-4-1981</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>14-5-1981</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>21-5-1981</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>30-5-1981</td>
<td>3</td>
<td>2</td>
<td>5</td>
<td>-</td>
</tr>
<tr>
<td>8-6-1981</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>15-6-1981</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>26-6-1981</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>13-7-1981</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>22-7-1901</td>
<td>2</td>
<td>3</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>31-7-1901</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>6-8-1901</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>12-8-1901</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>25-0-1901</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>4-9-1901</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>13-9-1901</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

* Date of planting: 13-7-1901.
### Table-6: Effect of various pesticides in controlling rhizome rot malady of turmeric and ginger.

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Treatment</th>
<th>Dos./rate</th>
<th>Turmeric</th>
<th>Ginger</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>% of infested rhizomes</td>
<td>resin mean</td>
<td>Yield of healthy rhizomes q/ha</td>
</tr>
<tr>
<td>1.</td>
<td>Agallol - A</td>
<td>0.25%</td>
<td>33.92</td>
<td>35.50</td>
</tr>
<tr>
<td>2.</td>
<td>BHC 50 WP - B</td>
<td>0.4%</td>
<td>30.34</td>
<td>33.29</td>
</tr>
<tr>
<td>3.</td>
<td>Carbofuran 40F - C</td>
<td>5.0%</td>
<td>29.11</td>
<td>32.63</td>
</tr>
<tr>
<td>4.</td>
<td>DDT 50 UP - D</td>
<td>0.4%</td>
<td>33.1</td>
<td>35.13</td>
</tr>
<tr>
<td>5.</td>
<td>Carbaryl 50WP - E</td>
<td>0.4%</td>
<td>33.7</td>
<td>35.47</td>
</tr>
<tr>
<td></td>
<td></td>
<td>% of infested rhizomes</td>
<td>resin mean</td>
<td>Yield of healthy rhizomes q/ha</td>
</tr>
<tr>
<td>I) Seed treatment</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Agallol - A</td>
<td>0.25%</td>
<td>33.92</td>
<td>35.50</td>
</tr>
<tr>
<td>2.</td>
<td>BHC 50 WP - B</td>
<td>0.4%</td>
<td>30.34</td>
<td>33.29</td>
</tr>
<tr>
<td>3.</td>
<td>Carbofuran 40F - C</td>
<td>5.0%</td>
<td>29.11</td>
<td>32.63</td>
</tr>
<tr>
<td>4.</td>
<td>DDT 50 UP - D</td>
<td>0.4%</td>
<td>33.1</td>
<td>35.13</td>
</tr>
<tr>
<td>5.</td>
<td>Carbaryl 50WP - E</td>
<td>0.4%</td>
<td>33.7</td>
<td>35.47</td>
</tr>
<tr>
<td>II) Seed treatment + Soil application</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>A + BHC 10%</td>
<td>5 kg a.i./ha</td>
<td>20.05</td>
<td>32.46</td>
</tr>
<tr>
<td>7.</td>
<td>A + Phorate 10G</td>
<td>1.07 kg a.i./ha</td>
<td>27.05</td>
<td>31.29</td>
</tr>
<tr>
<td>8.</td>
<td>D. A + Quinalphos 5G</td>
<td>-do-</td>
<td>29.07</td>
<td>33.66</td>
</tr>
<tr>
<td>10.</td>
<td>A + Carbofuran 3G</td>
<td>-do-</td>
<td>29.62</td>
<td>32.03</td>
</tr>
<tr>
<td>11.</td>
<td>B + BHC 10%</td>
<td>5 kg a.i./ha</td>
<td>23.00</td>
<td>20.42</td>
</tr>
<tr>
<td>12.</td>
<td>B + Phorate 10G</td>
<td>1.07 kg a.i./ha</td>
<td>20.17</td>
<td>31.96</td>
</tr>
<tr>
<td>13.</td>
<td>B + Quinalphos 5G</td>
<td>-do-</td>
<td>30.07</td>
<td>33.72</td>
</tr>
<tr>
<td>14.</td>
<td>B + Carbaryl 46</td>
<td>-do-</td>
<td>20.55</td>
<td>32.11</td>
</tr>
<tr>
<td>15.</td>
<td>B + Carbofuran 3G</td>
<td>-do-</td>
<td>29.77</td>
<td>33.04</td>
</tr>
<tr>
<td>III) Seed treatment + drenching</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16.</td>
<td>A + Agallol</td>
<td>0.25%</td>
<td>29.03</td>
<td>32.52</td>
</tr>
<tr>
<td>17.</td>
<td>A + Cheshunt Camp.</td>
<td>0.3%</td>
<td>32.01</td>
<td>34.42</td>
</tr>
<tr>
<td>18.</td>
<td>A + Blitox</td>
<td>0.25%</td>
<td>30.23</td>
<td>33.31</td>
</tr>
<tr>
<td>19.</td>
<td>A + Nemagon</td>
<td>0.1%</td>
<td>32.24</td>
<td>34.59</td>
</tr>
<tr>
<td>20.</td>
<td>B + Agallol</td>
<td>0.25%</td>
<td>33.90</td>
<td>35.49</td>
</tr>
<tr>
<td>21.</td>
<td>B + Cheshunt camp.</td>
<td>O.3%</td>
<td>31.31</td>
<td>34.01</td>
</tr>
<tr>
<td>22.</td>
<td>B + Blitox</td>
<td>0.25%</td>
<td>32.50</td>
<td>34.66</td>
</tr>
<tr>
<td>23.</td>
<td>B + Nemagon</td>
<td>0.1%</td>
<td>32.12</td>
<td>33.65</td>
</tr>
</tbody>
</table>
Table 8 contd...

<table>
<thead>
<tr>
<th></th>
<th>2.</th>
<th>3.</th>
<th>4.</th>
<th>5.</th>
<th>6.</th>
<th>7.</th>
<th>8.</th>
<th>9.</th>
</tr>
</thead>
<tbody>
<tr>
<td>IV) Seed treatment + Foliar application</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24. A + BHC 50WP</td>
<td>0.2%</td>
<td>30.72</td>
<td>33.61</td>
<td>140.06</td>
<td>19.02</td>
<td>25.01</td>
<td>30.05</td>
<td></td>
</tr>
<tr>
<td>25. A + Carbaryl 50WP</td>
<td>0.2%</td>
<td>34.60</td>
<td>35.91</td>
<td>125.50</td>
<td>34.06</td>
<td>35.73</td>
<td>30.27</td>
<td></td>
</tr>
<tr>
<td>26. A + Quinalphos 25 EC</td>
<td>0.05%</td>
<td>30.67</td>
<td>33.57</td>
<td>119.75</td>
<td>29.03</td>
<td>31.65</td>
<td>52.70</td>
<td></td>
</tr>
<tr>
<td>27. A + Endosulfan 35 EC</td>
<td>0.05%</td>
<td>29.75</td>
<td>33.02</td>
<td>133.36</td>
<td>31.55</td>
<td>33.44</td>
<td>55.27</td>
<td></td>
</tr>
<tr>
<td>28. A + Carbaryl 50WP + Dithane 2 70</td>
<td>0.5%</td>
<td>29.61</td>
<td>32.95</td>
<td>125.02</td>
<td>16.30</td>
<td>23.64</td>
<td>40.24</td>
<td></td>
</tr>
<tr>
<td>29. B + BHC 50WP</td>
<td>0.2%</td>
<td>29.75</td>
<td>32.04</td>
<td>126.07</td>
<td>22.24</td>
<td>27.91</td>
<td>34.44</td>
<td></td>
</tr>
<tr>
<td>30. B + Carbaryl 50WP</td>
<td>0.2%</td>
<td>27.65</td>
<td>31.73</td>
<td>124.47</td>
<td>26.36</td>
<td>30.41</td>
<td>53.64</td>
<td></td>
</tr>
<tr>
<td>31. B + Quinalphos 25 EC</td>
<td>0.05%</td>
<td>29.11</td>
<td>31.95</td>
<td>130.50</td>
<td>24.94</td>
<td>29.24</td>
<td>43.33</td>
<td></td>
</tr>
<tr>
<td>32. B + Endosulfan 35 EC</td>
<td>0.05%</td>
<td>30.25</td>
<td>33.37</td>
<td>120.00</td>
<td>34.02</td>
<td>35.92</td>
<td>20.09</td>
<td></td>
</tr>
<tr>
<td>33. B + Carbaryl 50 WP + Dithane Z 70</td>
<td>0.7%</td>
<td>33.96</td>
<td>35.57</td>
<td>116.41</td>
<td>51.33</td>
<td>45.76</td>
<td>19.72</td>
<td></td>
</tr>
</tbody>
</table>

V) Seed treatment + Whorl application

<table>
<thead>
<tr>
<th></th>
<th>34. A + Carbaryl 4 G</th>
<th>0.25 kg a.i./ha</th>
<th>34.07</th>
<th>36.13</th>
<th>140.03</th>
<th>41.32</th>
<th>39.63</th>
<th>31.11</th>
</tr>
</thead>
<tbody>
<tr>
<td>35. A + Endosulfan 4G</td>
<td>-do-</td>
<td>30.90</td>
<td>33.97</td>
<td>140.50</td>
<td>25.76</td>
<td>30.01</td>
<td>56.39</td>
<td></td>
</tr>
<tr>
<td>36. B + Carbaryl 4G</td>
<td>-do-</td>
<td>31.55</td>
<td>34.06</td>
<td>139.47</td>
<td>22.37</td>
<td>27.47</td>
<td>61.66</td>
<td></td>
</tr>
<tr>
<td>37. B + Endosulfan 4G</td>
<td>-do-</td>
<td>35.39</td>
<td>36.49</td>
<td>132.25</td>
<td>20.05</td>
<td>32.50</td>
<td>23.33</td>
<td></td>
</tr>
<tr>
<td>38. Diazinon 5G Soil Appln. 1.07 kg a.i./ha + Diazinon 20 EC spray</td>
<td>0.05%</td>
<td>3D.43</td>
<td>33.21</td>
<td>146.42</td>
<td>21.77</td>
<td>26.04</td>
<td>56.66</td>
<td></td>
</tr>
<tr>
<td>39. Untreated control</td>
<td>-</td>
<td>.80.41</td>
<td>30.31</td>
<td>122.24</td>
<td>51.90</td>
<td>46.16</td>
<td>16.30</td>
<td></td>
</tr>
<tr>
<td>S.E</td>
<td>1.52</td>
<td>14.27</td>
<td>5.45</td>
<td>14.30</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C.D. at 5%</td>
<td>4.19</td>
<td>N.S.</td>
<td>15.10</td>
<td>39.05</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 9: Effect of different oilcakes cakes against rhizome rot malady of ginger.

<table>
<thead>
<tr>
<th>Cake</th>
<th>Dose (ton/ha)</th>
<th>Dead shoots* (%)</th>
<th>Rotten rhizomes (Q/ha)</th>
<th>Yield of healthy rhizomes (%)</th>
<th>Av. population of nematicides 250 ml -</th>
<th>Infestation of fungi in rotten rhizomes (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neem fruit</td>
<td>2.5</td>
<td>24.12 (28.72)**</td>
<td>16.83 (23.95)</td>
<td>50.00</td>
<td>10.5</td>
<td>100</td>
</tr>
<tr>
<td>Cotton seed</td>
<td>2.5</td>
<td>34.20 (35.53)</td>
<td>16.75 (23.02)</td>
<td>55.00</td>
<td>12.7</td>
<td>77.22</td>
</tr>
<tr>
<td>Karanj</td>
<td>2.5</td>
<td>35.27 (36.27)</td>
<td>19.29 (25.96)</td>
<td>55.89</td>
<td>12.8</td>
<td>83.33</td>
</tr>
<tr>
<td>Groundnut</td>
<td>2.5</td>
<td>35.40 (36.30)</td>
<td>24.50 (29.64)</td>
<td>45.00</td>
<td>20.0</td>
<td>1 U.11</td>
</tr>
<tr>
<td>Neem seed</td>
<td>2.5</td>
<td>36.48 (37.14)</td>
<td>26.07 (30.60)</td>
<td>41.67</td>
<td>20.5</td>
<td>127.77</td>
</tr>
<tr>
<td>Mahua</td>
<td>2.5</td>
<td>42.76 (40.84)</td>
<td>26.38 (30.88)</td>
<td>37.22</td>
<td>21.5</td>
<td>140.11</td>
</tr>
<tr>
<td>Kusum</td>
<td>2.5</td>
<td>44.48 (41.31)</td>
<td>26.19 (30.74)</td>
<td>28.05</td>
<td>23.0</td>
<td>146.44</td>
</tr>
<tr>
<td>Control</td>
<td></td>
<td>70.70 (57.31)</td>
<td>53.09 (46.81)</td>
<td>18.06</td>
<td>36.3</td>
<td>422.22</td>
</tr>
<tr>
<td>S.E. ±</td>
<td></td>
<td>3.46</td>
<td>2.50</td>
<td>6.66</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C.D. at 5%</td>
<td></td>
<td>10.49</td>
<td>7.57</td>
<td>20.20</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Mean of three replications; ** Figures in parentheses are arcsin values.
Table 10: Efficacy of different insecticides tested during 1979-80 to 1981-82 against rhizome fly on turmeric.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Dose kg a.i./ha</th>
<th>1970-79</th>
<th>Mean yield of healthy rhizomes (Q/ha)</th>
<th>1979-80</th>
<th>Mean yield of healthy rhizomes (Q/ha)</th>
<th>1981-82</th>
<th>Mean yield of healthy rhizomes (Q/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bromophos 5G</td>
<td>1.0</td>
<td>2.29(7.53)*</td>
<td>191.17</td>
<td>2.47(8.92)</td>
<td>265.00</td>
<td>2.04(9.66)</td>
<td>157.85</td>
</tr>
<tr>
<td>Quinalphos 5G</td>
<td>1.0</td>
<td>2.34(7.74)</td>
<td>180.33</td>
<td>4.35(11.31)</td>
<td>270.00</td>
<td>3.67(11.01)</td>
<td>151.43</td>
</tr>
<tr>
<td>Phorate 10G</td>
<td>2.0</td>
<td>1.88(7.90)</td>
<td>198.00</td>
<td>4.18(11.80)</td>
<td>295.00</td>
<td>4.19(11.76)</td>
<td>161.07</td>
</tr>
<tr>
<td>Aldicarb 10G</td>
<td>2.0</td>
<td>2.20(8.50)</td>
<td>182.67</td>
<td>5.47(13.09)</td>
<td>295.33</td>
<td>2.73(9.21)</td>
<td>194.43</td>
</tr>
<tr>
<td>Carbaryl 4G</td>
<td>1.0</td>
<td>2.52(7.46)</td>
<td>130.17*</td>
<td>8.08(16.40)</td>
<td>301.67</td>
<td>3.83(11.18)</td>
<td>157.85</td>
</tr>
<tr>
<td>B.H.C 10% D</td>
<td>7.0</td>
<td>1.50(6.87)</td>
<td>176.67</td>
<td>5.90(13.69)</td>
<td>264.17</td>
<td>3.96(11.49)</td>
<td>152.72</td>
</tr>
<tr>
<td>Carbaryl 10% D</td>
<td>7.5</td>
<td>2.33(8.66)</td>
<td>196.00</td>
<td>4.94(12.66)</td>
<td>291.67</td>
<td>4.12(11.68)</td>
<td>155.93</td>
</tr>
<tr>
<td>Isofenphos 5G</td>
<td>1.0</td>
<td>4.52(11.26)</td>
<td>150.50</td>
<td>6.17(14.36)</td>
<td>299.17</td>
<td>4.48(12.07)</td>
<td>152.08</td>
</tr>
<tr>
<td>Carbofuran 3G</td>
<td>1.0</td>
<td>4.90(12.75)</td>
<td>175.67</td>
<td>8.03(16.25)</td>
<td>302.67</td>
<td>5.06(12.82)</td>
<td>176.10</td>
</tr>
<tr>
<td>Quinalphos 1.5% D 1.0</td>
<td>5.54(12.87)</td>
<td>161.00</td>
<td>9.65(17.24)</td>
<td>213.33</td>
<td>6.00(15.07)</td>
<td>154.64</td>
<td></td>
</tr>
<tr>
<td>Dinitrin 5G</td>
<td>1.0</td>
<td>2.57(9.10)</td>
<td>164.00</td>
<td>5.97(13.17)</td>
<td>258.17</td>
<td>3.91(11.49)</td>
<td>152.72</td>
</tr>
<tr>
<td>DDT 10% D</td>
<td>7.0</td>
<td>0.97(4.97)</td>
<td>197.67</td>
<td>7.90(14.92)</td>
<td>203.33</td>
<td>4.53(12.57)</td>
<td>171.97</td>
</tr>
<tr>
<td>Lindane 6G</td>
<td>1.0</td>
<td>2.77(9.40)</td>
<td>1D4.33</td>
<td>7.49(15.66)</td>
<td>256.67</td>
<td>8.62(15.67)</td>
<td>126.33</td>
</tr>
<tr>
<td>Heptachlor 5% D</td>
<td>3.5</td>
<td>2.32(7.91)</td>
<td>161.00</td>
<td>8.67(15.57)</td>
<td>230.50</td>
<td>2.75(15.07)</td>
<td>25.43</td>
</tr>
<tr>
<td>Sevidol 4:4 G</td>
<td>2.0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>4.35(12.06)</td>
<td>157.85</td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>18.01(25.06)</td>
<td>123.33</td>
<td>18.31(25.06)</td>
<td>191.67</td>
<td>13.92(21.07)</td>
<td>128.33</td>
<td></td>
</tr>
<tr>
<td>S.E. ±</td>
<td>2.37</td>
<td>17.26</td>
<td>1.97</td>
<td>26.17</td>
<td>2.63</td>
<td>8.62</td>
<td>25.43</td>
</tr>
</tbody>
</table>
| C.D. at 5%      | 7.01           | N.S.     | 5.80 | N.S.     | 2.75 | 25.43 | * Figures in parentheses are arcSin values.
Table 1†: Efficacy of different insecticides tested during 1979-80 to 1981-02 against rhizome fly on turmeric (Pooled data)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Dose kg a.i./ha.</th>
<th>Av. per cent infested rhizomes 1979-80</th>
<th>1980-81</th>
<th>1981-02</th>
<th>Pooled mean</th>
<th>Weighted mean 1979-80</th>
<th>1980-81</th>
<th>1981-02</th>
<th>Pooled mean</th>
<th>Yield of healthy rhizomes g/ha 1980-81</th>
<th>Pooled mean</th>
<th>Yield of healthy rhizomes g/ha 1981-02</th>
<th>Pooled mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bromophos (Nexion 5G)</td>
<td>1.0</td>
<td>2.29 (7.73)</td>
<td>2.47 (8.92)</td>
<td>2.84 (9.66)</td>
<td>2.53 (8.77)</td>
<td>9.32</td>
<td>191.17</td>
<td>265.00</td>
<td>157.85</td>
<td>204.67</td>
<td>172.64</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quinalphos (Ekalux 5G)</td>
<td>1.0</td>
<td>2.34 (7.74)</td>
<td>4.35 (11.31)</td>
<td>3.67 (11.01)</td>
<td>3.45 (10.02)</td>
<td>10.69</td>
<td>108.33</td>
<td>270.00</td>
<td>154.43</td>
<td>203.25</td>
<td>167.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aldicarb (Temik 10G)</td>
<td>2.0</td>
<td>2.20 (3.50)</td>
<td>5.47 (13.09)</td>
<td>2.73 (9.21)</td>
<td>3.47 (10.27)</td>
<td>9.76</td>
<td>102.67</td>
<td>295.03</td>
<td>194.44</td>
<td>224.31</td>
<td>200.62</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phorate (Thimet 10G)</td>
<td>2.0</td>
<td>1.08 (7.90)</td>
<td>4.18 (11.80)</td>
<td>4.19 (11.76)</td>
<td>3.42 (10.49)</td>
<td>11.34</td>
<td>190.00</td>
<td>295.00</td>
<td>161.06</td>
<td>210.02</td>
<td>170.71</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B.H.C. 10D</td>
<td>7.0</td>
<td>1.50 (6.87)</td>
<td>5.90 (13.69)</td>
<td>3.96 (11.49)</td>
<td>3.79 (10.68)</td>
<td>11.33</td>
<td>176.67</td>
<td>264.17</td>
<td>152.72</td>
<td>197.85</td>
<td>166.13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carbaryl (Sevin 10D)</td>
<td>7.0</td>
<td>2.33 (8.66)</td>
<td>4.94 (12.66)</td>
<td>4.12 (11.60)</td>
<td>3.80 (11.00)</td>
<td>11.50</td>
<td>196.00</td>
<td>291.67</td>
<td>155.93</td>
<td>214.53</td>
<td>174.21</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carbaryl (Sevin 4G)</td>
<td>1.00</td>
<td>4.52 (11.26)</td>
<td>6.17 (14.36)</td>
<td>4.48 (12.07)</td>
<td>5.06 (12.56)</td>
<td>12.35</td>
<td>150.50</td>
<td>299.17</td>
<td>152.00</td>
<td>200.50</td>
<td>163.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carbofuran (Furandan 3G)</td>
<td>1.0</td>
<td>4.90 (12.75)</td>
<td>0.03 (16.25)</td>
<td>5.06 (12.02)</td>
<td>6.02 (13.94)</td>
<td>13.37</td>
<td>175.67</td>
<td>3.02.67</td>
<td>175.10</td>
<td>217.04</td>
<td>185.75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quinalphos (Ekalux 1.5 D)</td>
<td>1.0</td>
<td>5.54 (12.87)</td>
<td>9.65 (17.24)</td>
<td>6.80 (15.07)</td>
<td>7.33 (15.06)</td>
<td>15.10</td>
<td>161.00</td>
<td>213.33</td>
<td>154.64</td>
<td>175.32</td>
<td>160.62</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>—</td>
<td>10.01 (25.06)</td>
<td>18.31 (25.33)</td>
<td>13.92 (21.37)</td>
<td>16.75 (24.09)</td>
<td>22.79</td>
<td>123.33</td>
<td>191.67</td>
<td>120.33</td>
<td>147.70</td>
<td>132.69</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

S.E.†: 2.37 1.97 0.83 0.07 Inter- action

C.D. at 5%: 7.01 5.80 2.75 2.57 N.S. N.S. N.S. 25.43 35.11 N.S.

* Figures in parentheses are arcsin values.
<table>
<thead>
<tr>
<th>Treatment</th>
<th>Yield of healthy rhizomes (q/ha)</th>
<th>Increase in yield over control (q/ha)</th>
<th>Value of additional yield @ Rs.100/q</th>
<th>Cost of pesticides/ha (Rs.)</th>
<th>Cost of labour/ha (Rs.)</th>
<th>Total cost (Rs.)</th>
<th>Net profit over control (Rs.)</th>
<th>Return per rupee investment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bromophos (Nexion 5G)</td>
<td>204.67</td>
<td>56.89</td>
<td>5689.00</td>
<td>1080.00</td>
<td>200.00</td>
<td>1286.00</td>
<td>4409.00</td>
<td>4.44</td>
</tr>
<tr>
<td>Quinalphos (Ekalux 5G)</td>
<td>203.25</td>
<td>55.47</td>
<td>5547.00</td>
<td>1225.00</td>
<td>200.00</td>
<td>1425.00</td>
<td>4122.00</td>
<td>3.89</td>
</tr>
<tr>
<td>Aldicarb (Temik 10G)</td>
<td>224.31</td>
<td>76.53</td>
<td>7653.00</td>
<td>1735.00</td>
<td>200.00</td>
<td>1935.00</td>
<td>5718.00</td>
<td>3.96</td>
</tr>
<tr>
<td>Phorate (Thimet 10G)</td>
<td>218.02</td>
<td>70.24</td>
<td>7024.00</td>
<td>1354.00</td>
<td>200.00</td>
<td>1554.00</td>
<td>5470.00</td>
<td>4.52</td>
</tr>
<tr>
<td>B.H.C. Dust 10G</td>
<td>197.85</td>
<td>50.07</td>
<td>5007.00</td>
<td>361.00</td>
<td>200.00</td>
<td>561.00</td>
<td>4446.00</td>
<td>8.93</td>
</tr>
<tr>
<td>Carbaryl (Sevin 10D)</td>
<td>214.53</td>
<td>66.75</td>
<td>6675.00</td>
<td>1841.00</td>
<td>200.00</td>
<td>2041.00</td>
<td>4634.00</td>
<td>3.27</td>
</tr>
<tr>
<td>Carbaryl (Sevin 4G)</td>
<td>199.23</td>
<td>51.45</td>
<td>5145.00</td>
<td>1375.00</td>
<td>200.00</td>
<td>1575.00</td>
<td>3570.00</td>
<td>3.27</td>
</tr>
<tr>
<td>Isofenphos (Oftanol 5G)</td>
<td>200.58</td>
<td>52.80</td>
<td>5280.00</td>
<td>Rates not available</td>
<td>Rates not available</td>
<td>Rates not available</td>
<td>Rates not available</td>
<td>Rates not available</td>
</tr>
<tr>
<td>Carbofuran (Furadan 3G)</td>
<td>217.84</td>
<td>70.06</td>
<td>7006.00</td>
<td>1754.00</td>
<td>200.00</td>
<td>1954.00</td>
<td>5052.00</td>
<td>3.58</td>
</tr>
<tr>
<td>Quinalphos (Ekalux 1.5 D)</td>
<td>176.32</td>
<td>26.32</td>
<td>2832.00</td>
<td>1590.00</td>
<td>200.00</td>
<td>1790.00</td>
<td>1042.00</td>
<td>1.78</td>
</tr>
<tr>
<td>Control</td>
<td>147.70</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>
Table 13: Efficacy of insecticides against rhizome fly, *M. coerulescens* on ginger.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Dose Kg a.i.</th>
<th>Av. per cent affected shoots</th>
<th>1981-82</th>
<th>1982-83</th>
<th>Pooled mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bromophos (Nexion 5G)</td>
<td>1.0</td>
<td>1.90(7.71)</td>
<td>5.26</td>
<td>12.93</td>
<td>10.32</td>
</tr>
<tr>
<td>Quinalphos (Ekalux 5G)</td>
<td>1.0</td>
<td>2.41(8.64)</td>
<td>4.76</td>
<td>12.43</td>
<td>10.54</td>
</tr>
<tr>
<td>Phorate (Thimate 10G)</td>
<td>2.0</td>
<td>1.32(6.40)</td>
<td>6.84</td>
<td>15.06</td>
<td>10.73</td>
</tr>
<tr>
<td>Isofenphos (Oftanol 5G)</td>
<td>1.0</td>
<td>2.48(8.97)</td>
<td>7.30</td>
<td>15.65</td>
<td>12.31</td>
</tr>
<tr>
<td>Carbofuran (Furadan 3 G)</td>
<td>1.0</td>
<td>2.63(8.66)</td>
<td>7.27</td>
<td>15.58</td>
<td>12.22</td>
</tr>
<tr>
<td>Carbaryl (Sevin 10D)</td>
<td>7.0</td>
<td>4.31(11.80)</td>
<td>6.76</td>
<td>15.04</td>
<td>13.42</td>
</tr>
<tr>
<td>Quinalphos (Ekalux 1.5 D)</td>
<td>1.0</td>
<td>5.26(13.14)</td>
<td>6.87</td>
<td>15.12</td>
<td>14.13</td>
</tr>
<tr>
<td>Carbaryl (Sevin 4 G.)</td>
<td>1.0</td>
<td>6.65(14.15)</td>
<td>5.97</td>
<td>14.18</td>
<td>14.17</td>
</tr>
<tr>
<td>Sevidol 4:4 G</td>
<td>2.0</td>
<td>6.14(13.41)</td>
<td>7.63</td>
<td>15.68</td>
<td>14.55</td>
</tr>
<tr>
<td>Aldicarb (Temik 10 G)</td>
<td>2.0</td>
<td>8.19(15.18)</td>
<td>6.65</td>
<td>14.04</td>
<td>15.01</td>
</tr>
<tr>
<td>B.H.C. 10 D</td>
<td>7.0</td>
<td>14.11(21.51)</td>
<td>6.03</td>
<td>14.10</td>
<td>17.81</td>
</tr>
<tr>
<td>Control</td>
<td>--</td>
<td>19.22(25.93)</td>
<td>15.07</td>
<td>22.04</td>
<td>24.39</td>
</tr>
<tr>
<td>S.E. †</td>
<td>2.62</td>
<td>1.30</td>
<td>2.27</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C.D. at 5%</td>
<td>7.67</td>
<td>3.02</td>
<td>7.07</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figures in parentheses are arcsin values.
Table 14: Percentage of affected shoots by *M. coeruleifrons* in different ginger varieties (1970-79)

<table>
<thead>
<tr>
<th>Variety</th>
<th>Av. per cent affected shoots</th>
<th>Variety</th>
<th>Av. per cent affected shoots</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nadia</td>
<td>9.41 (17.47)</td>
<td>Himachal Pradesh</td>
<td>40.51 (39.52)</td>
</tr>
<tr>
<td>Poona (local)</td>
<td>14.92 (22.71)</td>
<td>Ernal Manjeri</td>
<td>40.74 (39.60)</td>
</tr>
<tr>
<td>Thodupzha</td>
<td>15.78 (23.30)</td>
<td>Vengara</td>
<td>40.76 (39.66)</td>
</tr>
<tr>
<td>Rio De Janerio</td>
<td>16.25 (23.69)</td>
<td>Jorbat</td>
<td>40.77 (39.67)</td>
</tr>
<tr>
<td>Tura</td>
<td>17.07 (24.33)</td>
<td>Wyand Kunnamugalam</td>
<td>40.97 (39.72)</td>
</tr>
<tr>
<td>Arrippa</td>
<td>18.94 (25.78)</td>
<td>Thingpuri</td>
<td>41.15 (39.90)</td>
</tr>
<tr>
<td>Thinladium</td>
<td>19.50 (26.15)</td>
<td>Kurakhal</td>
<td>41.57 (40.11)</td>
</tr>
<tr>
<td>Vallu vanad</td>
<td>32.97 (35.03)</td>
<td>Marnar</td>
<td>42.15 (40.69)</td>
</tr>
<tr>
<td>Wynad local</td>
<td>36.18 (36.99)</td>
<td>Ernad chernal</td>
<td>43.63 (41.35)</td>
</tr>
<tr>
<td>Assam</td>
<td>39.29 (38.81)</td>
<td>Uttar Pradesh</td>
<td>44.69 (41.93)</td>
</tr>
<tr>
<td>Jugijan</td>
<td>39.60 (39.90)</td>
<td>Narassaputtam</td>
<td>45.33 (42.39)</td>
</tr>
<tr>
<td>Burdwan</td>
<td>46.11 (39.23)</td>
<td>Wynad Mannantoday</td>
<td>45.67 (42.68)</td>
</tr>
<tr>
<td>Kuruppannapad</td>
<td>40.29 (39.39)</td>
<td>Sierra Leone</td>
<td>46.27 (42.88)</td>
</tr>
<tr>
<td>Taffinjara</td>
<td>40.31 (35.40)</td>
<td>Thaiwan</td>
<td>46.59 (43.05)</td>
</tr>
<tr>
<td>China</td>
<td>40.46 (39.49)</td>
<td>Bajpai</td>
<td>47.16 (43.36)</td>
</tr>
</tbody>
</table>

S.E. 1.95

C.D. at 5% 5.64

*Figures in parentheses are arcsin values.*
Table 15: Reaction of turmeric varieties to the rhizome fl., M. coeruleifrons

<table>
<thead>
<tr>
<th>Variety</th>
<th>Mean percentage of infestation</th>
<th>Variety</th>
<th>Mean percentage of infestation</th>
<th>Variety</th>
<th>Mean percentage of infestation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1978-79</strong></td>
<td></td>
<td><strong>1979-80</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S. L. Puram I</td>
<td>24.74 (29.83)</td>
<td>S. L. Puram I</td>
<td>34.57 (35.05)</td>
<td>S. L. Puram I</td>
<td>32.35 (35.05)</td>
</tr>
<tr>
<td>Kasturi tanuk</td>
<td>18.90 (25.74)</td>
<td>G. L. Puram II</td>
<td>29.22 (32.70)</td>
<td>Kasturi tanuk</td>
<td>29.22 (32.70)</td>
</tr>
<tr>
<td>Vinnal type</td>
<td>19.67 (26.32)</td>
<td>T. Sunnai</td>
<td>30.00 (33.21)</td>
<td>Vinnal type</td>
<td>30.00 (33.21)</td>
</tr>
<tr>
<td>Kuchipudi</td>
<td>21.25 (27.44)</td>
<td>Alleppey</td>
<td>32.25 (34.60)</td>
<td>Kuchipudi</td>
<td>32.25 (34.60)</td>
</tr>
<tr>
<td>Armoor</td>
<td>21.65 (27.72)</td>
<td>Rajapuri</td>
<td>33.01 (35.05)</td>
<td>Armoor</td>
<td>33.01 (35.05)</td>
</tr>
<tr>
<td>S. E.</td>
<td>2.78</td>
<td>S. E.</td>
<td>1.22</td>
<td>S. E.</td>
<td>1.22</td>
</tr>
<tr>
<td>C. D. at 5%</td>
<td>0.94</td>
<td>C. D. at 5%</td>
<td>3.66</td>
<td>C. D. at 5%</td>
<td>3.66</td>
</tr>
</tbody>
</table>

* Figures in the parentheses are the arcein values.
Table 14: Percentage of affected shoots by *M. coeruleifrons* in different ginger varieties (1978-79)

<table>
<thead>
<tr>
<th>Variety</th>
<th>Av. per cent affected shoots</th>
<th>Variety</th>
<th>Av. per cent affected shoots</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nadia</td>
<td>9.41 (17.47)</td>
<td>Himachal Pradesh</td>
<td>40.51 (39.52)</td>
</tr>
<tr>
<td>Poona (local)</td>
<td>14.92 (22.71)</td>
<td>Ernakulam</td>
<td>40.74 (39.60)</td>
</tr>
<tr>
<td>Thodupzha</td>
<td>15.78 (23.30)</td>
<td>Vengara</td>
<td>40.76 (39.66)</td>
</tr>
<tr>
<td>Rio-Do-Janerio</td>
<td>16.25 (23.69)</td>
<td>Jorhat</td>
<td>40.77 (39.67)</td>
</tr>
<tr>
<td>Tura</td>
<td>17.07 (24.33)</td>
<td>Wyand Kunnamugalam</td>
<td>40.97 (39.72)</td>
</tr>
<tr>
<td>Arrippa</td>
<td>18.94 (25.78)</td>
<td>Thingpuri</td>
<td>41.15 (39.90)</td>
</tr>
<tr>
<td>Thinladium</td>
<td>19.50 (26.15)</td>
<td>Kurakhal</td>
<td>41.57 (40.11)</td>
</tr>
<tr>
<td>Vallu vanad</td>
<td>32.97 (35.03)</td>
<td>Maran</td>
<td>42.15 (40.69)</td>
</tr>
<tr>
<td>Wynad local</td>
<td>36.10 (36.99)</td>
<td>Ernakulam</td>
<td>43.63 (41.35)</td>
</tr>
<tr>
<td>Assam</td>
<td>39.29 (33.81)</td>
<td>Uttar Pradesh</td>
<td>44.69 (41.93)</td>
</tr>
<tr>
<td>Jugijan</td>
<td>39.60 (39.90)</td>
<td>Narmadapuram</td>
<td>45.33 (42.39)</td>
</tr>
<tr>
<td>Burdwan</td>
<td>40.11 (39.23)</td>
<td>Wynad Rannantoday</td>
<td>45.67 (42.68)</td>
</tr>
<tr>
<td>Kuruppappamapad</td>
<td>40.29 (39.39)</td>
<td>Sierra Leone</td>
<td>46.27 (42.88)</td>
</tr>
<tr>
<td>Taffinjara</td>
<td>40.31 (35.40)</td>
<td>Thaiwan</td>
<td>46.59 (43.05)</td>
</tr>
<tr>
<td>China</td>
<td>40.46 (39.49)</td>
<td>Bajpai</td>
<td>47.16 (43.36)</td>
</tr>
</tbody>
</table>

S.E. ±

C.D. at 5%

Figures in parentheses are arcsin values.
Table 15: Reaction of turmeric varieties to the rhizome fly, M. coeruleifrons

<table>
<thead>
<tr>
<th>Variety</th>
<th>Mean percentage of infestation</th>
<th>Variety</th>
<th>Mean percentage of infestation</th>
<th>Variety</th>
<th>Mean percentage of infestation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sugandham</td>
<td>6.31 (14.48) *</td>
<td>Amsitapani</td>
<td>27.30 (31.49)</td>
<td>Tekkurpeta</td>
<td>1.92 (7.96)</td>
</tr>
<tr>
<td>Duggirala</td>
<td>7.28 (15.64)</td>
<td>Kothapetta</td>
<td>27.43 (31.54)</td>
<td>Sugandham</td>
<td>3.05 (10.10)</td>
</tr>
<tr>
<td>Kasturi tanuk</td>
<td>18.90 (25.74)</td>
<td>G.L.Puram-II</td>
<td>29.22 (32.70)</td>
<td>Duggirala</td>
<td>3.72 (11.05)</td>
</tr>
<tr>
<td>Von-timilla</td>
<td>19.67 (26.32)</td>
<td>T.Sunder</td>
<td>30.00 (33.21)</td>
<td>Waigaon</td>
<td>3.95 (11.49)</td>
</tr>
<tr>
<td>Nandyal type</td>
<td>20.51 (26.42)</td>
<td>Etamukkala</td>
<td>31.00 (33.21)</td>
<td>Kasturi</td>
<td>4.55 (12.25)</td>
</tr>
<tr>
<td>Kuchipudi</td>
<td>21.25 (27.44)</td>
<td>Alleppey</td>
<td>32.25 (34.60)</td>
<td>Erode</td>
<td>5.61 (13.71)</td>
</tr>
<tr>
<td>Armoor</td>
<td>21.65 (27.72)</td>
<td>Rajapuri</td>
<td>33.01 (35.05)</td>
<td>Selam</td>
<td>6.27 (14.34)</td>
</tr>
<tr>
<td>G.L.Puram I</td>
<td>24.74 (29.83)</td>
<td>Arippa</td>
<td>33.86 (35.57)</td>
<td>Alleppey</td>
<td>7.04 (15.35)</td>
</tr>
<tr>
<td>Karhadi local</td>
<td>25.08 (30.03)</td>
<td>Chayapsuppa</td>
<td>35.63 (36.69)</td>
<td>Rajapuri</td>
<td>19.22 (25.35)</td>
</tr>
<tr>
<td>Kodur type</td>
<td>26.30 (30.03)</td>
<td>Wynad local</td>
<td>41.90 (46.34)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

S.E. † 0.94
C.D. at 5% 2.78

S.E. † 1.22
C.D. at 5% 3.66

* Figures in the parentheses are the arcsin values.
Table 16: Reaction of turmeric varieties to rhizome fly, *M. coerulescens*.

<table>
<thead>
<tr>
<th>Variety</th>
<th>Av. per cent infested rhizomes Kg/plot</th>
<th>Av. yield of healthy rhizomes Kg/plot</th>
<th>Brj (Disc.5:1)</th>
<th>Av. per cent infested rhizomes Kg/plot</th>
<th>Av. yield of healthy rhizomes Kg/plot</th>
<th>Q/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Karve (Sangli)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waigaon</td>
<td>0.79 (3.16)</td>
<td>7.08</td>
<td>Kasturi</td>
<td>6.25 (12.27)</td>
<td>39.00</td>
<td></td>
</tr>
<tr>
<td>Kasturi</td>
<td></td>
<td></td>
<td>Waigaon</td>
<td>7.31 (14.84)</td>
<td>34.00</td>
<td></td>
</tr>
<tr>
<td>Tekhurpeta</td>
<td>1.22 (5.09)</td>
<td>3.50</td>
<td>Duggirala</td>
<td>20.65 (25.52)</td>
<td>71.00</td>
<td></td>
</tr>
<tr>
<td>Duggirala</td>
<td>2.17 (6.92)</td>
<td>6.58</td>
<td>Alleppy</td>
<td>44.84 (41.95)</td>
<td>11.12</td>
<td></td>
</tr>
<tr>
<td>Alleppy</td>
<td>3.04 (10.02)</td>
<td>5.75</td>
<td>Sugandhum</td>
<td>50.37 (45.22)</td>
<td>5.50</td>
<td></td>
</tr>
<tr>
<td>Sugandhum</td>
<td>4.15 (11.48)</td>
<td>5.42</td>
<td>Erode</td>
<td>51.22 (45.72)</td>
<td>10.50</td>
<td></td>
</tr>
<tr>
<td>Erode</td>
<td>4.60 (11.76)</td>
<td>3.86</td>
<td>Rajapuri</td>
<td>55.01 (46.16)</td>
<td>20.87</td>
<td></td>
</tr>
<tr>
<td>Rajapuri</td>
<td>4.93 (12.88)</td>
<td>6.17</td>
<td>Salum</td>
<td>55.36 (48.12)</td>
<td>11.37</td>
<td></td>
</tr>
<tr>
<td>Salum</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rajapuri (Check)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salum</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>t</em> +</td>
<td>2.20</td>
<td>0.67</td>
<td>5.93</td>
<td>6.63</td>
<td>24.40</td>
<td></td>
</tr>
<tr>
<td><em>0</em> at 5%</td>
<td>6.59</td>
<td>2.01</td>
<td>17.32</td>
<td>19.93</td>
<td>71.21</td>
<td></td>
</tr>
</tbody>
</table>

Figures in parentheses are arcsin values.
Table 17* Incidence of rhizome rot in turmeric and ginger

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Affected rhizomes (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Turmeric</td>
</tr>
<tr>
<td><strong>1979-80</strong></td>
<td></td>
</tr>
<tr>
<td>1. Inoculation of cultures alone</td>
<td></td>
</tr>
<tr>
<td>a) M. coeruleifrons maggots</td>
<td>100.00</td>
</tr>
<tr>
<td>b) Pythium fungus culture</td>
<td>0.00</td>
</tr>
<tr>
<td>c) Nematode complex</td>
<td>0.00</td>
</tr>
<tr>
<td>2. Inoculation with BHC 0.4% treated rhizomes</td>
<td></td>
</tr>
<tr>
<td>a) M. coeruleifrons maggots</td>
<td>100.00</td>
</tr>
<tr>
<td>b) Pythium fungus culture</td>
<td>0.00</td>
</tr>
<tr>
<td>c) Nematode complex</td>
<td>0.00</td>
</tr>
<tr>
<td>d) M. coeruleifrons maggots + Pythium</td>
<td>0.00</td>
</tr>
<tr>
<td>e) M. coeruleifrons maggots + nematodes</td>
<td>0.00</td>
</tr>
<tr>
<td>f) M. coeruleifrons maggots + Pythium + nematode complex</td>
<td>0.00</td>
</tr>
<tr>
<td>g) Pythium fungus culture + nematode complex</td>
<td>0.00</td>
</tr>
<tr>
<td>3. Inoculation with agallol 0.25% treated rhizomes</td>
<td></td>
</tr>
<tr>
<td>a) M. coeruleifrons maggots</td>
<td>100.00</td>
</tr>
<tr>
<td>b) Pythium Fungus culture</td>
<td>0.00</td>
</tr>
<tr>
<td>c) Nematode complex</td>
<td>0.00</td>
</tr>
<tr>
<td>d) M. coeruleifrons maggots + Pythium</td>
<td>0.00</td>
</tr>
<tr>
<td>e) M. coeruleifrons maggots + nematodes</td>
<td>0.00</td>
</tr>
<tr>
<td>f) M. coeruleifrons maggots + Pythium + nematode complex</td>
<td>0.00</td>
</tr>
<tr>
<td>g) Pythium fungus + nematode complex</td>
<td>0.00</td>
</tr>
<tr>
<td>4. Control - inoculated with treated rhizomes alone</td>
<td></td>
</tr>
<tr>
<td>a) BHC 0.4%</td>
<td>0.00</td>
</tr>
<tr>
<td>b) Agallol 0.25%</td>
<td>0.00</td>
</tr>
<tr>
<td>5. Control - Sterilized soil alone</td>
<td>33.00</td>
</tr>
<tr>
<td>6. Control - Soil from endemic area</td>
<td></td>
</tr>
</tbody>
</table>

| **1980-01** |          |        |
| 1. Inoculation of cultures alone |          |        |
| a) M. coeruleifrons maggots | 100.00 | 100.00 |
| b) Sclerotium fungus culture | 67.00 | 100.00 |
| 2. Inoculation of M. coeruleifrons maggots + Sclerotium fungus culture | 100.00 | 100.00 |
| 3. Control - Sterilized soil alone | 0.00 | G.00 |
| 4. Control - Soil from endemic area | 0.00 | 0.00 |

| **1982-83** |          |        |
| 1. Inoculation of cultures alone |          |        |
| a) M. coeruleifrons maggots | 100.00 | 100.00 |
| b) Fusarium fungus alone culture | 0.00 | 0.00 |
| 2. Inoculation of M. coeruleifrons maggots with Fusarium fungus culture | 100.00 | 100.00 |
| 3. Inoculation of injured rhizomes with |          |        |
| a) M. coeruleifrons maggots | 100.00 | 100.00 |
| b) Fusarium fungus culture | 33.00 | 67.00 |
| c) M. coeruleifrons maggots + Fusarium | 100.00 | 100.00 |
| 4. Control - Injured rhizomes alone | 0.00 | 0.00 |
| 5. Control - Healthy rhizomes alone | 0.00 | 0.00 |
| 5. Control - Soil from endemic areas | 0.00 | 0.00 |
Table 18 contd...

<table>
<thead>
<tr>
<th></th>
<th>Nites</th>
<th>Turmeric</th>
<th>Snails</th>
<th>Turmeric</th>
<th>Snails</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>i) Tyrophagus putrescentiae Schrank (Acarina: Acaridae)</td>
<td>Adults and young ones feed on rhizomes.</td>
<td>ii) Opeas gracile Hutton (Subulinidae: Mollusca)</td>
<td>Adults and young ones feed on rhizomes.</td>
<td>ii) Opeas gracile Hutton (Subulinidae: Mollusca)</td>
</tr>
<tr>
<td></td>
<td>ii) Unidentified</td>
<td>Turmeric</td>
<td>iii) Unidentified</td>
<td>Ginger</td>
<td>iii) Unidentified</td>
</tr>
<tr>
<td></td>
<td>iii) Unidentified</td>
<td>Ginger</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Pests:**

- Cigarette beetle
- Eusiderodes serricornis Fb (Anobiidae: Coleoptera)

**Hosts of insects:**

- 1) Trichopria sp (Dasiidae: Hymenoptera)
- ii) Adelencyrtus moderatus Howard (Encyrtidae: Hymenoptera)
- iii) Anisopteromalus calandrae Howard (Pteromalidae: Hymenoptera)

- Rhizome fly (N. coc:ruleifrons)
- Scales (A. martii)
- Cigarette beetle (L. serricornis)

Endo larval pupal parasite

Consult for identification to Commonwealth Institute of Entomology, London.
### Table 19. Plant Parasitic Nematodes associated with turmeric and ginger in Maharashtra

<table>
<thead>
<tr>
<th>Locality</th>
<th>Date of Collection</th>
<th>Nematodes</th>
<th>Population/250 ml soil</th>
<th>Locality</th>
<th>Date of Collection</th>
<th>Nematodes</th>
<th>Population/250 ml soil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chinchani, (Sangli)</td>
<td>1.10.1973</td>
<td>Tylenchus sp.</td>
<td>128</td>
<td>Nagathane, (Satara)</td>
<td>25.10.1970</td>
<td>Pratylenchus sp.</td>
<td>77</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tylenchorhyynchus sp.</td>
<td>111</td>
<td></td>
<td></td>
<td>Dorylaimellus sp.</td>
<td>494</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Helicotylenchus sp.</td>
<td>422</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kolhapur, (Kolhapur)</td>
<td>10.10.1970</td>
<td>Meloidogyne incognita</td>
<td>261</td>
<td>Nagathane, (Satara)</td>
<td>7.12.1979</td>
<td>Tylenchus sp.</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bolcodorus sp.</td>
<td>83</td>
<td></td>
<td></td>
<td>Dorylaimellus sp.</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Xiphinema insigne</td>
<td>66</td>
<td></td>
<td></td>
<td>Monochids</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Saprozoics</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pratylenchus thornei</td>
<td>5</td>
<td></td>
<td></td>
<td>Meloidogyne larvae</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rotylenchus reniformis</td>
<td>5</td>
<td></td>
<td></td>
<td>Saprozoics</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Saprozoics</td>
<td>40</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tylenchus sp.</td>
<td>15</td>
<td></td>
<td></td>
<td>Dorylaimellus sp.</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>X. insigne</td>
<td>5</td>
<td></td>
<td></td>
<td>Saprozoics</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Meloidogyne larvae</td>
<td>20</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>H. elegans</td>
<td>20</td>
<td></td>
<td></td>
<td>Dorylaimellus sp.</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bolcodorus sp.</td>
<td>5</td>
<td></td>
<td></td>
<td>Saprozoics</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>X. insigne</td>
<td>5</td>
<td></td>
<td></td>
<td>Meloidogyne larvae</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>T. nudus</td>
<td>10</td>
<td></td>
<td></td>
<td>Saprozoics</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>T. punensis</td>
<td>10</td>
<td></td>
<td></td>
<td>Dorylaimellus sp.</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Meloidogyne sp.</td>
<td>25</td>
<td></td>
<td></td>
<td>Saprozoics</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Monochids</td>
<td>20</td>
<td></td>
<td></td>
<td>Meloidogyne larvae</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Saprozoics</td>
<td>50</td>
<td></td>
<td></td>
<td>P. thornei</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 20. *Percentage occurrence of different plant parasitic and free living nematodes.*

<table>
<thead>
<tr>
<th>Nematodes</th>
<th>Percentage occurrence</th>
<th>Turmeric</th>
<th>Ginger</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Helicotylenchus</em> sp</td>
<td></td>
<td>75.00</td>
<td>37.50</td>
</tr>
<tr>
<td><em>Xiphinema</em> sp</td>
<td></td>
<td>50.00</td>
<td>0.00</td>
</tr>
<tr>
<td><em>Meloidogyne</em> sp</td>
<td></td>
<td>37.50</td>
<td>37.50</td>
</tr>
<tr>
<td><em>Tylenchorhynchus</em> sp</td>
<td></td>
<td>37.50</td>
<td>0.00</td>
</tr>
<tr>
<td><em>Tylenchus</em> sp</td>
<td></td>
<td>25.00</td>
<td>37.50</td>
</tr>
<tr>
<td><em>Boleodorus</em> sp</td>
<td></td>
<td>25.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Mononchids</td>
<td></td>
<td>12.50</td>
<td>37.50</td>
</tr>
<tr>
<td><em>Pratylenchus</em> sp</td>
<td></td>
<td>12.50</td>
<td>25.00</td>
</tr>
<tr>
<td>Rotylenchulus reniformis</td>
<td></td>
<td>12.50</td>
<td>12.50</td>
</tr>
<tr>
<td><em>Basira nasikensis</em></td>
<td></td>
<td>12.50</td>
<td>0.00</td>
</tr>
<tr>
<td>Dorylaimidae</td>
<td></td>
<td>0.00</td>
<td>62.50</td>
</tr>
<tr>
<td>Saprozoic</td>
<td></td>
<td>75.00</td>
<td>87.50</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Dose %</th>
<th>Av. nymphs per three leaves</th>
<th>Av. per cent reduction of tingid bugs after 43 hrs</th>
<th>96 hrs</th>
<th>mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monocrotophos (Monokem 40 EC)</td>
<td>0.02</td>
<td>24.67</td>
<td>100.00</td>
<td>(90.00)</td>
<td>(90.00)</td>
</tr>
<tr>
<td>Phosphamidon (Dimecron 05)</td>
<td>0.02</td>
<td>50.67</td>
<td>100.00</td>
<td>(90.00)</td>
<td>(90.00)</td>
</tr>
<tr>
<td>Methyldemeton (Metasystox 25 EC)</td>
<td>0.02</td>
<td>38.33</td>
<td>99.61</td>
<td>(82.90)</td>
<td>(80.95)</td>
</tr>
<tr>
<td>Penitrothion (U.P. 50 EC)</td>
<td>0.02</td>
<td>51.33</td>
<td>97.43</td>
<td>(32.54)</td>
<td>(84.11)</td>
</tr>
<tr>
<td>Penitrothion (Sumithion 50 EC)</td>
<td>0.02</td>
<td>33.67</td>
<td>93.21</td>
<td>(81.05)</td>
<td>(81.23)</td>
</tr>
<tr>
<td>Quinalphos (Ekalux 25 EC)</td>
<td>0.02</td>
<td>41.00</td>
<td>92.15</td>
<td>(74.88)</td>
<td>(94.11)</td>
</tr>
<tr>
<td>Quinalphos (U.P. 25 EC)</td>
<td>0.02</td>
<td>40.00</td>
<td>85.83</td>
<td>(72.52)</td>
<td>(81.05)</td>
</tr>
<tr>
<td>Dimethoatc (Rogor 30 EC)</td>
<td>0.02</td>
<td>47.67</td>
<td>78.51</td>
<td>(66.16)</td>
<td>(69.69)</td>
</tr>
<tr>
<td>Formothion (Anthio 25 EC)</td>
<td>0.02</td>
<td>49.67</td>
<td>68.29</td>
<td>(61.01)</td>
<td>(69.91)</td>
</tr>
<tr>
<td>Monocrotophos (Nuvacron 40 EC)</td>
<td>0.02</td>
<td>50.33</td>
<td>66.54</td>
<td>(59.94)</td>
<td>(60.62)</td>
</tr>
<tr>
<td>Chlorpyriphos (Coroban 20 EC)</td>
<td>0.02</td>
<td>31.67</td>
<td>63.99</td>
<td>(54.40)</td>
<td>(61.15)</td>
</tr>
<tr>
<td>Bromophos ethyl (Nexaagon 35 SC)</td>
<td>0.02</td>
<td>53.67</td>
<td>53.04</td>
<td>(50.67)</td>
<td>(57.11)</td>
</tr>
<tr>
<td>Malathion (Kitacol 50 EC)</td>
<td>0.02</td>
<td>57.67</td>
<td>54.99</td>
<td>(40.58)</td>
<td>(61.13)</td>
</tr>
<tr>
<td>Control</td>
<td></td>
<td>65.00</td>
<td>0.00</td>
<td>(0.00)</td>
<td>(7.17)</td>
</tr>
</tbody>
</table>

S.S †                      9.27  2.62
C.D. at 5% level            26.95  7.61

Figures in parentheses are arc-sin values.
Table 22. Efficacy of insecticides against scale insects, A. hartii infesting stored ginger rhizomes.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Dose</th>
<th>Av. per cent mortality of scales at different intervals</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2 days *</td>
<td>4 days *</td>
</tr>
<tr>
<td>Oncol 50 sp</td>
<td>25 gm/Kg</td>
<td>92.00 (76.77)**</td>
<td>97.67 (84.09)</td>
</tr>
<tr>
<td>Landrin 50 sp</td>
<td>12 gm/Kg</td>
<td>95.00 (02.40)</td>
<td>95.00 (79.41)</td>
</tr>
<tr>
<td>Isofenphos 40 SD</td>
<td>40 gm/Kg</td>
<td>94.67 (79.05)</td>
<td>95.00 (79.41)</td>
</tr>
<tr>
<td>Dimethoate 30 EC</td>
<td>2.7 ml/lit</td>
<td>03.33 (70.20)</td>
<td>91.33 (76.27)</td>
</tr>
<tr>
<td>Bromophos 25 SD</td>
<td>5 gm/Kg</td>
<td>90.67 (75.67)</td>
<td>37.67 (73.24)</td>
</tr>
<tr>
<td>Phosphamidon 85 EC</td>
<td>0.8 ml/lit</td>
<td>65.67 (54.24)</td>
<td>01.33 (64.56)</td>
</tr>
<tr>
<td>BHC 50 VIP</td>
<td>8.0 gm/lit</td>
<td>60.00 (50.86)</td>
<td>67.00 (56.42)</td>
</tr>
<tr>
<td>Control (Wet)</td>
<td>--</td>
<td>49.33 (44.59)</td>
<td>44.33 (41.56)</td>
</tr>
</tbody>
</table>

S.E. ±

C.D. at 5% level

* Average of three replications.
** Figures in parentheses are arc-sin values.
13. Results which can be exploited in field scale

i) Findings of survey undertaken during the period of operation of scheme will help in knowing the spread of pest in turmeric and ginger growing areas of Maharashtra state. It would also indicate the endemic areas observed in Sangli and Satara districts and extent of loss (25% in turmeric and 31% in ginger) caused by the pest.

ii) Studies on bionomics will be useful in understanding the behaviour of pest under field conditions and weak-links in its life cycle which can be tackled for its efficient management. For instance the fact that eggs are laid in the soil around the plants indicates the possibility of preventing the maggot from getting access to plants by using suitable insecticides like bromophos, quinalphos, phcratc and BHC which were found to be quite effective in the trials conducted against the pest. Similarly, the information on seasonal incidence has indicated the number of applications of insecticides required for checking the pest.

iii) Work on screening of varieties for their reaction to pest has yielded valuable information. In turmeric 'Waggon' and 'Kasturi' and in ginger 'Mudia' are less susceptible varieties to the pest than the presently grown varieties which can be successfully exploited.

iv) The studies on role played by different agencies in causing rhizome rot malady have clearly brought out that rhizome fly is primarily responsible for the malady. This would enable in concentrating the efforts in this direction.

v) The findings that rhizome fly populations are regulated in nature by larval pupal endoparasite, Trichopria sp. indicates the possibility of its utilization in integrated pest management.
Papers published:


Papers sent out for publications:


15. Suggestions for future lines of research:

In the light of the findings obtained in this project the following line of work may be suggested.

i) As a result of survey undertaken in different agroclimatic regions of the Maharashtra State, it was observed that the M. coerulescens is practically absent in Chandrapur and Wardha districts, while it was in serious form in Sanqli and Satara districts. A further thorough survey is, therefore, required to be undertaken to identify the factors responsible for its absence in the above areas.

ii) An intensive search may be made for the parasites which may be found in association with the pest. Studies may also be made on the possibility of mass releases of suitable indigenous parasites like Trichopria sp. for the control of pest. The toxicity of recommended insecticides to such parasites also needs to be studied.

iii) Screening of turmeric and ginger germplasms against the pest is necessary to locate sources of resistance.

iv) Though during the tenure of the scheme the insecticides tested were found promising in reducing the pest and the losses cause'd by it, it needs to be pursued further with newer and more potent insecticides. It is also important to determine residues of recommended insecticides in rhizomes at harvest. Also the bionomics studies of the pest revealed.
that carry over of the pest takes place through stages present in infested seed rhizomes, hence there is urgent need of finding out suitable control measures for use in storage.

v) There have been indications that besides *M. cocculifera* maggot, the other species of dipteran maggots like *E. pulchrum* (Syrphidae), *Neoloxota sp* (Chloropidae), *A. orientalis* (Muscidae), *S. calcitrans* (Muscidae) etc. are involved in rhizome rot malady in fields. It would therefore, be worthwhile to study the intensity of infestation of different species and study the role played by them in causing the rot of rhizomes. Studies may also be made on seasonal incidence and biology of species of economic importance.

vi) The studies on aspects like effect of different fertilizer levels, soil amendments, inter-cropping and planting time on the incidence of the pest are required to be made in future.

vii) The pest complex studies indicated several pests infesting turmeric and ginger crops under favourable climatic conditions. The detailed studies on biology, seasonal incidence, losses caused and appropriate control measures for these pests need to be undertaken.

16. **Acknowledgements:**

The Principal Investigator and his Co-workers are indebted to the Indian Council of Agricultural Research for the financial aid provided for the project. The facilities provided by the Associate Dean and Professor of Entomology, Mahatma Phule Agricultural University, College of Agriculture, Kolhapur are gratefully acknowledged. Thanks are due to Prof. R.B. Patil, I/c, Turmeric Research Station, Digraj (Dist. Sangli) for his help and to Shri. Patangrao Laxman Salunkhe, Nagthans (fiats: and Shri. Jagannath Shripati Patil, Chinchani (Sangli) for providing fields for the experiments. We sincerely thank the Director, Commonwealth Institute of Entomology, British Museum, London for identification of pests and parasites.

17. **Signatures:**

(S. A. Ghorpade)
Incharge of Scheme and
| Month | Agril. School, Digraj (Sanli) | | | Agril. School, Dorgiaon (Satara) | | |
|---|---|---|---|---|---|
| | Temperature OC | Rainfall (mm) | Rainy days | Rainfall (mm) | Rainy days |
| | Maximum | Minimum | | | | |
| Jan, 78 | 30.1 | 11.8 | 0.0 | 0 | 0.0 | 0 |
| Feb, 78 | 39.9 | 16.7 | 11.0 | 1 | 7.5 | 4 |
| Mar, 78 | 34.2 | 10.1 | 0.0 | 0 | 4.0 | 0 |
| Apr, 78 | 38.4 | 22.9 | 60.5 | 8 | 64.5 | 5 |
| May, 78 | 39.2 | 25.3 | 27.5 | 7 | 77.5 | 4 |
| Jun, 78 | 30.9 | 24.2 | 89.0 | 13 | 157.0 | 15 |
| Jul, 78 | 27.7 | 23.2 | 70.0 | 15 | 120.0 | 16 |
| Aug, 78 | 28.0 | 23.7 | 100.5 | 21 | 223.5 | 22 |
| Sep, 78 | 30.0 | 23.1 | 171.0 | 13 | 103.5 | 14 |
| Oct, 78 | 31.5 | 22.2 | 134.0 | 7 | 122.0 | 4 |
| Nov, 78 | 30.6 | 22.6 | 62.5 | 2 | 85.0 | 4 |
| Dec, 78 | — | — | — | — | — | — |

| Month | Agril. School, Digraj (Sanli) | | | Agril. School, Dorgiaon (Satara) | | |
|---|---|---|---|---|---|
| | Temperature OC | Rainfall (mm) | Rainy days | Rainfall (mm) | Rainy days |
| | Maximum | Minimum | | | | |
| Jan, 79 | 31.0 | 15.0 | 0.0 | 0 | 0.0 | 0 |
| Feb, 79 | 33.5 | 10.0 | 0.0 | 0 | 0.0 | 0 |
| Mar, 79 | 33.0 | 18.0 | 0.0 | 0 | 0.0 | 0 |
| Apr, 79 | 34.0 | 16.0 | 2.0 | 1 | 0.0 | 0 |
| May, 79 | 37.0 | 30.0 | 3.0 | 0 | 0.0 | 0 |
| Jun, 79 | 41.0 | 18.0 | 0.0 | 0 | 0.0 | 0 |
| Jul, 79 | 40.5 | 23.0 | 1.5 | 1 | 0.0 | 0 |
| Aug, 79 | 41.5 | 22.0 | 29.5 | 1 | 0.0 | 0 |
| Sep, 79 | 40.0 | 25.0 | 13.0 | 2 | 2.5 | 1 |
| Oct, 79 | 39.0 | 24.0 | 20.0 | 4 | 27.5 | 1 |
| Nov, 79 | 34.0 | 22.0 | 51.3 | 9 | 106.5 | 6 |
| Dec, 79 | 33.0 | 25.0 | 22.0 | 6 | 20.0 | 4 |

I - First fortnight, II - Second fortnight  (M-morning, E-evening)
### Meteorological data in endemic areas (1970 to 1991)

Agril. School, Diagaj (Sancrli)

<table>
<thead>
<tr>
<th>Month</th>
<th>Temperature OC</th>
<th>Rainfall (mm)</th>
<th>Rainy days</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Maximum</td>
<td>Minimum</td>
<td></td>
</tr>
<tr>
<td>Jan, 78</td>
<td>30.1</td>
<td>11.8</td>
<td>0</td>
</tr>
<tr>
<td>Feb, 78</td>
<td>39.9</td>
<td>16.7</td>
<td>1</td>
</tr>
<tr>
<td>Mar, 78</td>
<td>34.2</td>
<td>10.1</td>
<td>0</td>
</tr>
<tr>
<td>Apr, 78</td>
<td>33.4</td>
<td>22.9</td>
<td>8</td>
</tr>
<tr>
<td>May, 78</td>
<td>38.2</td>
<td>25.3</td>
<td>7</td>
</tr>
<tr>
<td>Jun, 78</td>
<td>30.9</td>
<td>24.2</td>
<td>13</td>
</tr>
<tr>
<td>Jul, 78</td>
<td>27.7</td>
<td>23.2</td>
<td>15</td>
</tr>
<tr>
<td>Aug, 78</td>
<td>28.0</td>
<td>23.7</td>
<td>21</td>
</tr>
<tr>
<td>Sep, 78</td>
<td>30.0</td>
<td>23.1</td>
<td>13</td>
</tr>
<tr>
<td>Oct, 78</td>
<td>31.5</td>
<td>22.2</td>
<td>7</td>
</tr>
<tr>
<td>Nov, 78</td>
<td>30.6</td>
<td>22.6</td>
<td>2</td>
</tr>
<tr>
<td>Dec, 78</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Agril. School, Borgaon' (Satara)

<table>
<thead>
<tr>
<th>Month</th>
<th>Temperature OC</th>
<th>Rainfall (mm)</th>
<th>Rainy days</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Maximum</td>
<td>Minimum</td>
<td></td>
</tr>
<tr>
<td>Jan, 78</td>
<td>30.1</td>
<td>11.8</td>
<td>0</td>
</tr>
<tr>
<td>Feb, 78</td>
<td>39.9</td>
<td>16.7</td>
<td>1</td>
</tr>
<tr>
<td>Mar, 78</td>
<td>34.2</td>
<td>10.1</td>
<td>0</td>
</tr>
<tr>
<td>Apr, 78</td>
<td>33.4</td>
<td>22.9</td>
<td>8</td>
</tr>
<tr>
<td>May, 78</td>
<td>38.2</td>
<td>25.3</td>
<td>7</td>
</tr>
<tr>
<td>Jun, 78</td>
<td>30.9</td>
<td>24.2</td>
<td>13</td>
</tr>
<tr>
<td>Jul, 78</td>
<td>27.7</td>
<td>23.2</td>
<td>15</td>
</tr>
<tr>
<td>Aug, 78</td>
<td>28.0</td>
<td>23.7</td>
<td>21</td>
</tr>
<tr>
<td>Sep, 78</td>
<td>30.0</td>
<td>23.1</td>
<td>13</td>
</tr>
<tr>
<td>Oct, 78</td>
<td>31.5</td>
<td>22.2</td>
<td>7</td>
</tr>
<tr>
<td>Nov, 78</td>
<td>30.6</td>
<td>22.6</td>
<td>2</td>
</tr>
<tr>
<td>Dec, 78</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Month</th>
<th>Rainfall (mm)</th>
<th>Rainy days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan, 78</td>
<td>0.0</td>
<td>0</td>
</tr>
<tr>
<td>Feb, 78</td>
<td>0.0</td>
<td>0</td>
</tr>
<tr>
<td>Mar, 78</td>
<td>0.0</td>
<td>0</td>
</tr>
<tr>
<td>Apr, 78</td>
<td>0.0</td>
<td>0</td>
</tr>
<tr>
<td>May, 78</td>
<td>0.0</td>
<td>0</td>
</tr>
<tr>
<td>Jun, 78</td>
<td>0.0</td>
<td>0</td>
</tr>
<tr>
<td>Jul, 78</td>
<td>0.0</td>
<td>0</td>
</tr>
<tr>
<td>Aug, 78</td>
<td>0.0</td>
<td>0</td>
</tr>
<tr>
<td>Sep, 78</td>
<td>0.0</td>
<td>0</td>
</tr>
<tr>
<td>Oct, 78</td>
<td>0.0</td>
<td>0</td>
</tr>
<tr>
<td>Nov, 78</td>
<td>0.0</td>
<td>0</td>
</tr>
<tr>
<td>Dec, 78</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

I - First fortnight, II - Second fortnight

(M-morning, E-evening)
1. GENERAL:
   Farmer's Name:
   Village:
   District:
   Date of Survey:
   Block:
   Field No.:

2. FARMER'S RESOURCES:
   Total land: hectare/s
   Area under Turmeric: hectare/s
   Ginger: hectare/s
   Variety:
   Has he changed varieties in the last 5 years: YES/NO

3. DESCRIPTION OF THE SELECTED PLOT:
   Season/Year: Kharif/Rabi/Summer
   Area: hectare/s
   Previous crop/s:
   Crop rotation:
   Is this a regular pattern: YES/NO

SOIL:
   Type: Sandy/Loam/Clay/Medium black/Murram
   Location: Upland/Lowland

PREPARATORY CULTIVATION OF THE PLOT:
   Sr.No.  Operation  Date(s)  Implements used
   1.
   2.
   3.
   4.
   5.

5. SOWING:
   SEED: Source - Own
   - Purchased: Farmer
   Merchant
   Other (Specify)
   Quality: Healthy/Infested
   Value: Rs/hectare
   Date/Week of sowing:
   Seed rate:
   Row-to-row distance:
   Plant-to-plant distance:
   Method of sowing:
   Seed dressing/Treatment:
   Ideal sowing period:
<table>
<thead>
<tr>
<th>Name</th>
<th>Quantity</th>
<th>Date of application</th>
<th>Method of application</th>
<th>Stage of the crop</th>
</tr>
</thead>
<tbody>
<tr>
<td>F.Y.M. or Compost Fertilizer</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>i)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ii)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>iii)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cakes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remarks</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**7. IRRIGATION:**

<table>
<thead>
<tr>
<th>Source of irrigation</th>
<th>Method of irrigation</th>
<th>Date(s)/Week</th>
<th>Stage of the crop</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canal/Well/tubewell</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**8. INTERCULTURE:**

<table>
<thead>
<tr>
<th>Name of operation</th>
<th>Implement/Tool used</th>
<th>Date of operation</th>
<th>Stage of the crop</th>
<th>Remarks</th>
</tr>
</thead>
</table>

**9. PLANT PROTECTION MEASURES ADOPTED:**

<table>
<thead>
<tr>
<th>Date</th>
<th>Pest/disease observed</th>
<th>Stage of crop used</th>
<th>Pesticide method used</th>
<th>Quantity</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1.  
2.  
3.  
4.  
5.  

**10. METEOROLOGICAL OBSERVATIONS:**

<table>
<thead>
<tr>
<th>Rainfall</th>
<th>Period</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Higher</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scarcity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unusual</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### 11. HARVEST

<table>
<thead>
<tr>
<th>Date</th>
<th>Method</th>
<th>Stage of crop</th>
<th>Remarks</th>
</tr>
</thead>
</table>

### 12. YIELD

<table>
<thead>
<tr>
<th>Total Yield</th>
<th>Kg/ha.</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Prevailing market prices at harvest</th>
<th>Rs/Quintal</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Yield from 100 sq. meter area</th>
<th>Kg.</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Infested rhizomes</th>
<th>Kg.</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Healthy rhizomes</th>
<th>Kg.</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Healthy rhizomes</th>
<th>Kg.</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Causes for low or high yield</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Stage(s) of rhizome fly recorded</th>
</tr>
</thead>
</table>

### 13. STORAGE

<table>
<thead>
<tr>
<th>Type</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Whether seed rhizomes</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Store separately or otherwise</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Is it used to store other commodities</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Storage capacity</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Problems for storage if any</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Prophylactic measures to avoid storage loss</th>
</tr>
</thead>
</table>

### 14. INNOVATIONS AND RELEVANCE OR SURVEY T. RESEARCH OBJECTIVES

Kolhapur: Signature of the Officer-in-charge.