BIOECOLOGY AND CONTROL OF PESTS OF ROSE

BY

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THESIS

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DECLARATION

I hereby declare that this thesis entitled "**Bioecology and control of pests of rose**" is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title at any other University or Society.

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CERTIFICATE

Certified that this thesis entitled "Bioecology and control of pests of rose" is a record of research work done independently by Sri. V. Vijayan Nair under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to him.

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Introduction

INTRODUCTION

Flowers are the loveliest of the objects around us and roses are indisputably the "queen of flowers". Wild roses were available on earth long before the emergence of man on this globe. Geological records show that these plants were present atleast thirty million years ago. In the wild situation they could compete well with other species of plants and roses emerged as a successful group of plants in nature. From very ancient times the rose flowers were being loved and cherished by man. In the modern age it holds a unique place as a source of relaxation for the tiring mind obsessed with the endless worries of the so called civilization. The craze of man for the varietyof colours and the wide scope in providing the same in rose flowers prompted the breeders to produce newer and newer varieties and a fantastically divergent and endeavouring types and varieties of this plant has come into existence all over the world.

The growing demand for cut flowers used in ceremonies, for purpose of worship, in indoor and outdoor decorations, for beautifying the gardens etc has put rose cultivation on an industrial footing. Consequent to this intensive breeding efforts, the inherent susceptibility of the newer varieties to pests and diseases created serious problems

to the rosarians. It became inevitable to use the pesticides in a very intensive scale to see the lovely roses thriving and flowering in the premises.

Butani (1974) reported 50 species of insects and mites as pests of rose, out of which only a few were found to cause serious damage. Some species of thrips causing severe damage to the leaves and flowers of rose were reported earlier also (Ayyar, 1940; Ananthakrishnan, 1960 and 1971). Mites feeding on the plant (Bindra and Singh, 1970) and scales and other pests affecting the foliage (Nair, 1975) were also on record. Retithrips syriacus Mayet a highly polyphagous species of thrips, has became a major pest of rose in the recent past. Detailed studies on the biology, on the nature and extent of damage caused by the different pests and control of many of these pests are lacking.

Commercial cultivation of budded roses has necessitated the application of plant protection chemicals in schedule, very often at short intervals of five to six days to protect their valuable plants from the ravages of pests and diseases. This intense use of plant protection chemicals have already created resistance problems in the management of pest in the gardens in and around Trivandrum. Judicious pesticide management programme have to be developed for the successful growing of rose.

The basic informations on the nature and extent of damage caused by different pests, the distribution of the pests in relation to seasonal variations, their host range and bioecology are essential for developing integrated control strategies. Identifying the peak period in the prevalence of various pests may facilitate the restricted use of pesticides in the gardens and prevent further population build up of the pests so that the future pesticides use can be limited.

Laboratory and field experiments on these aspects have not been carried out in a sound footing so far. Hence investigations were taken up with the following objectives:

1. Survey of the pests affecting rose plants in different locations of Trivandrum Taluk for a period of one year, adopting standard statistical procedures.

2. Correlation of the variability in pest population observed during the different periods of the year with the prevalent climatic factors.

3. Identification of the different species of insects and mites infesting rose and studies on the biology and nature of damage caused by the important pest species.

4. Assessment of the influence of host plants on the biology and development of R. syriacus.

5. Evaluation of insecticides for the control of insect and mite pests of rose.

REVIEW OF LITERATURE

Rose is subjected to attack by pests belonging to different taxonomic positions doing heavy damage to the vegetative parts as well as to the floral parts. A brief review of literature on the different pests of rose is given below.

1.1 The thrips

1.1.1 Selenothrips rubrocinctus Giard. This was first reported in 1898 causing serious damage to cocoa in West Indies. In India the first report was on cashewnut leaves from Cochin (Ayyar, 1929). The other alternate hosts reported for the thrips were Artocarpus sp., Terminalia sp. and avacado (Cotterell, 1930). Dry season (Cotterell, 1930) and drought weather with much sunshine (Reyne, 1930) were found to favour the insect development in the field. An internal eulophid nymphal parasite Dasyscapus parvipennis had been identified from the thrips (Cotterell, 1930 and Ferriere, 1931). The bionomics of S. rubrocinctus had been worked out by Wang (1982) and he observed eight overlapping generations of the thrips. The life-cycle took about 20-30 days. The population increased sharply and reached the peak in late September-October, then declining rapidly in response to lower temperature and reduced food quality;

population growth was favoured by warm dry weather.

1.1.2 Scirtothrips dorsalis Hood. This was first reported as a pest of chillies and castor plants in Coimbatore by Ayyar in 1919. The other alternate hosts of the thrips were groundnut, gogu, Cassia fistula and brinjal (Ayyar, 1932). In 1960, S. dorsalis was reported as a pest of rose by Ananthakrishnan. Acacia, Prosopis, Azadirachta, Caesalpinia, Nelumbium, Punica, Camellia thea, Coffea arabica, Citrus sp. and Lycopersicon lycopersicum were also found to be alternate hosts of this pest (Ananthakrishnan, 1980).

1.1.3 R. syriacus Mayet. Rose leaves were infested with this thrips alone or in association with Rhipiphorothrips cruentatus. Infestation by the thrips resulted in almost completely bleached leaves, filled with excreta, presenting a sickly appearance and finally drying up. Observation on the duration from first instar to the adult indicated that it took 9-11 days on rose and 9-13 days on castor leaves. This species had also been noted to cause damage to the leaves of pomegranate (Ananthakrishnan, 1973). The other alternate hosts were Vitis vinifera, Arachis hypogea, Punica granatum, Acalypha sp., Cassia auriculata, cotton and grape vine (Ananthakrishnan, 1980). R. syriacus was also recorded

as a pest of coffee in India in 1953 which feed on both sides of the leaves, causing silvery patches (Kumar et al., 1984).

1.1.4 Rhipiphorothrips cruentatus H. This was first collected from rose from Coimbatore by Ayyar 1918 (Karny, 1926) and was reported to be a serious pest on the tender leaves of rose which turn sickly and dry up (Ayyar, 1940). It was also called as rose leaf thrips and was found highly polyphagous. By their concentrated feeding, mostly on lower surfaces of the leaves the leaves turned brown, withered curled up and ultimately dropped down. Once they damage the lower surface, they moved upwards to the dorsal side and with the leaf beginning to dry up, the individuals migrated to healthy leaves (Ananthakrishnan, 1973). Polistus olivaceus (Dy.) (lebracus (f)) was found preying upon the nymphs of R. cruentatus (Dhaliwal, 1975).

1.1.5 Other thrips

Serious injury was caused to roses by Thrips furscipennis Hal. the eggs of which were laid within the tissues of the outer petal about the time the buds begin to open. The major injury was caused by the feeding of the adults at the tip of the young bud. The larvae

apparently caused no injury when feeding between the petals of the unopened bud. The larvae pupated on the inner side of the calyx. The foliage was rarely injured but in the absence of buds, eggs were laid within the opening leaves at week shoots early in spring (Speyer, 1931).

Taeniothrips lefroyi Bagn., T. rhopalantennalis Shum., T. melanurus Bagn. and Physothrips andrewsi Bagn. were also recorded infesting the leaves and flowers of rose.

In rose, Thrips flavus (Schrank), T. coloratus (Priesner) and T. hawaiiensis (Morgan) attacking flowers and Taeniothrips traegardhi (Trybom) and Aeolothrips collaris (Priesner) attacking leaves were also listed by Ananthakrishnan (1973).

1.2 The mites

The species of mites commonly found damaging rose plants were Tetranychus telarius Linnaeus. T. equatorius McGregor and Brevipalpus phoenicis (Geijaskee).

Butani (1974) reported that the common mites of rose were Tetranychus telarius Linnaeus, T. equatorius McGregor (cucurbitae Rahman & Sapra) and Brevipalpus phoenicis (Geijaskee). Of these T. telarius was more destructive and had a very wide range of host plants including almond, apple, brinjal, bhindi, castor, cherry, cotton, grape vine,

papaya, peach, pear, strawberry and tomato. Both nymphs and adults were found congregating on the underside of leaves, protected by silky webs. They were found to suck the cell sap causing blotches on the leaves which ultimately dry up and the leaves fall down. These mites appeared with the onset of monsoon and were most active during September to January, thereafter the activity declined till April when they disappeared due to excessive heat.

In Varanasi district, T. urticae was found in medicinal plants in the year 1971-74 especially during summer (Lal and Mukharji, 1977).

Castor was also reported as an alternate host of T. urticae by Vora et al .(1984) who worked out the detailed biology on the alternate food plants and the control measures.

A survey of 95 commercial flower growers in New Zealand showed that carnations, Gypsophila, roses, orchids, chrysanthemums were more frequently infested with T. urticae (Chapman and Penman, 1985).

Pillai and Jolly (1986) found that T. equatorius, the common mite of rose was infesting mulberry plants and the population was highest between March to July. A temperature range of 28-33°C with a low humidity (40-50%)

was favourable for breeding. Low temperature coupled with humidity had an adverse effect on number of eggs laid.

1.3 The scale insects

The hard scales Aspidiotus lataniae Signoret, A. orientalis Newstead, Icerya aegyptiaca Douglas (Butani 1974), Aonidiella aurantii Maskell (Ayyar, 1940), Aspidiotus dictyospermi var arecae Newst., A. transparens Gr., Chionaspis sp. and Lindingaspis rossi (Maskell) and the soft scales Saissetia hemisphaericum Targ. and Icerya purchasi Mask. (Nair, 1975) were found to infest rose and cause heavy damage. The biology, nature of damage and control of Aulacaspis rosae was worked out in rose and the other alternate hosts are rasp berries, lemongrass and blackberry (Anon, 1986).

1.4 The Jassids

The jassid, Empoasca sp. had been recorded on rose during premonsoon period (Butani, 1974).

1.5 The aphids

Macrosiphum rosaeformis Das was recorded as infesting rose by Ayyar (1940). The other commonly found aphids on roses were M. euphorbiae Thomas, M. rosae Linnaeus and Siphonophora rosae Leam which appear only during winter from January to February (Butani, 1974).

Nair (1975) also reported M. rosaeformis Das, M. rosae L., M. euphorbiae Th., Chaetosiphon tetrapodes Wlk. and Rhodobium porasum Sand. infesting tender shoots of rose.

Agarwala and Chaudhuri (1981) observed M. rosae L., and Sitobion rosaeformis Das (M. rosaeformis D.) infesting roses in West Bengal; Aphidius rosae Hal. and Aphelinus sp. were reported as the hymenopteran parasites attacking the aphids.

The effect of climatic factors on the common rose aphid M. rosaeformis was studied by Atwal and Dhingra (1972) and they revealed that temperature played an important role in aphid growth and development.

The population characteristics and partial life-cycle of Acrythosiphon porosum were worked out in hybrid tea roses (Alverson and Parler, 1983).

1.6 The white fly

Aleurocanthus rosae Singh laid eggs on the undersurface of rose leaves. The nymphs were brownish-yellow and puparia jet black with cottony fringe all around. This was reported to have a countrywide distribution occurring as a serious pest in some places. Aleurodes cotesi another species of whitefly also was reported infesting rose (Nair, 1975).

1.7 The coreid bug

The coreid bug Euthochtha galeator Fab was found feeding on roses. They attack the young twigs and cause malformed flowers and drooping leaves. Golden coloured eggs were laid on leaves. Spiny nymphs were seen near terminal shoots and the stout bodied brown adults on stem, bud or foliage (Mead, 1981).

1.8 The caterpillar pests

The lepidopterous pests recorded on rose include Euproctis fraterna M., E. scintillans W., Parasa lepida Cr., Achaea janata L. and Stauropus alternus (Ayyar, 1940). In addition to these lepidopteran pests, Haleystogramma hibiscist (Gelechiidae), Indarbela tetraonis (Moo) Arbelidae), Soritia leptalina Koll. (Zygaenidae), Eucosma zelota Meyr. and Argyroploce aprobola Meyr. (Eucosmidae), Peronia schallerina Linn., Ulodennis trigrapha Meyr. and Platypella agrobola Meyr. (Totricidae), Taragama siva Lef. (Lasiocampidae), Thalassodes veraria Guen. and Hyposidra successaria Wlk. (Geometridae), Spodoptera litura F., Silepta celtis Meyr., Heliothis armigera and Parallelia algira (Noctuidae) were also reported as pests of rose (Nair, 1975). Euproctis lunata Walker found feeding on roses was reported by Singh and Grewal (1981). Lymantria obfuscata was recorded as a pest of rose by Dharmadhikari et al., 1985, from Kashmir and Himachal Pradesh.

Severe infestation of roses by larvae of H. armigera was observed in Simla, the level of infestation being 3-17 larvae per plant (Kishore & Misra, 1983).

1.9 The beetle pests

The rose chaffer beetles Macrodactylus subspinosus (Fab.) and M. uniformis Hb. damaged the leaves and the grubs damaged the roots of rose plants (Anon., 1931). Hardouin (1931) found that the larvae of Otiorhynchus rugosostmatus caused considerable damage to underground parts of rose. Phyllopertha horticola L. and Cetonia aurata L. were attacking the leaves and flowers whereas Anthonomus rubi Hbst. oviposit in the flower buds in which the larvae feed (Reichert, 1931). The rose chaffer beetles Oxycetonia versicolor F., Adoretus versutus H. and Sthenias grisator F. girdling the twigs were found to do damage to roses (Ayyar, 1940). Large number of Popillia complanata Newman and Anomala spp. appeared during April-May 1966 and destroyed rose flowers by feeding on the petals at Kodaikanal (Abraham et al., 1970). A survey on cetonid pests in Rajasthan showed that adults of Chiloloba acuta (Wied.) were found damaging the leaves of roses (Bhatnagar, 1970). Subsequently, A. cardoni Brenske, A. bicavdatus, A. caliginosus Burmeister va. bicolor Brenske A. lasiophagus Bureister, A. stoliczke, A. bangalorensis Brenske, Lachnosterna cosanguinea Blanchard and Prycetonia versicolor were also reported to do damage to roses (Butani, 1974).

Nair (1975) reported Chiloloba acuta Wied., Serica calcuttae Br. feeding on leaves and A. lobiceps Arr., A. bicolor Br., A. caliginosus, Popillia cupricollis Hope and Anomala transversa Burm., the ruteline beetles feeding on leaves and flowers. The other beetles reported by him were Mylabris pustulata Thunb. feeding on the flowers and Coelosterna spinator Fb. gnawing the twigs and Cryptocephalus dodecospilus Suff. and Calaspis hypochlora Lef. feeding on rose leaves. Myllocerus setuliferus Desh and Macraspis chrysis L. the two curculionids were also seen damaging flowers and the leaves of rose.

Another sp. of Popillia, Popillia schizonycha Arrow was found feeding on the petals of roses (Rai, 1978). The buprestid Agrilus aurichalcus was also reported to feed on roses (Bily, 1982).

New record of six beetle pests of rose were made in a survey during 1979-80 at Bangalore (Verghese and Prasad, 1983) which were Crytocephalus insubidus Suffrian, C. dichotomus Suffrian, C. aequalis, C. lavareae belonging to the family chrysomelidae and Myllocerus discolor Bohiman, M. undecimpustulatus Faust and Peltotrachelus cognatus Marshall belonging to curculionidae.

1.10 Other pests

Megachile anthracina J cause damage to the foliage of roses (Ayyar, 1940). Megachile centuncularis (L) a solitary bee cut pieces out of rose leaves to line their nests which are built in a hollow branch or crack in the wall (DeMeirleire, 1969). Megachile disjuncta Fab. has also seen reported to do damage to rose (Nair, 1970).

The tettigonid Phaneroptera quadripunctata Br. was recorded as damaging the buds and peduncles of roses (Jossel, 1931).

Termites are destructive to roses especially in nurseries. Microtermes obesi (Anandi) Holmgren was found infesting rose, chrysanthemum and amaranthus. Termites were more active during January-February and again from September-October. Attacked plants wither, dry and ultimately dry away (Butani, 1974).

1.11 Control studies on pests of roses

1.11.1 The thrips

S. rubrocinctus was found to be killed by spraying of Bordeaux mixture and subsequently it acted as a repellant (De Verteuil, 1931).

R. syriacus control was achieved with BHC 0.1%, dimethoate 0.03%, methyl demeton 0.025% or parathion 0.025% (Ananthakrishnan, 1973).

Spraying with BHC 0.1%, dimethoate 0.03%, methyl demeton 0.025% or parathion 0.025% gave effective control of thrips R. cruentatus (Ayyar, 1940).

Control of R. cruentatus using 0.1% lindane or 0.2% DDT and repeating after a week was suggested by Pal (1966).

Repeated spraying with parathion or other phosphatics was found to keep the plants free from thrips infestation (Nair, 1970).

1.11.2 The mites

Chlorobenzilate, carbophenothion and chlorfenson were found to give significantly better control of T. telarius during December-January (Suplicy N. filho and Calza, 1968).

Wilson and Oliver (1969) evaluated six acaricides for control of mites on roses. Methidathion and G.S. 19851 (isopropyl 4,4 dibromolenzilate) gave the best control of T. telarius and T. cinnabarinus. Chlorobenzilate, Galecron, Nissol and tetradifon were less effective but gave significant control.

Dusting of sulphur or spraying 0.25% wettable sulphur twice with one month interval was found to control the mites infesting rose (Butani, 1974).

The most commonly used acaricides against T. urticae were cyhexatin, propargite, dicofol, bromopropylate and azocyclotin (Chapman and Penman, 1985).

The effectiveness of abamectin against T. urticae was tested in commercial rose greenhouses in Netherlands. Excellent control was obtained for 3-5 weeks after application at concentration of 4.5 ppm. Translaminar activity of abamectin at 4.5 ppm against the tetranychid feeding on rose leaves was demonstrated in laboratory tests (Green et al., 1985).

T. cinnabarinus on rose under glasshouse conditions could be controlled by dichlorvos even at very low concentrations of 2.8 ml/100 cu.m , but repeated applications were necessary for complete control (Kehat et al., 1969).

1.11.3 The Scale insects

The control of A. aurantii, suggested by Pal (1966) was to prune and destroy the infested leaves and twigs; scraping the scales and destroying the same and rubbing the affected stem with swab of cotton soaked with methylated spirit.

Good control of A. aurantii on roses was obtained by spraying with 0.1% parathion twice an year in the latter half of October and latter half of April; a mixture of 0.05% malathion and parathion and 0.025% diazinon gave better control of the scale (Batra et al. 1968).

In the case of orchards, spraying 0.05% endosulfan or DDVP, once immediately after pruning and again in March-April was found to control the scale (Butani, 1974).

Granules of disulfoton, phorate, fensulfothion and carbofuran @ 1.5 and 3 kg ai/ha were tested against L. rosae the rose scale. Carbofuran at the lower dose and disulfoton and phorate at the higher rate gave the best results (Srinivasan et al., 1974). In another study made on the control of rose scale, out of the six insecticides tried, phoxim, monocrotophos, methyl demeton and formothion were found to be more effective (Govindarajan et al., 1977).

1.11.4 The Aphids

Complete control of the aphid M. rosaeformis Das. was obtained with spray of parathion 0.025%, malathion 0.1%, carbophenothion 0.05%, dimethoate 0.03% and methyl demeton 0.025% (Balasubramanian, 1974).

The commonly found aphids on rose like M. rosaeformis, M. euphorbiae, M. rosae and S. rosae could be easily controlled with 1-2 dustings of pyrethrum powder or spraying with nicotine sulphate in soapy water (1 : 800), 0.05% endosulfan, 0.1% malathion or 0.03% dimethoate (Butani, 1974).

MATERIALS AND METHODS

2.1 Assessment of incidence of major pests of rose in Trivandrum

A detailed survey was conducted on the incidence of insect and mite pests of rose in Trivandrum taluk. Six locations were selected in the taluk ensuring maximum representation of urban household gardens. They were Kowdiar, Paruthippara, Karamana, Palkulangara, Vanchiyoor and Vellayani. From each location, four gardens maintained under more or less uniform management practices were selected.

2.1.1 Observations

From each garden, ten plants were selected at random and the observations were recorded on different species of pests at monthly intervals starting from August 1986 to August 1987.

2.1.1.1 The leaf thrips *R. syriacus*

From each plant selected, the population was assessed by counting the total number of thrips present on ten older leaves. The extent of damage was assessed in terms of the percentage of plants infested and the percentage of leaves infested.

2.1.1.2 The flower thrips, S. dorsalis

In order to assess the percentage of damage caused to the leaves, the total number of tender leaves and the crinkled leaves were counted and the percentage worked out. The total number of flower buds and the damaged flower buds were also recorded to assess the damage to the buds.

2.1.1.3 The scale, A. aurantii

Scale insects were counted from one cm length each from the basal, middle and the top regions of the infested part of the stem in each plant.

2.1.1.4 The aphid, M. rosaeformis

The total number of aphids present in the tender portions of the 10 plants selected at random were counted.

2.1.1.5 Mealy bug and cow bug

Total number of these insects observed on the plants were recorded.

2.1.1.6 The beetles

2.1.1.6.1 Adoretus spp.

As the beetles were nocturnal in habit, the damage on the leaves was taken as the index of the population. Hence the number of damaged leaves were counted.

2.1.1.6.2 Ascerica mollis Wlk.

These beetles found feeding on the tender most leaf before opening, were counted.

2.1.1.6.3 P. complanata Newn

The beetles were collected and counted from the flowers.

2.1.1.6.4 Other beetles

The number of beetles found scraping the tender leaves and gnawing off the epidermal cells of tender stem were counted.

2.1.1.7 Grasshoppers

The number of grass hoppers found damaging the plant were counted.

2.1.1.8 Leaf and flower feeding caterpillars

Total number of caterpillars of the six different species, found in each garden was recorded.

2.1.1.9 Mites

The number of two species of mites, T. cinnabarinus and T. neocaledonicus, was counted from five older leaves selected at random from each plant.

2.1.1.10 Weather data

Meteorological observations such as maximum temperature, minimum temperature, relative humidity, rainfall

and number of rainy days were recorded during the period of the survey.

2.2. Studies on the biology of *R. syriacus* on different host plants

The biology of *R. syriacus* was studied on four different host plants, viz., rose, castor, cassava and subabul in the laboratory. Leaves were collected from the host plants, cleaned and the petiole of one leaf each was introduced into a specimen tube containing water so as to keep it without drying for two to three days. It was kept inside a glass chimney and closed with muslin cloth held tightly with a rubber band. Ten such settings were arranged for each host plant. A pair of freshly moulted adults of the thrips were introduced on the host plant. The first instar nymphs emerging from the leaves were transferred to new leaves with the help of fine camel hair brush. The observations were continued till they moulted to adult. The incubation period, duration of different nymphal stages, prepupal and pupal periods were noted during the course of these observations. Observations on the head width, thoracic width, antennal length and total length of the different instars reared on different hosts were also recorded using an ocular micrometer.

For observing the total number of eggs laid by a female a separate setting was arranged with rose leaf as the host, as described in the above para. The eggs were identified by the lactophenol clearing method as described by Gaadoura and Venkataraman (1967). Lactophenol solution was prepared by mixing one part of glycerine, one part of phenol and one part of lactic acid (85%) with two parts of distilled water. The solution was boiled in a test tube and the leaves were immersed inside the solution for five minutes and then transferred to cold phenol in a beaker for 5-7 minutes. They were taken out, dried and the eggs were directly counted under a stereo microscope. This was done daily for a period of fifteen days by providing fresh leaves for egg laying everyday.

2.3 Chemical control of pests of rose

2.3.1 Experiment to evaluate different insecticides at lower doses for the control of R. syriacus on rose

A field experiment was conducted to assess the relative efficacy of different insecticides in controlling R. syriacus on rose at the Instructional farm, College of Agriculture, Vellayani during December 1986.

2.3.1.1 Raising of experimental plants

The variety 'Happiness' was maintained in pots of size 30 x 30 cm. The plants were observed for the infestation of R. syriacus. When the population of the thrips was found to be fairly high, plants having a uniform population of the insect were selected for the experiment.

2.3.1.2 Treatments

Seven emulsifiable concentrates and two granular formulations of insecticides were included in the treatments. They were endosulfan (Thiodan 35 EC of M/S. Hoechst Pharmaceuticals and Chemicals), fenthion (Lebaycid 1000 of M/S. Bayer India Ltd.) methyl parathion (Metacid 50 LC of M/s. Bayer India Ltd.), quinalphos (Ekalux 25 EC of M/S. Sandoz India Ltd.) dimethoate (Rogor 30 EC of M/S. Rallis India Ltd.) monocrotophos (Nuvacron 36 WSC of M/S Hindustan Ciba Ltd), phosphamidon (Dimecron 86 WSC of M/s. Hindustan Ciba Ltd.) phorate (Thimet 10G of M/s. Cyanamide India Ltd.) and carbofuran (Furadan 3G of M/S. Rallis India Ltd.).

Each insecticide was tried at the recommended, half and one fourth the recommended doses (vide Table 19) Emulsions of the insecticides were prepared by mixing the required quantity of formulations with water. A

quantity of 100 ml spray fluid was applied on each plant, using a hand sprayer. Required quantities of the granular insecticides were directly applied to the soil in the pots. A set of three plants sprayed with water alone served as control. The treatments were replicated thrice and they were arranged in completely randomised design.

2.3.1.3 Observations

Observations on the nymphal and adult population of the thrips were recorded at one day before and 7 and 14 days after application. The data was subjected to statistical analysis.

2.3.2 Experiment to evaluate different insecticides for the control of insect and mite pests of rose.

In order to assess the bioefficacy of different insecticides on other species of pests affecting rose, a second experiment was conducted during March-April 1986. in the rose garden attached to Instructional farm in the College of Agriculture, Vellayani.

2.3.2.1 Treatments

The same set of insecticides were tried in this experiment except the two granular insecticides (vide

Table 20). Each insecticide was tried at the recommended and double the recommended doses. Treatments were applied as described in para 2.3.1.2.

2.3.2.2 Observations

The extent of damage caused by S. dorsalis, A. aurantii and T. neocaledonicus was assessed as given under para 2.1.1. The observations were recorded at one day before and 7 and 14 days after application of the insecticides.

2.3.3 Experiment to assess the effect of carbofuran applied at different doses, on the control of pests of rose.

Another pot culture experiment was conducted to study the effect of varying doses of carbofuran on the control of insect and mite pests of rose in the Instructional farm, Vellayani during April-May 1986.

2.3.3.1 Treatments

Carbofuran was applied at six doses viz.0.03, 0.06, 0.09, 0.12, 0.15 and 0.18 g ai/pot (Table 24). The required quantity of the insecticide was directly applied to the soil in the pot. Controlled irrigation was followed @ 1½ litre of water/pot. Each treatment was replicated four times and the treatments were arranged in CRD.

Observations on the population of R. syriacus (nymphs + adults), A. aurantii and T. neocaledonicus and the damage caused by S. dorsalis were recorded as described under para 2.1.1.

2.4. Statistical analysis of the data

The data obtained from the survey on different pests of rose was analysed using one way classification analysis (Snedecor and Cochran, 1967). Separate C.D. values were computed for comparing the mean population/ damage between locations within each month and also between the location wise pooled means for different months.

Analysis of variance was used for comparing the treatment means of the experiments 2.3.1 and 2.3.3. Since the pre-treatment population in experiment 2.3.2. showed heterogeneity, analysis of co-variance was adopted. The treatment effects in 7th day observations was compared using pre-count as covariate, for 14th day, the pre-count and 7th day observations were used as covariates.

3. RESULTS

3.1. Survey on the major pests of rose in Trivandrum

A survey was conducted in the rose gardens of Trivandrum Taluk from six locations on the major pests attacking the rose plants during 1986-87. The major pests observed were the thrips Retithrips syriacus Mayet, Scirtothrips dorsalis Hood, the scale Aonidiella aurantii Maskell, the beetles, Adoretus spp. and the mites Tetranychus neocaledonicus Andre and Tetranychus cinnabarinus Koch. The population of the different species were assessed either as the number of insects observed, or as the extent of damage caused to the leaves/plants. The results of the observations recorded at monthly intervals from August 1986 to August 1987 in the different locations are given below:

3.1.1. Survey on the incidence of R. syriacus

Incidence of R. syriacus was assessed in terms of the population, percentage of plants infested and percentage of leaves infested by the pest.

3.1.1.1. Pest population

The population of R. syriacus from August 1986 to August 1987 from the different rose gardens of Trivandrum is given in Table 1.

Table 1. Population of *R. syriacus* observed on rose at different places in Trivandrum Taluk from August 1986 to August 1987

Locations	Number of thrips observed on 100 leaves during the month of												Mean
	Aug.'86	Sep.'86	Oct.'86	Nov '86	Dec.'86	Jan.'87	Feb.'87	Mar.'87	Apr.'87	May '87	Jun.'87	Jul.'87	Aug.'87	
Kowdiar	1.15 (1.47)	3.93 (2.22)	6.04 (2.65)	8.55 (3.09)	29.50 (5 52)	26.85 (5.28)	22.27 (4.82)	24.57 (5.06)	10.47 (3.39)	20.24 (4.61)	11.16 (3.49)	9.34 (3.21)	3.93 (2.22)	12.08 (3.62)
Paruthippara	1.91 (1.71)	3.99 (2.23)	3.42 (2.10)	0.71 (1.31)	5.05 (2.46)	11.33 (3.51)	14.16 (3.89)	14.27 (3.91)	19.78 (4.56)	8.47 (3.08)	1.61 (1 62)	3.41 (2.10)	0.83 (1.35)	5.77 (2.60)
Karamana	0.71 (1.31)	3.80 (2.19)	1.49 (1.58)	2 90 (1.97)	4.44 (2.33)	10.99 (3.46)	6.95 (2.82)	19.94 (4.58)	12.87 (3.72)	3.10 (2.02)	1.25 (1.50)	3.40 (2.10)	1.39 (1.54)	4.74 (2.40)
Palkulangara	1.72 (1.65)	5.06 (2.46)	6.02 (2.65)	4.74 (2.40)	5.40 (2.53)	14.39 (3.92)	19.02 (4.47)	31.64 (5.71)	20.31 (4.62)	9.30 (3.21)	3.34 (2.08)	6.68 (2.77)	3.39 (2.09)	8.74 (3.12)
Vanchiyoor	1.55 (1.60)	1.23 (1.49)	8.91 (3.15)	7.93 (2.99)	12.02 (3.61)	17.35 (4.28)	25.65 (5.16)	22.33 (4.83)	27.05 (5.30)	17.03 (4.25)	6.75 (2.78)	10.52 (3.39)	8.12 (3.02)	11.44 (3.53)
Vellayani	3.74 (2.18)	8.72 (3.12)	26.52 (5.25)	13.60 (3.82)	26.67 (5.26)	28.95 (5.47)	27.91 (5.38)	23.03 (4.90)	12 56 (3.68)	10 87 (3.45)	2.71 (1.93)	7.66 (2.94)	2.64 (1.91)	13.36 (3 79)
Mean	1.73 (1.65)	4.23 (2.29)	7.39 (2.90)	5.74 (2.60)	12.10 (3.62)	17.68 (4.32)	18.58 (4.43)	22.34 (4.83)	16.73 (4.21)	10 80 (3 44)	3.99 (2.23)	6.58 (2 75)	3.09 (2.02)	

Figures in parentheses are transformed values ($\sqrt{x+1}$)

CD for comparing mean populations observed in different months (at 5 per cent level) 0 98

CD for comparing the mean populations observed at different places in each month (at 5 per cent level) 3.15

Mean population of the thrips observed in different months during the period of survey ranged from 1.73 to 22.34. The population was at significantly higher levels from January (17.68), February (18.58), March (22.34) and April (16.73). The mean population in December (12.10) and May (10.80) also came on par with the population level observed in April. Least population was observed in the months of August (1.73 and 3.09); the population observed in June (3.99), September (4.23) and November (5.74) also came on par with this. The mean population noted on October (7.39) and July (6.58) also were on par with that of November (5.74). However, the mean population of thrips in the different locations did not show any significant variation among themselves, the values being 4.74 to 13.36.

When the population of thrips was observed in the different months, in Kowdiar area it varied from 1.15 to 29.50. The population started increasing from December (29.5) maintaining at higher levels upto the month of May (20.24). During the preceeding period, August to November, the population ranged from 1.15 to 8.55 and during the succeeding period of June to August the range was 11.16 to 3.93.

In Paruthippara also a similar trend of increase in the population of thrips was observed from the month

of January (11.33) to May (8.47), the population reaching the maximum in April (19.78). The range of population prior to January was from 1.91 to 5.05 and after May it was 1.61 to 0.83.

In Palkulangara also the population increase started from January (14.39) and a high level of population was maintained in the gardens upto May (9.3), the population being 19.02 in February, 20.31 in April and 31.64 in March. There was a reduction in the population to the tune of 1.72 to 5.40 during August-December and from 3.34 to 3.39 in the succeeding months of June to August 1987.

The population of thrips observed in the gardens of Karamana varied from 0.71 in August '86 to 1.39 in August '87, the population being more from the months of January to April, the values ranging from 10.99 to 12.87. The number of thrips observed in the month of March (19.94) was found to be the highest compared to other months. Preceeding to December, the population ranged from 0.71 to 4.44 from August to December and in the succeeding months of May to August, the range was 3.10 to 1.39 .

In the case of the other two areas the range in the population was from 1.23 to 27.05 in Vanchiyoor and 2.64 to 28.95 in Vellayani. A similar trend in increase

in the population was observed from the month of January to May in both the areas. The population from January (17.35) to May (17.03) in Vanchiyoor was found to be higher, the maximum population being in April (27.05). The population range was from 1.23 to 12.02 in the preceeding period and 6.75 to 10.52 in the succeeding months in Vanchiyoor area. Similarly an increased population was seen from December (26.67) upto March (23.03) with a slight decline in the two subsequent months (12.56 and 10.87). The population during June, July and August were 2.71, 7.66 and 2.64 respectively.

3.1.1.2. Percentage of plants infested

The level of infestation by *R. syriacus* on rose plants as evidenced by the percentages of infested plants observed in the six locations are given in Table 2.

It is seen that the mean percentage of damage caused by *R. syriacus* varied from 5.30 to 5.74 over the entire period of the survey; the maximum damage was seen in March with a mean of 19.17% which was significantly more compared to the damage levels observed in January (11.87), February (13.21) and April (14.7) which were on par among themselves. The damage observed in all the other months (5.30 to 8.03%) was found to be statistically on par.

Table 2. Percentage of rose plants infested by *R. syriacus* observed at different places in Trivandrum Taluk from August 1986 to August 1987

Locations	Mean percentage of infested plants observed during the month of													Mean
	Aug.'86	Sep.'86	Oct.'86	Nov.'86	Dec.'86	Jan.'87	Feb.'87	Mar.'87	Apr.'87	May '87	Jun.'87	Jul.'87	Aug.'87	
Kowdiar	3.66 (2.16)	6.49 (2.74)	8.23 (3.04)	14.47 (3.93)	12.08 (3.62)	16.47 (4.18)	16.47 (4.18)	26.18 (5.21)	14.60 (3.95)	10.36 (3.37)	8.33 (3 05)	5.12 (2.47)	6.49 (2.74)	10.79 (3.43)
Paruthippara	3.66 (2.16)	6.49 (2.74)	5.12 (2.47)	1.49 (1.58)	5.12 (2.47)	14.60 (3.95)	14.05 (3.88)	14.05 (3.88)	16.61 (4.20)	6.40 (2.72)	1.49 (1.58)	6.49 (2.74)	3.66 (2.16)	6.90 (2.81)
Karamana	1.49 (1.58)	5.12 (2.47)	1.49 (1.58)	2.59 (1.90)	5.12 (2.47)	5.12 (2.47)	5.12 (2.47)	17.20 (4.27)	16.61 (4.20)	3.59 (2.14)	1.49 (1.58)	5.12 (2.47)	3.66 (2.16)	4.97 (2.44)
Palkulangara	8.33 (3.05)	12.20 (3.63)	10.36 (3.37)	5.12 (2.47)	5.12 (2.47)	10.36 (3.37)	14.60 (3.95)	18.73 (4.44)	18.73 (4.44)	10.36 (3 37)	8.33 (3.05)	6.49 (2.74)	6.49 (2.74)	10.00 (3 32)
Vanchiyoor	8.33 (3 05)	3.66 (2.16)	8.33 (3.05)	8.33 (3.05)	8.33 (3.05)	12.08 (3.62)	16.60 (4.20)	23.68 (4.97)	12.08 (3.62)	9.89 (3.30)	12.08 (3.62)	9 89 (3.30)	8.33 (3.05)	10.48 (3.39)
Vellayani	8.33 (3 05)	12.59 (3.69)	14.47 (3.93)	14.47 (3.93)	14.47 (3.93)	14.47 (3.93)	14.47 (3.93)	16.47 (4.18)	10.36 (3.37)	8.33 (3.05)	5.12 (2.47)	10.36 (3.37)	6.49 (2.74)	11.30 (3.51)
Mean	5.30 (2.51)	7.44 (2.91)	7.46 (2.91)	6.91 (2 81)	8.03 (3.01)	11.87 (3.59)	13.21 (3.77)	19.17 (4.49)	14.70 (3.96)	7.96 (2.99)	5.55 (2.56)	7 12 (2.85)	5.74 (2.60)	

Figures in parentheses are transformed values ($\sqrt{x+1}$)

CD for comparing the mean percentages of infested plants observed in different months (at 5 per cent level) 0.74

CD for comparing the mean percentages of infested plants observed at different places in each month (at 5 per cent level) 2.21

The perusal of the data on the individual gardens showed that in general, the percentage damage increased from the month of January to April in Paruthippara (14.05 to 16.61), Palkulangara (10.36 to 18.73) and Vanchiyoor (12.08 to 23.68%), but in Kowdiar the increase was seen from November (14.47) onwards upto May (10.36) whereas in Vellayani it was from September (12.59) to April (10.36).

The variation in the percentage damage was from 3.66 to 26.18 in Kowdiar. The increased damage was visible from November onwards, extending upto May (range 10.36 to 26.18) and then a reduction upto August (8.33 to 6.49).

In Paruthippara and Vanchiyoor the damage increased from January onwards with a range in percentages of 14.05 to 16.61 and 12.08 to 23.68 respectively, and this increase was persisting upto April. In the preceeding as well as the subsequent months, the percentages decreased. In Palkulangara the increase in damage was from January to May with a range of 10.36 to 18.73 per cent. The percentage damage was 8.33, 12.2 and 10.36 in August, September and October respectively. The minimum damage (5.12) was observed in the months of November and December. From June onwards a gradual decrease in damage was noticed (8.33 to 6.49%). The

range of damage in Karamana was from 1.49 to 17.20. The intensity of damages were highest in the months of March (17.20) and April (16.61). In the other months of observation the percentage damage varied from 3.59 to 5.12 except in August (1.49), October (1.49), November (2.59) and June (1.49) when the damage was found to be comparatively less. Damage in Vellayani ranged from 5.12 per cent to 16.47 per cent. Here the higher damage levels ranged for a longer period from September (12.59%) to April (10.36%) with the maximum in March (16.47%), thereafter declining to 6.49 per cent in August and 5.12 per cent in January.

3.1.1.3. Percentage of leaves infested

The mean percentage of leaves infested by the thrips R. syriacus for the period from August 1986 to August 1987 is presented in Table 3.

Maximum percentage of infestation was seen in March (4.68) followed by April (4.22), which were significantly higher than all the other months. Percentage damage to leaves during February (3.76) and January (3.41) were also on par. The percentage of damage in May (2.58) and December (2.39) were again statistically similar, but were superior when compared to November (1.64), October (1.53) and September (1.48) which were on par among themselves. In June (1.18) and

Table 3. Percentage of rose leaves infested by R. syriacus observed at different places in Trivandrum Taluk from August 1986 to August 1987

Locations	Mean percentage of damaged leaves observed from 100 leaves during the month of													Mean
	Aug '86	Sep.'86	Oct.'86	Nov.'86	Dec.'86	Jan.'87	Feb.'87	Mar.'87	Apr.'87	May 87	Jun '87	Jul 87	Aug.'87	
Kowdiar	0.66 (1.29)	3.05 (2.01)	1.83 (1.68)	2.22 (1.80)	4.96 (2.44)	5.65 (2.58)	4.46 (2.34)	5.53 (2.56)	2.71 (1.93)	3.56 (2.14)	1 61 (1.62)	1.43 (1.56)	0.93 (1.39)	2.79 (1.95)
Paruthippara	0.66 (1.29)	1.12 (1.46)	0.83 (1.35)	0.56 (1.25)	1.25 (1.50)	2.63 (1.90)	2.83 (1.96)	2.88 (1.97)	4.42 (2.33)	2.27 (1.81)	0.40 (1.18)	0.93 (1.39)	0.46 (1.21)	1.51 (1.58)
Karamana	0.40 (1.18)	1.23 (1.49)	0.56 (1.25)	0.86 (1.36)	1.30 (1.52)	2.49 (1.87)	2.11 (1.76)	4.63 (2.37)	4.65 (2.38)	1.37 (1.54)	0.40 (1.18)	0.87 (1.37)	0.66 (1.29)	1.50 (1 58)
Palkulangara	0.93 (1.39)	1.23 (1.49)	1.36 (1.54)	1.23 (1.49)	1.25 (1.50)	2.69 (1.92)	3.10 (2.02)	4.57 (2.36)	5.08 (2.47)	2.62 (1.90)	1.36 (1.54)	1.12 (1.46)	1.16 (1.47)	2.01 (1.74)
Vanchiyoor	0 93 (1.39)	0.46 (1.21)	1.57 (1.60)	2.15 (1.77)	2.05 (1.75)	2.40 (1 84)	5.79 (2.60)	5.68 (2 59)	5.45 (2.53)	3.63 (2.15)	2.40 (1.84)	1.62 (1.62)	1.46 (1.57)	2.55 (1.88)
Vellayani	1.81 (1.68)	2.22 (1.80)	3.46 (2.11)	3.33 (2.08)	4.45 (2.33)	5.16 (2.48)	4.77 (2.40)	5.01 (2.45)	3.28 (2.07)	2.28 (1.81)	1.22 (1.49)	1.83 (1.68)	0.72 (1.31)	2.91 (1.98)
Mean	0.87 (1.37)	1.48 (1.58)	1.53 (1.59)	1.64 (1.63)	2.39 (1.84)	3.41 (2.10)	3.76 (2.18)	4 68 (2.38)	4.22 (2.28)	2.58 (1.89)	1.18 (1 48)	1.29 (1.51)	0.88 (1.37)	

Figures in parentheses are transformed values ($\sqrt{x+1}$)

CD for comparing the mean percentages of infested leaves observed in different months (at 5 per cent level) 0.08

CD for comparing the mean percentages of infested leaves observed at different places in each month (at 5 per cent level) 1.05

July (1.29) the percentage damage to leaves were on par but both were significantly superior to the month of August 1986 (0.87) and August 1987 (0.88).

In Kowdiar and Vellayani the percentage damage to leaves ranged from 0.66 to 5.65 and 0.72 to 5.16 respectively over the entire period of the survey. The peak period of damage as evidenced by the percentage of leaves infested in both the areas was from December to March with a range of 4.46 to 5.65 in Kowdiar and 4.45 to 5.16 in Vellayani and thereafter a declining trend was observed which continued upto August. Prior to December, the percentage of leaves damaged ranged from 0.66 to 3.05 in Kowdiar and 1.81 to 3.46 in Vellayani. The range of damage was from 0.46 to 5.79 in Vanchiyoor, a higher percentage of damage was seen during February (5.79), March (5.68), April (5.45) and May (3.63). In Karamana and Palkulangara the higher incidence of damage was in March and April, the values in percentage being 4.63 and 4.65 for Karamana and 4.57 and 5.08 for Palkulangara respectively. During the other periods of the survey the percentage of leaves damaged were more or less uniform with 0.4 to 2.49 and 0.93 to 3.10 preceeding the peak months of damage and 0.4 to 1.37 and 1.12 to 2.62 in the succeeding months in Karamana and Palkulangara, respectively. In Paruthippara the damage was maximum in April (4.42%). In the months of August '87

June and November the least damages to the tune of 0.46, 0.40 and 0.56% respectively were seen. The other months recorded a percentage damage ranging from 0.66 to 2.88. Here the intensity of damage was more from January to May with a range of 2.27 to 4.42.

The population of R. syriacus and the extent of damage caused to rose during the period of survey in relation to the weather parameters are comprehensively shown in Fig.1.

3.1.2. Survey on the incidence of S. dorsalis

The data on the survey was assessed in terms of the damage caused by the thrips on the tender leaves and also on the flower buds.

3.1.2.1. Percentage of tender leaves damaged

Monthly observations on the percentage of younger leaves damaged by the thrips S. dorsalis in different rose gardens observed from August 1986 to August 1987 are presented in Table 4.

It is seen that the mean percentage of damage to younger leaves by S. dorsalis was significantly higher in December (13.96). The percentage damage in January (8.07) was found to be on par with that of February (6.27) and

Fig. 1. Population of R. syriacus and the extent of damage caused by them on rose plants, observed in different months, in relation to weather parameters.

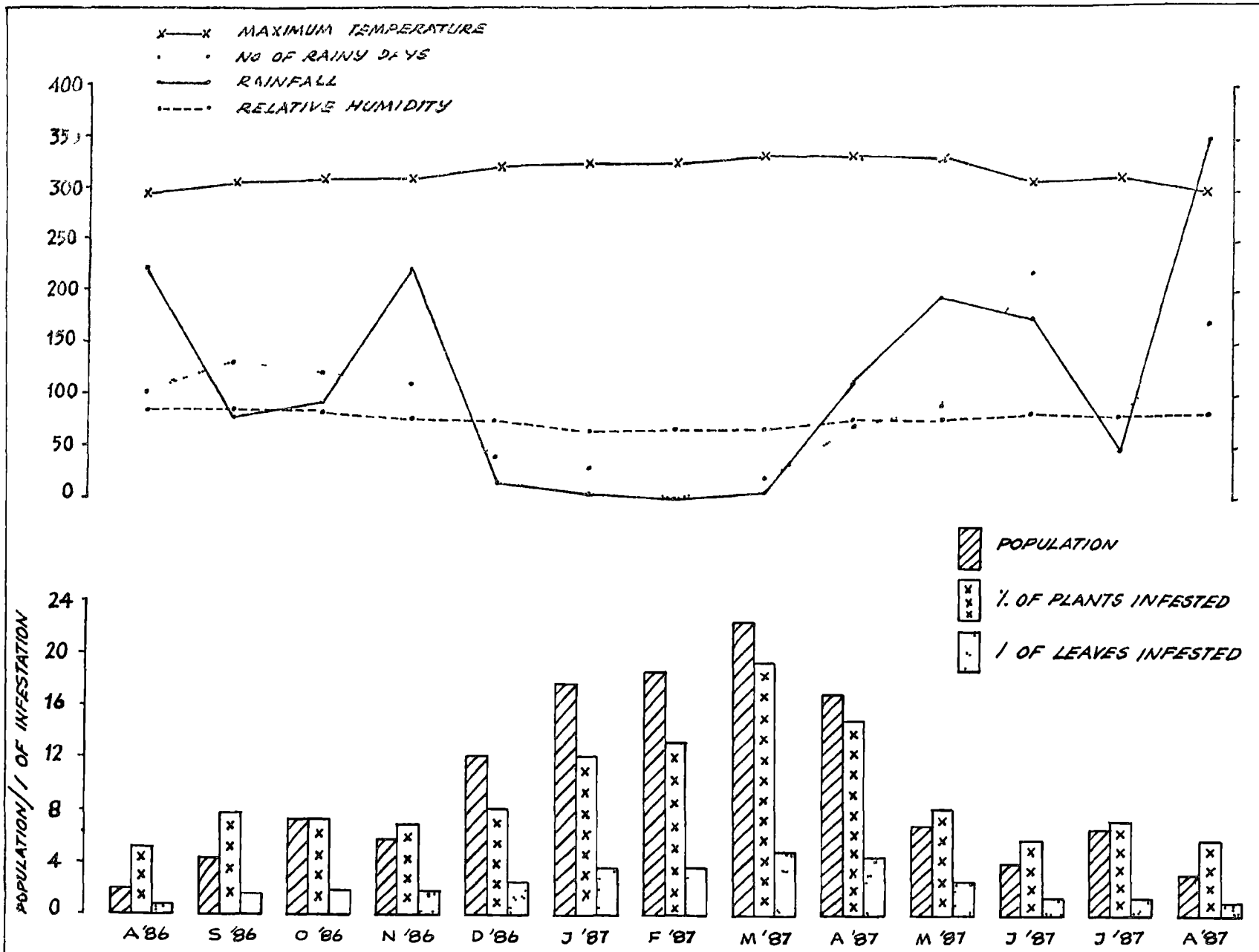

MAXIMUM TEMPERATURE
NO OF RAINY DAYS
RAINFALL
RELATIVE HUMIDITY
400
350
300
250
200
150
100
50
0
40
35
30
25
20
15
10
5
0
POPULATION
% OF PLANTS INFESTED
/ OF LEAVES INFESTED
POPULATION// OF INFESTATION
24
20
16
12
8
4
0
A '86
S '86
O '86
N '86
D '86
J '87
F '87
M '87
A '87
M '87
J '87
J '87
A '87

FIG 1

Table 4 Percentage of damage to younger leaves by *S dorsalis* observed on rose at different places in Trivandrum Taluk for the period from August 1986 to August 1987

	Mean percentage of damaged tender leaves observed during the month of													Mean
	Aug.'86	Sep.'86	Oct.'86	Nov.'86	Dec.'86	Jan.'87	Feb.'87	Mar.'87	Apr.'87	May '87	Jun.'87	Jul.'87	Aug.'87	
Kowdiar	0.00 (1.00)	0.46 (1.21)	5.64 (2.58)	7.61 (2.93)	29.34 (5.51)	9.41 (3.23)	6.53 (2.74)	7.29 (2.88)	3 58 (2.14)	3.06 (2.02)	1.05 (1 43)	0.83 (1 35)	0 00 (1.00)	4.33 (2 31)
Paruthippara	0.66 (1.29)	0.46 (1.21)	0.83 (1.35)	0.66 (1.29)	2.59 (1.89)	3.87 (2.21)	4.14 (2.27)	1.44 (1.56)	1.16 (1.47)	1.76 (1.66)	1.30 (1.52)	0 22 (1 10)	0 00 (1.00)	1.32 (1.52)
Karamana	0.46 (1.21)	0 46 (1.21)	0 93 (1.39)	0.22 (1.10)	6.97 (2.82)	6.80 (2.79)	3 40 (2.10)	3.28 (2.07)	2.22 (1.80)	1.15 (1.47)	0 22 (1.10)	0 00 (1.00)	0 00 (1 00)	1.62 (1.62)
Palkulangara	0.66 (1.29)	0 66 (1.29)	6.07 (2.66)	7.94 (2.99)	18.06 (4.37)	12.98 (3.74)	5.43 (2.54)	6.03 (2.65)	2.12 (1.77)	0.22 (1.10)	0.46 (1.21)	0.72 (1 31)	0 00 (1.00)	3.61 (2.15)
Vanchiyoor	1.60 (1.61)	1.69 (1.64)	1.36 (1.54)	1.80 (1.67)	14.86 (3.98)	5.84 (2.62)	6.68 (2.77)	5.03 (2.46)	5.00 (2.45)	1.44 (1.56)	0.00 (1.00)	0 22 (1 10)	0 00 (1.00)	2.82 (1.95)
Vellayani	3.39 (2.09)	0.66 (1.29)	2.80 (1.95)	9.10 (3.18)	20.46 (4.63)	11.17 (3.49)	13.16 (3 76)	6.25 (2.69)	8.61 (3.10)	5.14 (2.48)	2.88 (1 97)	3.07 (2.02)	1 83 (1.68)	5.97 (2.64)
Mean	1.00 (1.41)	0.71 (1.31)	2.65 (1.91)	3.81 (2.19)	13.96 (3.87)	8.07 (3.01)	6.27 (2.70)	4.69 (2.39)	3.49 (2.12)	1.94 (1.72)	0 88 (1.37)	0 73 (1.32)	0.24 (1.11)	

Figures in parentheses are transformed values ($\sqrt{x+1}$)

CD for comparing the mean percentages of damaged leaves observed in different months (at 5 per cent level) 0.71

CD for comparing the mean percentages of damaged leaves observed at different places in each month (at 5 per cent level) 1.6

March (4.69). During November (3.81), April (3.49), October (2.65) and May (1.94), the percentage of damage did not show any significant difference. The lowest percentage damage noticed in August '87 (0.24) was on par with the damage during the other months (0.71 to 1.94).

In Vellayani area, higher percentage of damage to younger leaves occurred during the period of December (20.46), January (11.17) and February (13.16). Thereafter a gradual decrease in the damage was noticed from March (6.25) onwards to August (1.83). The damage was minimum in September (0.66).

In Kowdiar there was no damage in August 1986, which increased to the maximum in December (29.34) and declined to zero by the next August. A similar trend was noticed in Palkulangara also where the peak period of damage was observed in December (18.06) with a slight reduction in the two preceeding and succeeding months. The damage varied from 6.07 to 7.94 and 5.43 to 6.03 respectively, in the other months of observation the damage varied from 0.66 to 2.12 only.

In Vanchiyoor the maximum percentage damage was noticed in December (14.86) with 5.84 per cent during January and a slight increase of 6.68 during February,

5.03 during March and 5.0 during April, thereafter reducing to zero in June and August. A similar trend was noticed in Paruthippara also with high damage during December (2.59), January (3.87) and February (4.14) and then gradually reducing to zero in August. Karamana area also had high damage during December (6.97) and January (6.80). Subsequently a reduction in the percentage of damage in the tender leaves was noticed from February (3.4) onwards, reaching zero level by July. Even the months prior to December showed only marginal damage ranging from 0.22 to 0.93.

3.1.2.2. Percentage of flower buds infested

Extent of damage to flower buds by the thrips S. dorsalis for the period of August 1986 to August 1987 from the different gardens in Trivandrum are presented in Table 5.

The mean percentage damage was seen maximum in the month of December (25.52) which was comparable to that of January (18.64) without any significant reduction. Damage done during March (17.69), February (15.14) and April (13.80) were found to be on par among themselves and also with that of January. During November, the damage was 7.20 per cent and this came on par with that of May (6.06) and June (4.42). The damage noticed in

Table 5. Extent of damage to flower buds by *S. dorsalis* on rose at different places in Trivandrum Taluk for the period from August 1986 to August 1987

Locations	Mean percentage of damaged flower buds observed during the month of													Mea
	Aug '86	Sep.'86	Oct.'86	Nov.'86	Dec.'86	Jan.'87	Feb.'87	Mar.'87	Apr.'87	May '87	Jun.'87	Jul.'87	Aug.'87	
Kowdiar	1.05 (1.43)	3.85 (2.20)	9.31 (3.21)	17.65 (4.32)	29.84 (5.55)	22.61 (4.86)	14.82 (3.98)	23.32 (4.93)	13.32 (3.78)	4.92 (2.43)	5.47 (2.54)	3.37 (2.09)	1.91 (1.71)	9.96 (3.3
Paruthippara	0.40 (1.18)	1.12 (1.46)	1.05 (1.43)	2.80 (1.95)	16.66 (4.20)	13.52 (3.81)	9.02 (3.17)	13.34 (3.79)	7.08 (2.84)	4.25 (2.29)	3.37 (2.09)	3.59 (2.14)	0.40 (1.18)	4.8 (2.4
Karamana	0.71 (1.31)	1.05 (1.43)	2.91 (1.98)	1.91 (1.71)	17.58 (4.31)	15.97 (4.12)	8.10 (3.02)	14.03 (3.88)	13.50 (3.81)	3.49 (2 12)	1.76 (1.66)	1.23 (1.49)	0.40 (1.18)	5.0 (2.46
Palkulangara	0.00 (1.00)	0.40 (1.18)	2.24 (1.80)	9.20 (3.19)	42.25 (6.58)	26.97 (5 29)	24.03 (5.00)	11.77 (3.57)	13.55 (3.81)	3.90 (2.21)	2.65 (1.91)	2.37 (1.83)	1.43 (1.56)	7.98 (3.00
Vanchiyoor	0.40 (1.18)	0.40 (1.18)	1.40 (1.55)	4.84 (2.42)	21.35 (4.73)	13.37 (3.79)	11.51 (3.54)	24.86 (5.09)	19.13 (4.49)	9.71 (3.27)	5.54 (2.56)	0.99 (1.41)	0.00 (1.00)	6.76 (2.79
Vellayani	3.45 (2.11)	2.06 (1.75)	2.61 (1.90)	11.96 (3.60)	29.59 (5.53)	21 32 (4.72)	28.19 (5.40)	20.96 (4.69)	17.88 (4 35)	12.11 (3 62)	9 25 (3.20)	9 07 (3.17)	7.26 (2.87)	12.02 (3.61
Mean	0.87 (1.37)	1.36 (1.54)	2.92 (1.98)	7.20 (2.86)	25 52 (5.15)	18.64 (4.43)	15.14 (4.02)	17.69 (4.32)	13 80 (3.85)	6.06 (2.66)	4.42 (2.33)	3.10 (2.02)	1.51 (1.58)	

Figures in parentheses are transformed values ($\sqrt{x+1}$)

CD for comparing the mean percentages of damaged flower buds observed in different months (at 5 per cent level) 0.80

CD for comparing the mean percentages of damaged flower buds observed at different places in each month (at 5 per cent level) 2.11

March (13.34) and April (7.08) and then declined. Minimum damage occurred in the months of August (0.40).

In Karamana the damage to flower buds was high in December (17.58), January (15.97), March (14.03) and April (13.5). Thereafter a decline in the extent of damage to the tune of 3.49 to 0.40 in the succeeding months and 0.71 to 2.91 in the preceeding months were seen. The damage was minimum in August 1987 (0.40).

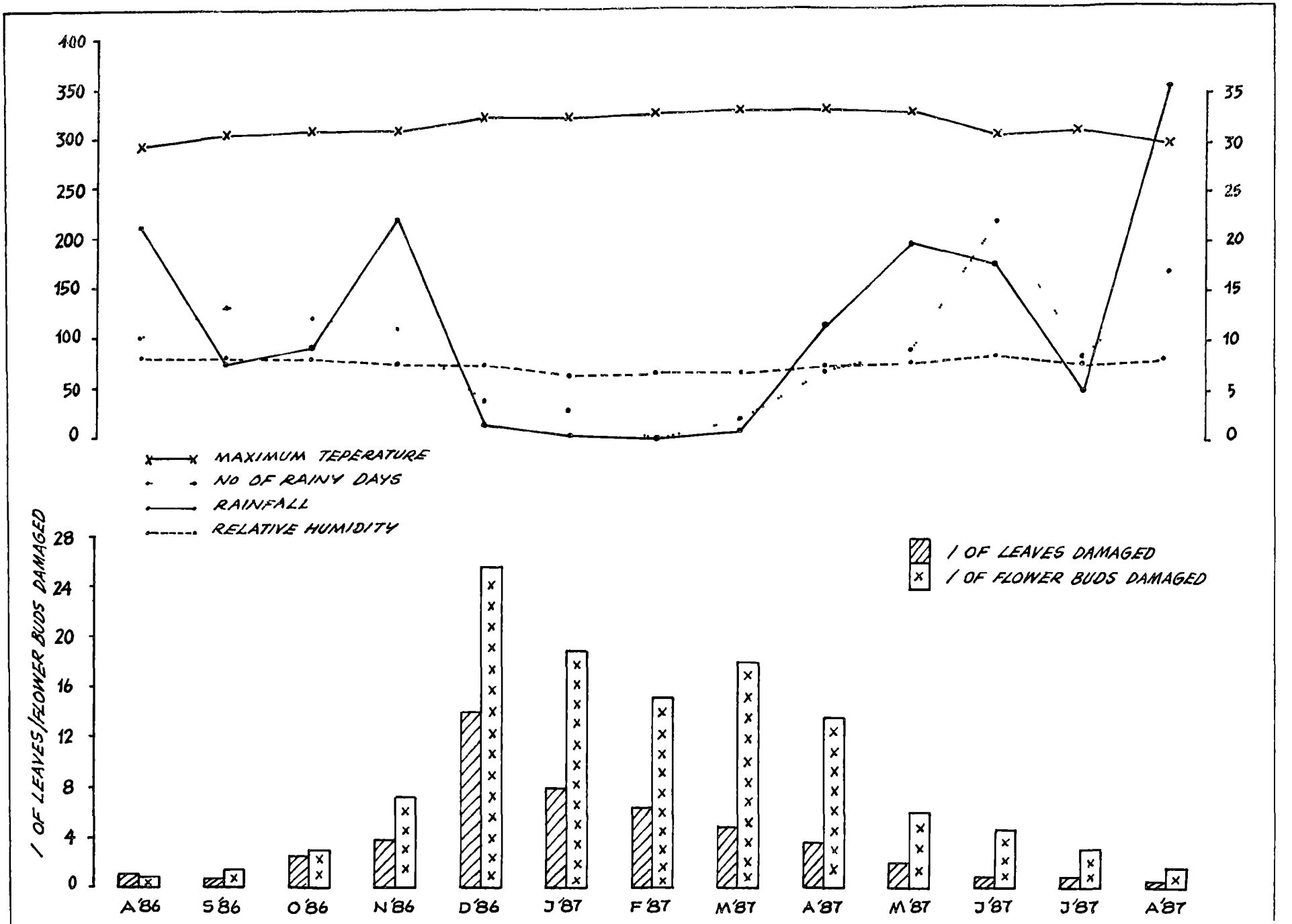
In Palkulangara also a sudden increase was noticed in December (42.25) from an extent of 9.2 per cent in November. In January and February (26.97 and 24.03) also the attack remained heavy with a slight reduction in the per cent damage during March (11.77) and April (13.55) and thereafter to 1.43 in August '87.

The extent of damage caused by S. dorsalis to tender leaves and flower buds of rose in relation to the weather parameters are comprehensively shown in Fig.2.

3.1.3. Survey on incidence of the rose scale, A. aurantii

The data was assessed in terms of the population and percentage of plants infested by the pest.

Fig. 2. Extent of damage caused by S. dorsalis on the leaves and flowerbuds of rose plants, observed in different months, in relation to weather parameters.


400
350
300
250
200
150
100
50
0
35
30
25
20
15
10
5
0
MAXIMUM TEPERATURE
NO OF RAINY DAYS
RAINFALL
RELATIVE HUMIDITY
% OF LEAVES/FLOWER BUDS DAMAGED
28
24
20
16
12
8
4
0
% OF LEAVES DAMAGED
% OF FLOWER BUDS DAMAGED
A'86
S'86
O'86
N'86
D'86
J'87
F'87
M'87
A'87
M'87
J'87
J'87
A'87

3.1.3.1. Pest population

The population of A. aurantii from August 1986 to August 1987 from the different gardens of Trivandrum are given in Table 6.

The mean population during the period of the survey in different months ranged from 4.89 in July '87 to a maximum of 10.46 during November. The population during October (10.18) was also higher when compared to other months but the population observed over the entire period of the survey did not show much variation and were statistically on par.

Regarding the population of the scale observed in the different locations, it was seen that in Kowdiar area, the variation was from 2.40 (June) to 26.89 (October). More number of scales were observed during August '86 (22.96), September (21.4), October (26.89), November (19.99) and January (16.92); in the other months, the population was from 2.4 to 12.7.

In Paruthippara, the number of scales was higher during the months of September (13.45), March (13.24) and August '87 (13.55) with the maximum in October (13.99). The minimum number of 2.44 was observed in April. In the other months population ranged from 3.24 (January) to 10.12 (July).

Table 6. Population of A. aurantii on rose at different places in Trivandrum Taluk during the period from August 1986 to August 1987

Locations	Number of scales from 3 cm length during the month of													Mean
	Aug.'86	Sep.'86	Oct.'86	Nov.'86	Dec.'86	Jan.'87	Feb.'87	Mar.'87	Apr.'87	May '87	Jun.'87	Jul.'87	Aug.'87	
Kowdiar	22.96 (4.89)	21.40 (4.73)	26.89 (5.28)	19.99 (4.58)	8.07 (3.01)	16.92 (4.23)	7.12 (2.85)	2.98 (1.99)	2.76 (1.94)	12.23 (3.64)	2.40 (1.84)	3.77 (2.18)	12.70 (3.70)	10.92 (3.45)
Paruthippara	7.95 (2.99)	13.45 (3.80)	13.99 (3.87)	5.52 (2.55)	3.95 (2.22)	3.24 (2.06)	9.77 (3.28)	13.24 (3.77)	2.44 (1.85)	6.86 (2.80)	7.31 (2.88)	10.12 (3.34)	13.55 (3.81)	8.11 (3.02)
Karamana	3.30 (2.07)	5.74 (2.60)	12.34 (3.65)	16.26 (4.15)	10.39 (3.38)	13.26 (3.78)	8.71 (3.12)	5.90 (2.63)	12.23 (3.64)	6.79 (2.79)	11.28 (3.50)	1.23 (1.49)	8.45 (3.07)	8.41 (3.07)
Palkulangara	2.17 (1.78)	2.38 (1.84)	3.49 (2.12)	7.33 (2.89)	5.96 (2.64)	7.16 (2.86)	1.84 (1.69)	2.49 (1.87)	1.95 (1.72)	4.16 (2.27)	5.34 (2.52)	3.39 (2.10)	3.68 (2.16)	3.79 (2.19)
Vanchiyoor	1.12 (1.46)	0.22 (1.10)	1.49 (1.58)	6.73 (2.78)	1.95 (1.72)	2.49 (1.87)	1.49 (1.58)	3.10 (2.02)	3.10 (2.02)	0.71 (1.31)	0.71 (1.31)	5.25 (2.50)	4.06 (2.25)	2 27 (1.81)
Vellayani	6.90 (2.81)	8 25 (3.04)	11.65 (3.56)	10.29 (3.36)	13.06 (3.75)	14.84 (3.98)	15.73 (4.09)	17.30 (4.28)	10.79 (3.43)	13.86 (3.86)	12.84 (3.72)	7.72 (2.95)	8 01 (3.00)	11.43 (3.53)
Mean	6.12 (2.67)	7.14 (2.85)	10.18 (3.34)	10.46 (3.39)	6.76 (2.79)	8.79 (3.13)	6.66 (2.77)	6.62 (2.76)	4.92 (2.43)	6.72 (2.78)	5.92 (2.63)	4.89 (2.43)	8.01 (3.00)	

Figures in parentheses are transformed values ($\sqrt{x+1}$)

CD for comparing the mean populations observed in different months (at 5 per cent level) 1.14

CD for comparing the mean populations observed at different places in each month (at 5 per cent level) 3.48

The population of the scales in gardens of Karamana area ranged from 1.23 in July to 16.26 in November. There was an increase in population during the period of October (12.34) to January (13.26) and also during April (12.23) and June (11.28). In the other months the population range was from 3.3 (August) to 8.71 (February).

In Palkulangara the highest population was noticed during November (7.33) followed by January (7.16) and the minimum in February (1.84). No significant variation was noticed in the population levels during the other months of the survey (range 1.95 to 5.96). The lowest population of the scale was noticed in Vanchiyoor with a maximum in November (6.73) and minimum in September (0.22).

Compared to other locations more number of scales were observed in Vellayani area, the range being 6.90 (August) to 17.30 (March). From October (11.65) an increase in the population was observed reaching the maximum during March (17.30); thereafter a decline was shown from April. The population fluctuations from April to August '87 were 10.79, 13.86, 12.84, 7.72 and 8.01 respectively for the different months of observation.

3.1.3.2. Percentage of plants infested

Mean percentage of plants infested by the scale A. aurantii in gardens of Trivandrum for the period from August '86 to August '87 are presented in Table 7.

The mean percentage of plants infested in the different gardens during the period of the survey with a range from 6.41 in April to 9.63 in January did not show significant variation in the extent of damage caused by the scale.

In Kowdiar, the percentage of infested plants was higher during August '86 (19.36), September (16.61), October (14.60), November (14.60) and May (14.60). The percentage of plants infested during March (3.66) was the lowest. During the other months, the percentages varied from 6.49 to 12.2.

In Karamana, the higher percentage incidence of plants infested was observed during October and November (16.70) and it was minimum in July (3.66). The percentage of infestation showed very little variation from 8.23 to 12.52 in other months of observations except in August '87 (5.12%).

Percentage infestation on plants did not show much difference in the gardens of Palkulangara but for

Table 7. Percentage of rose plants infested by A. aurantii observed at different places in Trivandrum Taluk for the period from August 1986 to August 1987

Locations	Mean percentage of infested plants observed during the month of												Mean
	Aug.'86	Sep.'86	Oct '86	Nov.'86	Dec.'86	Jan.'87	Feb.'87	Mar.'87	Apr.'87	May 87	Jun.'87	Jul.'87	Aug.'87	
Kowdiar	19 36 (4.51)	16.61 (4.20)	14.60 (3.95)	14.60 (3.95)	10.00 (3.32)	10.00 (3.32)	12.20 (3.63)	3.66 (2.16)	6.49 (2.74)	14.60 (3.95)	6.49 (2.74)	6.49 (2.74)	8.33 (3.05)	10 59 (3 40
Paruthippara	8.23 (3.04)	10.77 (3.43)	9.78 (3.28)	6.80 (2.79)	8.23 (3.04)	6.40 (2.72)	10.77 (3 43)	12.52 (3.68)	5.12 (2.47)	6 40 (2.72)	9.54 (3 25)	13 92 (3.86)	16.47 (4.18)	9 39 (3.22
Karamana	9.54 (3.25)	12.52 (3.68)	16.70 (4.21)	16.70 (4.21)	14.10 (3.89)	14.10 (3.89)	8.23 (3.04)	8.23 (3.04)	11.95 (3.60)	10 77 (3.43)	12 52 (3.68)	3.66 (2.16)	5.12 (2.47)	10 73 (3.43
Palkulangara	5.43 (2.54)	3.59 (2.14)	1 49 (1.58)	6.30 (2.70)	6.30 (2.70)	6.30 (2.70)	3.59 (2.14)	2.59 (1.90)	2.59 (1.90)	3 59 (2 14)	5.43 (2.54)	4.53 (2.35)	4.53 (2.35)	4 21 (2.28)
Vanchiyoor	1.49 (1.58)	1.49 (1.58)	2.59 (1.90)	5.43 (2.54)	3.59 (2.14)	3 59 (2.14)	2.59 (1.90)	3.59 (2.14)	3.59 (2.14)	2.59 (1 90)	2.59 (1.90)	2.59 (1.90)	3.59 (2.14)	2.96 (1.99)
Vellayani	7.16 (2.86)	7.16 (2.86)	8.00 (3.00)	8 00 (3.00)	8.83 (3.13)	21 96 (4 79)	18 73 (4.44)	13.92 (3.86)	11.20 (3.49)	15 58 (4.07)	11.20 (3 49)	12.08 (3 62)	12 08 (3.62)	11 65 (3.56)
Mean	7.77 (2.96)	7.88 (2.98)	7.92 (2.99)	9.23 (3.20)	8.22 (3.04)	9.63 (3 26)	8.59 (3.10)	6.82 (2.80)	6 41 (2.72)	8 21 (3 04)	7.59 (2.93)	6.67 (2.77)	7.82 (2.97)	

Figures in parnetheses are transformed values ($\sqrt{x+1}$)

CD for comparing the mean percentages of infested plants observed in different months (at 5 per cent level) 0 99

CD for comparing the mean percentages of infested plants observed at different places in each month (at 5 per cent level) 3.43

an increase in November, December and January (6.30). Minimum plants infested was in October (1.49).

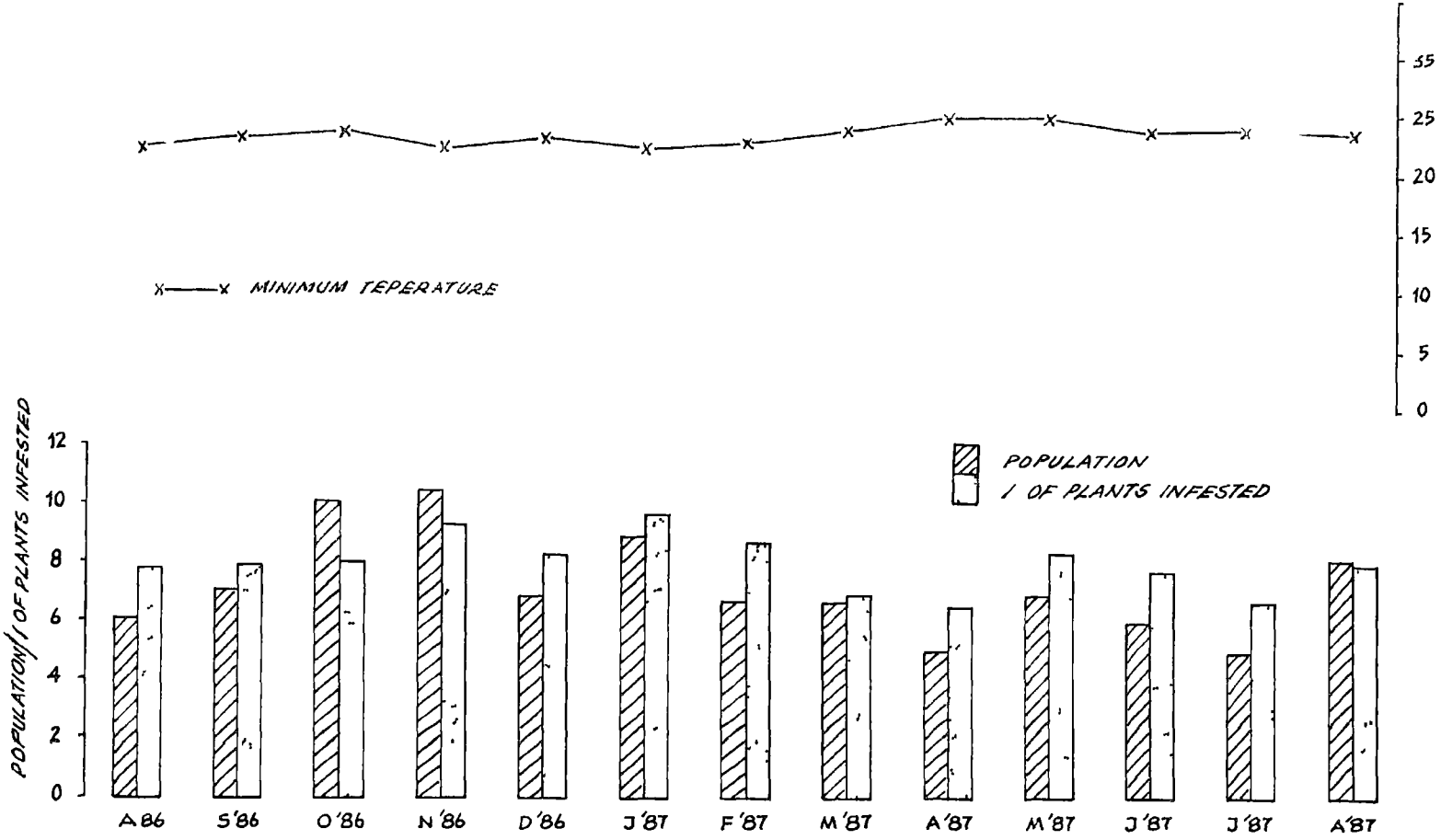
In Paruthippara the damaged plants increased during July (13.92) and August '87 (16.47) with the least damage during April (5.12). The percentage damage varied from 6.4 to 10.77 during the other months of observations.

There was more or less uniform damage by the scale insect in Vanchiyoor area which ranged from 1.49 during August and September to 3.59 in December, January, March and April with a maximum damage during November (5.43).

In Vellayani, the percentage of plants infested by the scale was seen high during January (21.96) and February (18.73). Thereafter a decline in the trend of infestation was noticed the range in percentage being 11.20 in April and June to 15.58 in May. During the preceeding months of August to December, the percentage of plants infested were from 7.16 to 8.83.

The population of A. aurantii and the extent of damage to rose plants during the period of the survey in relation to the weather parameters are comprehensively shown in Fig.3.

Fig. 3. Population of A. aurantii and the extent of damage caused by them on rose plants, observed in different months, in relation to weather parameters.


MINIMUM TEPERATURE
55
25
20
15
10
5
0
POPULATION
/ OF PLANTS INFESTED
POPULATION// OF PLANTS INFESTED
12
10
8
6
4
2
0
A'86
S'86
O'86
N'86
D'86
J'87
F'87
M'87
A'87
M'87
J'87
J'87
A'87

3.1.4. Survey on the incidence of the beetles *Adoretus* spp.

The level of infestation by the beetles *Adoretus* spp. was assessed by taking into account the percentage of leaves damaged and also the percentage of plants damaged in the rose gardens.

3.1.4.1. Percentage of leaves damaged

The extent of damage to rose leaves caused by the beetles for the period from August '86 to August '87 is given in Table 8.

The mean number of leaves damaged by the beetles in different months ranged from 1.53 (May) to 23.86 (December). The damage was high in the months of November (16.78) and December (23.86). In January the damage was 11.89 which was on par with the damage observed during November. The difference seen in the months of June (6.65), October (6.54), February (6.37), August '86 (3.86), July (3.73), September (3.45) and March (3.47), were statistically on par. The damage during the other months (range 1.53 to 3.47) were more or less similar and statistically did not show any significant difference.

Table 8. Extent of damages caused by Adoretus sp. on rose at different places in Trivandrum Taluk from August 1986 to August 1987

ocations	Mean number of damaged leaves observed in 10 plants during the month of													Mean
	Aug.'86	Sep.'86	Oct.'86	Nov.'86	Dec.'86	Jan.'87	Feb.'87	Mar.'87	Apr.'87	May '87	Jun. 87	Jul.'87	Aug.'87	
owdiar	2.86 (1.97)	5.72 (2.59)	5.29 (2.51)	22.62 (4.86)	25.01 (5.10)	16.06 (4.13)	11.36 (3.52)	6.92 (2.81)	6.05 (2.66)	4.47 (2.34)	9.24 (3.20)	5.81 (2.61)	2.47 (1.86)	8.54 (3.09)
aruthippara	1.15 (1.47)	1.43 (1.56)	2.11 (1.76)	9.80 (3.29)	17.18 (4.26)	8.32 (3.05)	3.37 (2.09)	0.56 (1.25)	0.86 (1.36)	0.00 (1.00)	3.18 (2.05)	0.99 (1.41)	0.40 (1.18)	2.92 (1.98)
aramana	2.57 (1.89)	1.44 (1.56)	2.38 (1.83)	6.22 (2.69)	13.22 (3.77)	6.04 (2.65)	5.87 (2.62)	2.20 (1.79)	2.08 (1.75)	1.39 (1.55)	6.09 (2.66)	2.04 (1.74)	1.83 (1.68)	3.70 (2.17)
ilkulangara	5.92 (2.63)	3.72 (2.17)	7.65 (2.94)	19.49 (4.53)	25.69 (5.17)	8.93 (3.15)	4.39 (2.32)	1.47 (1.57)	0.56 (1.25)	2.62 (1.90)	3.93 (2.22)	4.28 (2.30)	2.57 (1.89)	5.86 (2.62)
nchiyoor	2.91 (1.98)	2.86 (1.97)	7.46 (2.91)	18.85 (4.45)	30.23 (5.59)	16.66 (4.20)	9.02 (3.16)	8.53 (3.08)	0.40 (1.18)	1.25 (1.50)	8 38 (3.06)	4.04 (2.25)	1.91 (1.71)	7.12 (2.85)
llayani	9.85 (3.30)	6.86 (2.80)	19.42 (4.52)	29.14 (5.49)	35.29 (6.02)	17.94 (4.35)	5.62 (2.57)	3.71 (2.17)	1.15 (1.47)	0.56 (1.25)	10.55 (3.40)	6.49 (2 74)	6.15 (2.67)	9 82 (3.29)
an	3.86 (2.20)	3.45 (2.11)	6.54 (2.75)	16.78 (4.22)	23.86 (4.99)	11.89 (3.59)	6.37 (2.71)	3.47 (2.11)	1.60 (1.61)	1.53 (1.59)	6.65 (2.77)	3.73 (2.17)	2.36 (1.83)	

Figures in parentheses are transformed values ($\sqrt{x+1}$)

CD for comparing the mean percentages of damaged leaves observed in different months (at 5 per cent level) 0 79

CD for comparing the mean percentages of damaged leaves observed at different places in each month (at 5 per cent level) 2.24

The damage by the beetles in Kowdiar area ranged from 2.47 to 25.01 reaching the higher levels during the months of November (22.62), December (25.01) and January (16.06). From February onwards the number of leaves infested was lesser ranging from 2.47 to 11.36. Prior to November the incidence was 2.86 in August, 5.72 in September and 5.29 in October.

In Paruthippara and Karamana also almost a similar trend was seen in the damage done by the beetles to rose leaves; the peak period of damage started from November (9.8 and 6.22 respectively) reaching the maximum in December (17.18 and 13.22 respectively) and then declining (8.32 and 6.04 respectively). From February onwards the damage was seen reduced upto May (3.37 to 0 in Paruthippara and 5.87 to 1.39 in Karamana). During the month of June, the leaves damaged were more ie. 3.18 and 6.09 respectively and declining thereafter in both the places. During the early period of the survey also the number of leaves damaged, ranged from 1.15 to 2.57 only.

In the other three locations, Palkulangara, Vanchiyoor and Vellayani, the increased damage was evident from the month of October (7.65, 7.46 and 19.42 respectively) reaching the peak in December (25.69, 30.23 and 35.29 respectively). From February onwards the decline in the damage was seen to the tune of 4.39 to

0.56 in Palkulangara and 9.02 to 0.40 in Vanchiyoor. In Vellayani the leaves damaged was 5.62 in February, declining to a minimum of 0.56 in the month of May; thereafter a slight increasing trend was observed in June (10.55), July (6.49) and August '87 (6.15). Prior to October, the damage was more ie. 9.85 and 6.86 in August and September respectively.

3.1.4.2. Percentage of plants damaged

The percentage of plants damaged by Adoretus spp. in the six locations for the different periods of the survey is given in Table 9.

The mean percentage of plants infested ranged from 3.71 to 37.89 over the entire period of the survey. The maximum percentage of damage occurred in the month of December (37.89) which was significantly higher to the damage done during January (25.32) and November (24.47) which were on par. In the month of June a higher level of damage was seen (14.95). Percentage of plants damaged during the months of February (10.22), August '86 (10.09), September (9.17), October (9.09), March (8.47) and July (7.99) were also on par. Minimum percentage level of infestation was observed during the month of May (3.71) which was on par with that of August '87 (6.4) and April (3.93).

Table 9. Percentage of plants damaged by Adoretus sp. on rose at different places in Trivandrum Taluk for the period from August 1986 to August 1987

Locations	Mean percentage of damaged plants observed during the month of													Mean
	Aug.'86	Sep.'86	Oct.'86	Nov.'86	Dec. 86	Jan '87	Feb.'87	Mar.'87	Apr.'87	May '87	Jun.'87	Jul '87	Aug 87	
Kowdiar	8.33 (3.05)	8 33 (3.05)	8.33 (3.05)	29.58 (5.53)	31.23 (5 68)	24.45 (5.04)	9.78 (3.28)	9.78 (3 28)	10.00 (3.32)	5 12 (2.47)	10.36 (3 37)	8 33 (3 05)	5.12 (2.47)	11.89 (3.59)
Paruthippara	3.66 (2.16)	5.12 (2.47)	6.79 (2.79)	21 65 (4.76)	34.54 (5.96)	21.87 (4.78)	8.23 (3.04)	1.49 (1.58)	1.49 (1.58)	0.00 (1.00)	10 36 (3.37)	1 49 (1.58)	1 49 (1.58)	6.95 (2.82)
Karamana	8.23 (3 04)	6.40 (2.72)	2.59 (1.90)	5.43 (2.54)	25.04 (5.10)	14.10 (3.89)	9.77 (3.28)	6 40 (2.72)	5 12 (2.47)	8 23 (3.04)	18.26 (4.39)	8 33 (3.05)	5 12 (2.47)	8.76 (3.12)
Palkulangara	12.08 (3.62)	9.54 (3.25)	8.33 (3.05)	2°.31 (5.51)	44.32 (6.73)	22.46 (4.84)	5.12 (2.47)	10.00 (3.32)	1.49 (1.58)	6 79 (2.79)	12.08 (3 62)	10.36 (3.37)	10.36 (3.37)	12.36 (3.66)
Vanchiyoor	8.23 (3.04)	10.36 (3.37)	12.08 (3.62)	30.55 (5.62)	38.35 (6.27)	29.17 (5.49)	12.08 (3.62)	16.61 (4.20)	2.59 (1.90)	3.59 (2 14)	14.47 (3.93)	6.49 (2.74)	3.66 (2.16)	12.68 (3.70)
Vellayani	24.76 (5.08)	17.20 (4.27)	20.63 (4.65)	39 16 (6 34)	57 81 (7.67)	44.30 (6.73)	18.40 (4.40)	10.36 (3.37)	5.12 (2.47)	1.49 (1.58)	26 92 (5 28)	16 61 (4.20)	17.20 (4.27)	20 52 (4.64)
Mean	10.09 (3.33)	9.17 (3.19)	9.09 (3.18)	24.47 (5.05)	37.89 (6.24)	25.32 (5.13)	10.22 (3.35)	8.47 (3.08)	3.93 (2.22)	3 71 (2.17)	14 95 (3 99)	7.99 (3.00)	6.40 (2.72)	

Figures in parentheses are transformed values ($\sqrt{x+1}$)

CD for comparing the mean percentages of damaged plants observed in different months (at 5 per cent level) 1:01

CD for comparing the mean percentages of damaged plants observed at different places in each month (at 5 per cent level) 2.62

In Vellayani area the percentage of plants damaged, ranged from 1.49 to 57.81. The damage during November (39.16%), December (57.81%) and January (44.30%) were found to be at higher levels than in the other months of observation. The lowest damage percentage was noted during May (1.49), April (5.12) and March (10.36), whereas the damages during February (18.4), July (16.61) and August '87 (17.20) were in between.

A similar trend of increase in the percentage of plants infested by the beetle was observed in all the other locations excepting Karamana. In Kowdiar, the percentage of plants infested varied from 5.12 to 31.23. The intensity of damage showed an increasing trend from November (29.58%) to January (24.45%) with the maximum in December (31.23%). Prior to November the damage was more or less similar, the percentage being 8.33 for all the three months of August, September and October. From February onwards the percentage damage varied from 8.33 to 10.36 except in May and August '87, when the level of damage was only 5.12 per cent.

In Paruthippara, Palkulangara and Vanchiyoor, the percentage of plants infested showed higher levels during November to January, the values being 21.65 to 21.87, 29.31 to 22.46 and 30.55 to 29.17 with the maximum being in the month of December with 34.54, 44.32 and

38.35 respectively. The preceeding and the succeeding periods of the survey revealed lower percentage of damage, the values being 3.66 to 5.12 and 0 to 10.36 in Paruthippara, 8.33 to 12.08 and 1.49 to 12.08 in Palkulangara and 8.23 to 12.08 and 2.59 to 16.61 in Vanchiyoor respectively.

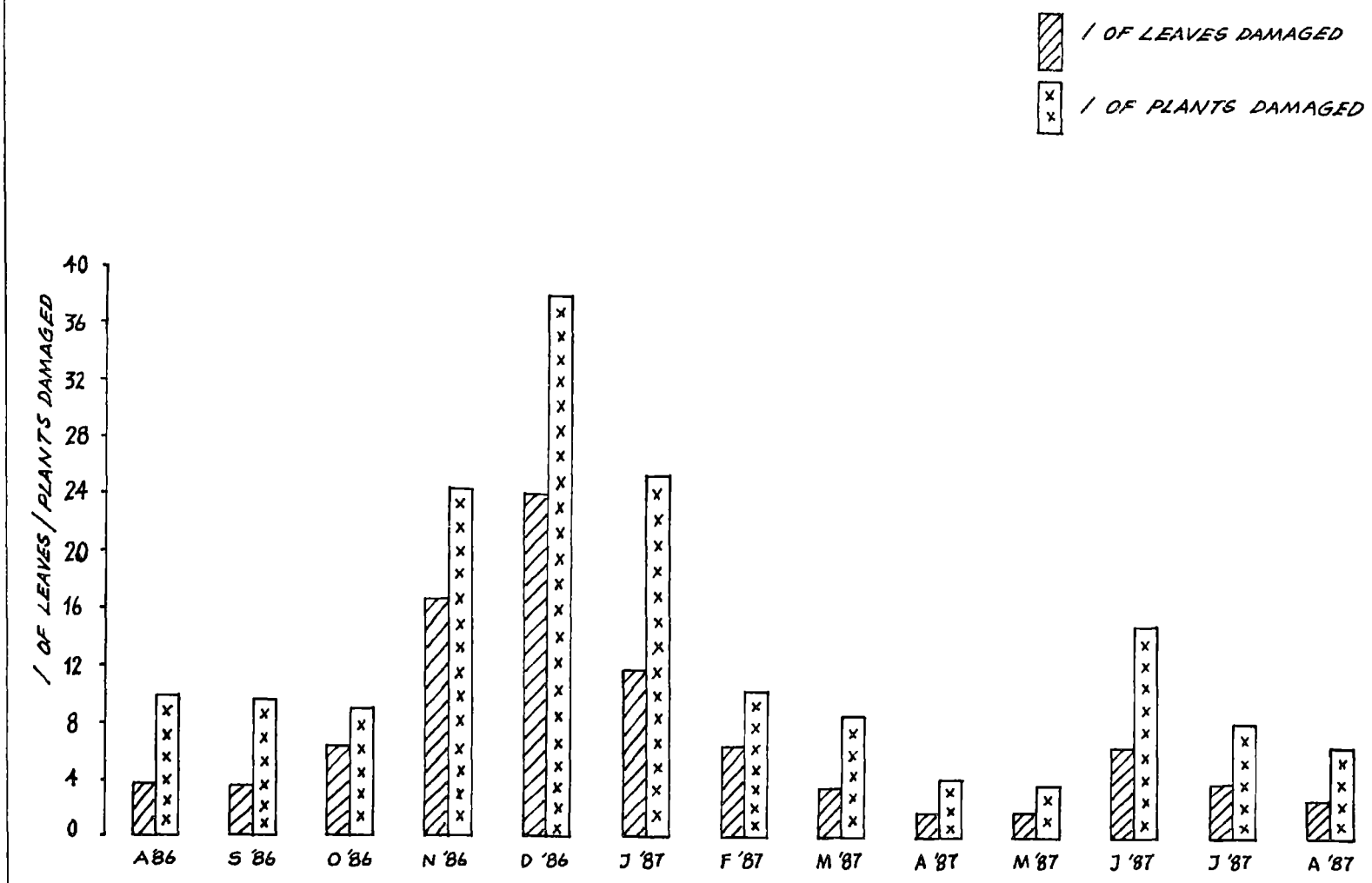
In Karamana, the maximum percentage of damage was seen during December (25.04) with a decline in the percentage damage from January (14.10) upto May (8.23). Then the damage showed an increase to the tune of 18.26% during June and then again a declining trend from July (8.33%). Prior to December the percentage of damage varied from 2.59 in October to 8.23 in August.

The extent of damage caused to rose leaves and the percentage of plants damaged are comprehensively shown in Fig.4.

3.1.5. Survey on the incidence of the spider mite *T. neocaledonicus*

Incidence of *T. neocaledonicus* was assessed in terms of the population, percentage of plants infested and percentage of leaves infested by the pest.

Fig. 4. Extent of damage caused by Adoretus spp. on rose plants, observed in different months.


/ OF LEAVES DAMAGED
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40
36
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A 86
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N 86
D 86
J 87
F 87
M 87
A 87
M 87
J 87
J 87
A 87

FIG. 4

3.1.5.1. Pest population

The population of the spider mite from August '86 to August '87 from the different rose gardens in Trivandrum are presented in Table 10.

The mean population of the mite during the period of the survey ranged from 12.32 to 175.49. The population was in a higher range from November to April and thereafter a decline till August. Mean population was the highest in April (175.49) and this came on par with the population in December (155.20), and March (128.85). The mean population in January (109.36), November (109.42) and February (104.14) were on par among themselves and with those of December and March. Minimum population was observed in the month of August (12.32 and 13.51) and this was on par with the population during September (15.53) and June (30.39). In May, (49.88), July (40.00) and October (37.95) the mean populations were statistically on par with that of June (30.39).

In Vellayani the population gradually increased from August '86 (21.82) reaching higher levels of 133.31 to 180.11 from November to April and thereafter declining till August '87 (27.76).

Table 10. Population of *T. neocaledonicus* on rose at different places in Trivandrum Taluk from August 1986 to August 1987

Locations	Number of mites observed on 50 leaves during the month of												Mean
	Aug.'86	Sep.'86	Oct.'86	Nov.'86	Dec.'86	Jan.'87	Feb. 87	Mar.'87	Apr. 87	May '87	Jun.'87	Jul 87	Aug.'87	
Kowdiar	38 30 (6 27)	53 03 (7.35)	40 71 (6 46)	201.20 (14.22)	369 63 (19.25)	149.62 (12.27)	202.45 (14.26)	206.34 (14.40)	182.73 (13 55)	42.54 (6.60)	29.65 (5.54)	52.43 (7.31)	13.40 (3 80)	100.97 (10.10)
Paruthippara	7 96 (2 99)	7 44 (2.90)	12 85 (3.72)	70.71 (8.47)	98.69 (9 98)	38 81 (6 31)	33.12 (5.84)	64.22 (8.08)	187 89 (13.74)	14 42 (3 93)	8.65 (3.11)	14 47 (3.93)	2.74 (1.93)	32.24 (5.77)
Karamana	9 53 (3 24)	8 43 (3.07)	58.98 (7.74)	127.93 (11.35)	167.22 (12.97)	127.47 (11.33)	138.07 (11.79)	122.57 (11.12)	182.79 (13 56)	91.83 (9.64)	47.44 (6.96)	42.25 (6.58)	9 83 (3.29)	74.08 (8.67)
Palkulangara	3.29 (2.07)	10.70 (3.42)	51.36 (7 24)	89 36 (9.51)	132.33 (11 55)	122.78 (11.13)	89.48 (9.51)	174.70 (13.26)	205.83 (14.38)	64.33 (8.08)	35.26 (6.20)	65.57 (8.16)	11.81 (3.58)	67.89 (8.30)
Vanchiyoor	5.45 (2.54)	11.66 (3.56)	28.94 (5 47)	61.58 (7.91)	60.93 (7.81)	79 73 (8.99)	66.16 (8.20)	86 21 (9 34)	120.36 (11.02)	22 92 (4.89)	26.94 (5.29)	15 37 (4 05)	22.96 (4 89)	40.76 (6.46)
Vellayani	21.82 (4 78)	15.76 (4 09)	45.39 (6 81)	133.31 (11.59)	177.62 (13.36)	168.08 (13.00)	141.11 (11.92)	147.49 (12.19)	180.11 (13.46)	92.41 (9.67)	43.96 (6.71)	69.49 (8.40)	27.76 (5.36)	86.10 (9.33)
Mean	12.32 (3 65)	15.53 (4.07)	37 95 (6.24)	109.42 (10.51)	155.20 (12.50)	109.36 (10.51)	104.14 (10.25)	128.85 (11.40)	175.49 (13 29)	49.88 (7 13)	30.39 (5.60)	40.00 (6 40)	13.51 (3.81)	

Figures in parentheses are transformed values ($\sqrt{x+1}$)

CD for comparing the mean populations observed in different months (at 5 per cent level) 2.54

CD for comparing the mean populations observed at different places in each month (at 5 per cent level) 5 86

In Kowdiar, the population sharply increased in November (201.2) reaching the maximum in December (369.63) with a drastic decline in January (149.62). Thereafter the population again increased in February (202.45), March (206.34) and April (182.73); from May (42.54) onwards the population decreased with the minimum in August '87 (13.40). The population prior to November ranged from 38.30 to 40.71 from August to October.

3.1.5.2. Percentage of plants infested

The mean percentage of plants infested by the spider mite T. neocaledonicus during the period from August '86 to August '87 in Trivandrum are presented in Table 11.

Mean percentage of plants infested by the mite as observed in the survey ranged from a minimum of 14.51 in August '86 to a maximum of 83.25 in April. Percentage infestation on plants during March (80.23), December (79.89), February (78.98) and January (78.35) were on par with that of April. No significant difference was observed in the months of November (64.33) and May (50.15) but in June (38.24) the percentage of plants damaged was on par with that of May. Minimum percentage of plants infested during

Table 11. Percentage of rose plants infested by T. neocaledonicus observed at different places in Trivandrum Taluk from August 1986 to August 1987

Locations	Mean percentage of infested plants observed during the month of													Mean
	Aug 86	Sep.'86	Oct '86	Nov '86	Dec.'86	Jan.'87	Feb.'87	Mar. 87	Apr.'87	May 87	Jun 87	Jul '87	Aug.'87	
Kowdiar	33 42 (5.87)	41.05 (6.48)	30 44 (5.61)	73.19 (8.61)	92.01 (9 64)	83.55 (9 20)	72.20 (8.56)	76.47 (8.80)	81 81 (9.10)	47.86 (7.00)	35.41 (6 03)	52.11 (7 29)	24.74 (5.07)	54.97 (7.48)
Paruthippara	13.64 (3.83)	11.20 (3.49)	13.64 (3.83)	62.67 (7.98)	77.10 (8.84)	54.01 (7.42)	58.51 (7.71)	65 55 (8.16)	69 91 (8.42)	23.07 (4.91)	23.07 (4.91)	15.12 (4.01)	9.89 (3.30)	33.89 (5.91)
Karamana	12.52 (3.68)	18.57 (4.42)	62 05 (7.94)	81 52 (9.08)	87.01 (9.38)	81 81 (9.10)	87.01 (9.38)	84.63 (9.25)	87.15 (9 39)	70.41 (8.45)	56.59 (7.59)	33.16 (5.84)	20.46 (4.63)	56.00 (7.55)
Palkulangara	6 49 (2.74)	14.60 (3 95)	36 61 (6.13)	48 91 (7.06)	73 04 (8.60)	84.28 (9 23)	87 15 (9.39)	89 56 (9.52)	89 86 (9 53)	66 05 (8.19)	38.69 (6.30)	52.11 (7 29)	18.73 (4.44)	49.50 (7.11)
Vanchiyocr	8.33 (3.05)	13.92 (3.86)	25.54 (5.15)	61.57 (7.91)	68.84 (8.36)	79.69 (8.98)	82.29 (9.13)	77.44 (8.86)	79 85 (9 00)	34.51 (5.96)	39.35 (6 35)	27 29 (5 32)	26.18 (5.21)	43.93 (6.70)
Vellayani	18 94 (4 47)	24.28 (5.03)	24.28 (5.03)	60.60 (7.85)	82.51 (9.14)	89.56 (9.52)	89 06 (9.49)	89.06 (9.49)	92.01 (9.64)	69.82 (8.42)	40.03 (6.41)	42.16 (6.57)	29 89 (5.56)	54 22 (7.43)
Mean	14.51 (3 94)	19.61 (4.54)	30.52 (5.61)	64.33 (8.08)	79.89 (8.99)	78 35 (8 91)	78.98 (8.94)	80.23 (9.01)	83.25 (9 18)	50 15 (7.15)	38.24 (6.26)	35.65 (6 05)	21 12 (4 70)	

Figures in parentheses are transformed values ($\sqrt{x+1}$)

CD for comparing the mean percentages of infested plants observed in different months (at 5 per cent level) 1.09

CD for comparing the mean percentages of infested plants observed at different places in each month (at 5 per cent level) 2 69

August '86 (14.51) was on par with those of September (19.61) and August '87 (21.12). In July the percentage damage was 35.65 and in October it was 30.52 both being on par with that of June.

Percentage infestation in different months in Kowdiar showed that there was an increase during the period from November to April with a range of 72.20 (February) to 92.01 (December). In the preceeding and succeeding months the percentage damage was less (30.44 to 41.05 and 24.74 to 52.11 respectively). The same trend was noticed in Paruthippara where during the months of November to April, the range was from 54.01 to 77.10%. The other months recorded a range of 9.89 to 23.07%. In Vanchiyoor also the damage per cent gradually increased from August with only 8.33 per cent damage reaching a higher level which was maintained from November to April in the range of 61.57 (November) to 82.29 (February). From May to August '87 the percentage of plants infested was only 26.18 to 39.35.

In Karamana the percentage of plants infested showed an increase for the period from October to June, with a range of 56.59 to 87.15. Minimum infestation in the area was in August '86 (12.52).

In Palkulangara the mean percentage of plants infested by mite increased from August onwards; from December to May a higher level of 66.05 to 89.86 was maintained and afterwards a decrease (18.73 to 38.11) was noticed. The maximum percentage of infestation was in April (89.86).

Vellayani area showed the highest percentage of plant infestation in April (92.01) and the lowest in August (18.94). Here also from November to May a higher intensity of infestation was noticed with a range of 60.6 to 92.01 per cent.

3.1.5.3. Percentage of leaves infested

Mean percentage of leaves infested by the mite T. neocaledonicus for the period from August '86 to August '87 in Trivandrum are given in Table 12.

The mean percentage of leaves infested during the months of April (74.15), December (72.02), March (71.62), January (69.73) and February (64.45) did not show any statistical significance. In November (50.31) the infestation was on par with that in February but significantly higher to May (31.66%) and June (21.40%) which were on par. Minimum percentage of leaves were infested in the months of August (7.13 and 8.50) which was statistically on par with that in September (10.06).

Table 12 Percentage of rose leaves infested by T. neocaledonicus observed at different places in Trivandrum Taluk from August 1986 to August 1987

Locations	Mean percentage of damaged leaves observed from 50 leaves during the month of													Mean
	Aug. 86	Sep.'86	Oct.'86	Nov.'86	Dec.'86	Jan.'87	Feb '87	Mar 87	Apr.'87	May '87	Jun.'87	Jul.'87	Aug. 87	
Kowdiar	20 43 (4.63)	23 98 (5.00)	14.30 (3.91)	59 06 (7.75)	86.56 (9.36)	67.64 (8.28)	56.28 (7.57)	73.90 (8.65)	65.45 (8.15)	23.83 (4.98)	19.12 (4 48)	30.77 (5.64)	8.18 (3.03)	38.25 (6.27)
Paruthippara	4 35 (2.31)	4.57 (2 36)	7.34 (2.89)	46.12 (6.86)	70.99 (8.48)	42.34 (6.58)	37.40 (6 20)	53.77 (7 40)	61.28 (7 89)	9 47 (3.24)	7 14 (2.85)	5.29 (2.51)	2.16 (1.78)	21.28 (4.72)
Karamana	5.65 (2.58)	6 72 (2.78)	38.34 (6.27)	64.79 (8.11)	80.34 (9.02)	70.05 (8.43)	67.87 (8.30)	73.81 (8.65)	78 49 (8.92)	42.21 (6 57)	28.14 (5.40)	17 50 (4.30)	8 20 (3 03)	39 13 (6.34)
Palkulangara	2.97 (1.99)	7 83 (2 97)	26.11 (5.21)	45.93 (6.85)	69.84 (8.42)	83 69 (9.20)	76 27 (8.79)	84 37 (9.24)	84 46 (9 24)	56.73 (7.60)	25.62 (5.16)	33.82 (5.90)	9.31 (3 21)	40 54 (6.45)
Vanchiyoor	3 59 (2 14)	5.47 (2.54)	16.18 (4 14)	37.76 (6.23)	55.92 (7 54)	71.16 (8.49)	68.23 (8.32)	65.89 (8.18)	68.87 (8 36)	21.32 (4.72)	23.72 (4.97)	10.49 (3.39)	10 02 (3.32)	29 98 (5.57)
Vellayani	11.25 (3.50)	17 52 (4 30)	20.83 (4.67)	50.50 (7.18)	70 36 (8.45)	88.55 (9.46)	86.67 (9.36)	80 15 (9 01)	88.34 (9.45)	50.49 (7.18)	29.57 (5.53)	26.89 (5.28)	16.01 (4.12)	44.31 (6.73)
Mean	7.13 (2.86)	10.06 (3.33)	19.39 (4.52)	50.31 (7.16)	72 02 (8 55)	69.73 (8.41)	64.45 (8.09)	71 62 (8 52)	74.15 (8.67)	31.66 (5.72)	21.40 (4.73)	19 28 (4.50)	8.50 (3 08)	

Figures in parentheses are transformed values ($\sqrt{x+1}$)

CD for comparing the mean percentages of infested leaves observed in different months (at 5 per cent level) 1.18

CD for comparing the mean percentagesof infested leaves observed at different places in each month (at 5 per cent level) 2 71

In October 19.39 per cent of leaves were infested which was on par with the infestation noted in July (19.28%).

In Kowdiar and Paruthippara, the mean percentage of leaves damaged increased sharply by November and retained higher incidence till April with a range of 56.28 to 86.56 and 37.4 to 70.99 respectively and thereafter declined to 8.18 and 2.16 in August '87 respectively.

In Karamana also infestation remained high in the months from November to April with a range of 64.79 to 80.34, the maximum being in December (80.34). The decline in the percentage of leaves infested in preceeding and succeeding months were 5.65 to 38.34 and 8.20 to 42.21 respectively.

Palkulangara and Vellayani areas showed high percentage of infestation from November to May to the tune of 45.93 to 84.46 and 50.49 to 88.55 respectively. In Palkulangara the minimum infestation was in August '86 (2.97) and the maximum in April (84.46) whereas it was in August '86 (11.25) and January (85.55) respectively in Vellayani.

In Vanchiyoor maximum percentage of infested leaves was observed in January (71.16). Here also the

infestation was higher in the months of November to April in the range of 37.76 to 71.16. The decline in percentage of plants infested ranged from 10.02 to 23.72 after the peak period of April and from 3.59 to 16.18 during August to October.

Population of T. neocaledonicus and the extent of damage caused to rose during the period of survey in relation to the weather parameters are comprehensively shown in Fig.5.

3.1.6. Survey on the incidence of T. cinnabarinus

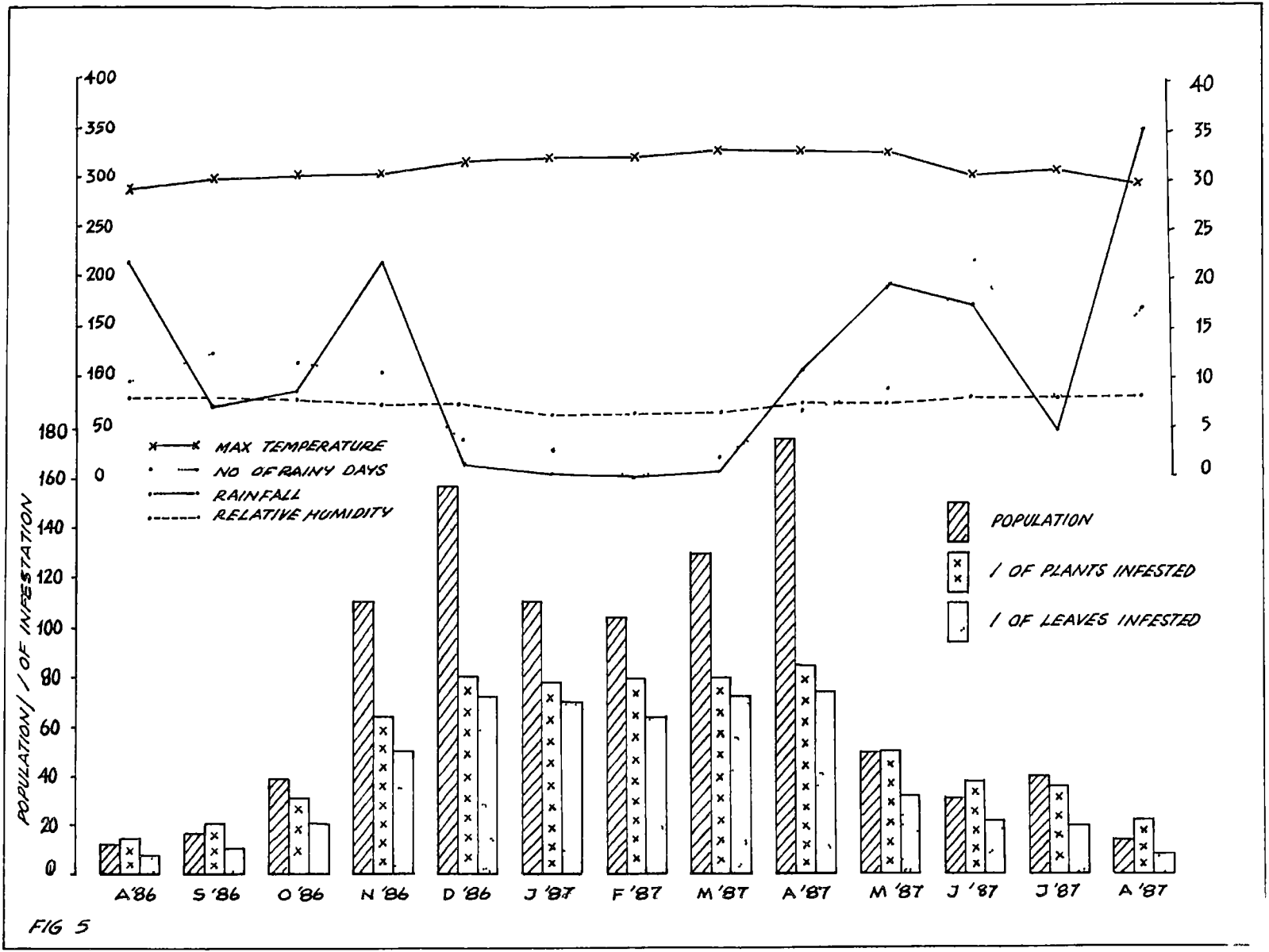
Incidence of T. cinnabarinus was assessed in terms of the population, percentage of plants infested and percentage of leaves infested by the pest.

3.1.6.1. Pest population

The population of T. cinnabarinus from August '86 to August '87 from the different gardens in Trivandrum is given in Table 13.

Mean population of the mite observed in different months during the period of the survey ranged from 0.81 to 4.51. The population was at higher levels in the months of December (4.51), April (4.25), March (3.02), January (2.83), November (2.55), February (2.13) and

Fig. 5. Population of T. urticae and the extent of damage caused by them on rose plants, observed in different months in relation to weather parameters.


400
350
300
250
200
150
100
50
0
180
160
140
120
100
80
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40
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40
35
30
25
20
15
10
5
0
MAX TEMPERATURE
NO OF RAINY DAYS
RAINFALL
RELATIVE HUMIDITY
POPULATION
/ OF PLANTS INFESTED
/ OF LEAVES INFESTED
POPULATION/ / OF INFESTATION
A'86
S'86
O'86
N'86
D'86
J'87
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M'87
A'87
M'87
J'87
J'87
A'87

FIG 5

Table 13 Population of *T. cinnabarinus* on rose at different places in Trivandrum Taluk from August 1986 to August 1987

Locations	Number of mites observed on 50 leaves during the month of													Mean
	Aug '86	Sep 86	Oct.'86	Nov '86	Dec '86	Jan.'87	Feb.'87	Mar.'87	Apr.'87	May '87	Jun 87	Jul '87	Aug '87	
Kowdiar	7 98 (3 00)	0 00 (1 00)	0 86 (1 36)	2.17 (1.78)	5 62 (2 57)	3 10 (2 02)	2.59 (1.90)	7 69 (2.95)	5.76 (2 60)	2.17 (1.78)	1.84 (1.69)	0 71 (1 31)	0 22 (1.10)	2.72 (1.93)
Paruthippara	1.25 (1 50)	1.49 (1.58)	0 86 (1.36)	2.90 (1.97)	3 39 (2.10)	1.37 (1.54)	0 22 (1.10)	2.28 (1.81)	0.22 (1.10)	0 40 (1.18)	0.00 (1 00)	1 25 (1.50)	1.12 (1 46)	1.18 (1.48)
Karamana	0.71 (1.31)	1.61 (1 62)	0.86 (1.36)	1.73 (1.65)	3.10 (2 02)	2.28 (1.81)	2.70 (1.92)	1.49 (1.58)	1.84 (1.69)	0.40 (1.18)	0.40 (1 18)	0 86 (1.36)	0.56 (1.25)	1.35 (1.53)
Palkulangara	0 00 (1.00)	0 00 (1.00)	0.00 (1 00)	0.56 (1.25)	6.28 (2.70)	3.68 (2.16)	1.12 (1.46)	3.10 (2 02)	4 41 (2.33)	0.56 (1.25)	0 00 (1 00)	0 71 (1.31)	0.22 (1 10)	1.27 (1.51)
Vanchiyoor	1.61 (1.62)	2 17 (1 78)	4.71 (2.39)	9.46 (3.23)	5.17 (2 48)	5.66 (2.58)	3.87 (2.21)	1.25 (1 50)	4.80 (2.41)	2.49 (1.87)	0.99 (1 41)	1 37 (1 54)	0.40 (1 18)	3.06 (2.02)
Vellay ni	2.37 (1.83)	0 99 (1.41)	2.28 (1.81)	0.99 (1.41)	3.89 (2.21)	1 61 (1 62)	3.11 (2.03)	3.68 (2.16)	12.16 (3.63)	9.54 (3.25)	2.91 (1.98)	1.83 (1 68)	2.91 (1.98)	3.31 (2.08)
Mean	1.92 (1.71)	0.95 (1.40)	1.40 (1.55)	2.55 (1.88)	4.51 (2.35)	2.83 (1.96)	2.13 (1.77)	3 02 (2.00)	4.25 (2.29)	2.07 (1.75)	0.89 (1.38)	1.11 (1 45)	0 81 (1.35)	

Figures in parentheses are transformed values ($\sqrt{x+1}$)

CD for comparing the mean populations observed in different months (at 5 per cent level) 0.61

CD for comparing the mean populations observed at different places in each month (at 5 per cent level) 1.07

May (2.07) which were on par among themselves. Population was minimum in June (0.89) and August '87 (0.81) which were on par with all other months except December, April and March.

In Karamana the population of the mite has shown an increasing trend from August (0.71) reaching the peak in December (3.10) and maintaining higher levels in January (2.28) and February (2.7) and thereafter declining gradually. The population was minimum in May and June (0.40).

Two peak populations of the mite were observed in Palkulangara during the months of December, January (6.28 and 3.68) and March, April (3.1 and 4.41) with low population in February (1.12). The population observed in other months were also very low.

In Vanchiyoor the population was high in October (4.71), November (9.46), December (5.17), January (5.66) and April (4.80). The minimum population was observed in August 1987 (0.40). During the other months of observation the population levels of 1.61, 2.17, 3.87, 1.25, 2.49 and 1.37 were noticed during August, September, February, March, May and July respectively. Other months had only negligible population of the mite.

In Kowdiar, the population of the mite varied from 0 to 7.98. Higher levels of mite population were recorded in August '86 (7.98), December (5.62), January (3.10), March (7.69) and April (5.76). Zero incidence was observed in the month of September. During the other periods of the survey the population ranged from 0.22 (August) to 2.59 (February).

In Paruthippara, almost a uniform level of population (2.28 to 3.39) was observed in November, December and March. The other months showed incidence, varying from zero (June) to 1.49 (September).

The mite population varied from 0.99 to 12.16 in Vellayani area. Maximum intensity of infestation was during April (12.16) followed by May (9.54). In the other months of the survey the population levels were more or less similar, the range being 1.61 to 3.89 except in September and November when a population of only 0.99 was recorded.

3.1.6.2. Percentage of plants infested

The percentage of plants seen infested by T. cinnabarinus during the period from August '86 to August '87 from the gardens in Trivandrum is presented in Table 14.

Table 14 Percentage of rose plants infested by T. cinnabarinus observed at different places in Trivandrum Taluk from August 1986 to August 1987

Locations	Mean percentage of infested plants observed during the month of													Mean
	Aug '86	Sep '86	Oct. 86	Nov '86	Dec.'86	Jan '87	Feb 87	Mar.'87	Apr 87	May 87	Jun '87	Jul 87	Aug.'87	
Powdiar	6 40 (2 72)	0 00 (1.00)	1 49 (1.58)	2.59 (1.90)	9 54 (3.25)	2.59 (1.90)	2 59 (1.90)	9 78 (3 28)	9 78 (3.28)	2.59 (1.90)	2 59 (1 90)	1 49 (1 58)	1 49 (1 58)	3 56 (2.14
Paruthippara	1.49 (1.58)	1 49 (1.58)	1.49 (1.58)	2.59 (1.90)	2 59 (1.90)	1.49 (1.58)	1.49 (1.58)	1 49 (1.58)	1.49 (1.58)	1.49 (1.58)	0.00 (1.00)	1.49 (1 58)	1 49 (1 58)	1.51 (1.58
Karamana	1.49 (1 58)	1.49 (1.58)	1.49 (1.58)	1.49 (1.58)	1.49 (1.58)	1.49 (1.58)	1.49 (1.58)	1.49 (1.58)	1.49 (1.58)	1.49 (1.58)	1.49 (1.58)	1.49 (1,58)	1.49 (1 58)	1.49 (1.58
Palkulangara	0 00 (1 00)	0 00 (1 00)	0 00 (1.00)	1 49 (1.58)	5.12 (2 47)	2.59 (1.90)	2.59 (1 90)	2.59 (1 90)	3.66 (2 16)	1.49 (1.58)	0 00 (1.00)	1 49 (1.58)	1 49 (1 58)	1 52 (1.59
Vanchiyoor	1 49 (1 58)	1 49 (1.58)	2 59 (1 90)	5.12 (2 47)	5 12 (2 47)	5.12 (2 47)	5.12 (2.47)	2 59 (1 90)	2 59 (1.90)	2.59 (1.90)	1 49 (1.58)	1 49 (1 58)	1 49 (1 58)	2 81 (1.95
Vellayani	3.66 (2 16)	1 49 (1 58)	1.49 (1.58)	1.49 (1.58)	6 49 (2.74)	6.49 (2.74)	3.66 (2.16)	6.49 (2.74)	8.33 (3.05)	8.33 (3.05)	3 66 (2.16)	3 66 (2 1)	3 66 (2 16)	4.27 (2 30
Mean	2.13 (1.77)	0 92 (1 39)	1.36 (1.54)	2.36 (1 83)	4 76 (2.40)	3.11 (2 03)	2.72 (1 93)	3 67 (2.16)	4.10 (2.26)	2.72 (1.93)	1.36 (1.54)	1.81 (1 68)	1 81 (1.68)	

Figures in parentheses are transformed values ($\sqrt{x+1}$)

CD for comparing the mean percentages of infested plants observed in different months (at 5 per cent level) 0 56

CD for comparing the mean percentages of infested plants observed at different places in each month (at 5 per cent level)1

The mean percentage of plants infested during the period of survey revealed significantly higher values for the months of December (4.76), April (4.10), March (3.67), January (3.11), February (2.72) and May (2.72) which were statistically on par among themselves. The percentage of plants infested was minimum in September (0.92). The data on the percentage of plants infested during the other months of observation did not show significant difference.

When the percentage of plants infested in Kowdiar area was observed, it was seen to be maximum in the months of March and April (9.78) followed by December (9.54) and August '86 (6.4). No incidence was observed in September.

In Paruthippara there was no incidence of the mite in the month of June whereas during November and December significantly higher percentage of infestation (2.59) was observed. A uniform level of infestation (1.49) was recorded during the other months. In Karamana also the percentage of plants infested remained steady throughout the period of the survey with a mean percentage of 1.49. The minimum percentage of plants infested in Palkulangara was zero from August to October and June, attaining the peak population during the month of December (5.12) followed by April (3.66). An incidence of 2.59 per cent was observed in the months of January, February and March.

In Vanchiyoor the percentage of plants infested remained the same with a mean value of 5.12 during the period from November to February. During the other months the per cent infestation was 1.49 from August '86 to September and June to August '87. A mean per cent incidence of 2.59 was observed throughout the period of the other months. Gardens at Vellayani showed minimum infestation on plants during September to November (1.49) with 3.66 percentage during the month of August, February, June and July. Percentage of plants infested was high during December (6.49), January (6.49), March (6.49), April (8.33) and May (8.33).

3.1.6.3. Percentage of leaves infested

The percentage of leaves infested by the mite T. cinnabarinus in six locations for the period of the survey from August '86 to August '87 is given in Table 15.

The mean percentage of leaves infested ranged from 0.50 to 2.48. The maximum percentage of leaves infested was in the month of December which was on par with the month of April (2.19), March (1.75) and January (1.60). The least percentage of infested leaves was seen in September (0.50) which was on par with November (1.24), February (1.17), August (1.14), May (1.13), October (0.81), July (0.67), August '87 (0.62) and June (0.56).

Table 15 Percentage of rose leaves infested by T. cinnabarinus observed at different places in Trivandrum Taluk from August 1986 to August 1987

Locations	Mean percentage of damaged leaves observed from 50 leaves during the month of													Mean
	Aug 86	Sep '86	Oct 86	Nov '86	Dec '86	Jan '87	Feb '87	Mar '87	Apr '87	May '87	Jun 87	Jul 87	Aug.'87	
Kowdiar	4 57 (2 36)	0.00 (1 00)	0.71 (1 31)	1.95 (1.72)	4 47 (2 34)	1.49 (1 58)	1.49 (1 58)	4 62 (2 37)	3 92 (2.22)	1 49 (1 58)	0 99 (1 41)	0.40 (1 18)	0.40 (1.18)	1.82 (1 68)
Paruthippara	0 71 (1 31)	0 71 (1.31)	0.99 (1.41)	1 49 (1.58)	1.49 (1.58)	0 71 (1 31)	0.40 (1.18)	0 99 (1 41)	0.40 (1.18)	0.40 (1 18)	0.00 (1.00)	0 71 (1.31)	0.71 (1.31)	0.72 (1.31)
Karamana	0 71 (1 31)	0.71 (1 31)	0 40 (1.18)	0.71 (1 31)	1 25 (1 50)	0.99 (1 41)	0 99 (1.41)	0 71 (1.31)	0 71 (1 31)	0 40 (1 18)	0.40 (1.18)	0.40 (1.18)	0.40 (1 18)	0 67 (1.29)
Palkulangara	0 00 (1 00)	0 00 (1.00)	0.00 (1.00)	0 71 (1.31)	2 86 (1.96)	1.95 (1.72)	0.71 (1.31)	1.73 (1.65)	1.96 (1.72)	0 40 (1 18)	0.00 (1.00)	0.40 (1.18)	0.40 (1.18)	0.76 (1.33)
Vanchiyoor	0 71 (1 31)	0 99 (1.41)	1 49 (1.58)	2.57 (1.89)	2.65 (1.91)	2.96 (1 99)	2 11 (1.76)	0.99 (1.41)	1.95 (1.72)	0 99 (1 41)	0.99 (1 41)	0.99 (1.41)	0.40 (1.18)	1.46 (1.57)
Vellayani	1 23 (1 49)	0.71 (1 31)	1 49 (1 58)	0 40 (1.18)	2.62 (1 90)	1 81 (1 68)	1.54 (1 59)	2 24 (1.80)	5 60 (2.57)	3 93 (2 22)	1.23 (1 49)	1.23 (1.49)	1.54 (1.59)	1.84 (1.69)
Mean	1 14 (1 46)	0.50 (1.22)	0.81 (1.34)	1.24 (1.50)	2 48 (1 87)	1.60 (1 61)	1.17 (1.47)	1.75 (1 66)	2 19 (1.79)	1 13 (1.46)	0.56 (1.25)	0.67 (1.29)	0.62 (1.27)	

Figures in parentheses are transformed values ($\sqrt{x+1}$)

CD for comparing the mean percentages of infested leaves observed in different months (at 5 per cent level) 0 36

CD for comparing the mean percentages of infested leaves observed at different places in each month (at 5 per cent level) 1.17

In Vowdiar area the mean percentage of leaves infested were high during August '86 (4.57), December (4.47), March (4.62) and April (3.92). No leaf damage was observed in September. In Paruthippara the percentage of leaves infested were more during November and December (1.49), in the other months it was more or less uniform ranging from 0.40 to 0.99, except in June when no leaf was infested. A similar uniform trend was noticed in Karamana also with a range in percentage of 0.40 to 1.25. Slightly higher percentage of incidence were noticed during December (2.86), January (1.95), March (1.73) and April (1.96) in Palkulangara area. The range of infestation in other months was from 0.4 to 0.71 with a zero incidence during August to October and in June.

In Vanchiyoor the percentage of leaves infested was higher during the months of November (2.57), December (2.65), January (2.96), February (2.11), April (1.95) and October (1.49). The minimum damage occurred in August '87 (0.40). The damage in Vellayani ranged from 0.40 to 5.60. Damage was higher during the months of December (2.62), March (2.24), April (5.6) and May (3.93). The percentage of leaves infested ranged from 1.23 to 1.81 during the other months of observation excepting September (0.71) and November (0.40).

Population of T. cinnabarinus and the extent of damage caused to rose during the period of survey in relation to the weather parameters are comprehensively shown in Fig.6.

3.1.7. Survey on the incidence of minor pests of rose

The population/damage of the minor pests recorded from August 1986 to August 1987 from the different gardens in Trivandrum is given in Table 16.

S. rubrocinctus and R. cruentatus were also observed besides the other thysanopterans during the course of the survey but they were only of minor importance.

Among the beetle pests observed P. complanata was seen to cause damage to rose flowers in the months of October-November and A. mollis feeding on tender leaf buds during October-November and June-July.

The mealy bug Pseudococcus sp. was noticed mostly in the months of April and May. Rose aphid M. rosaeformis was observed in the survey in the hot months of March-April.

The digger wasp was seen damaging the stem of roses from October to May and the intensity of damage was higher during November, February, March and April.

Fig. 6. Population of T. neocaledonicus and the extent of damage caused by them on rose plants observed in different months, in relation to weather parameters.

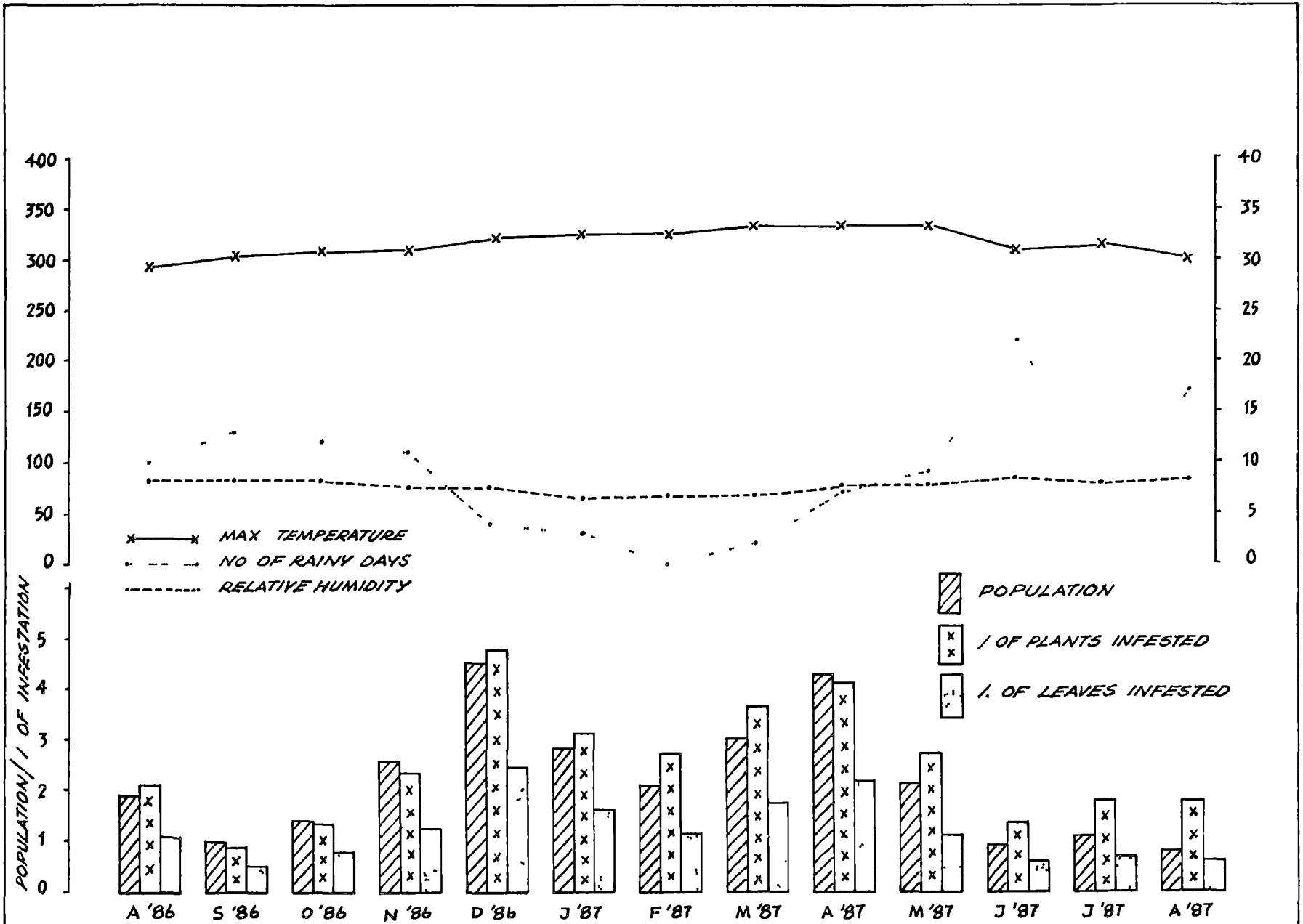

400
350
300
250
200
150
100
50
0
40
35
30
25
20
15
10
5
0
MAX TEMPERATURE
NO OF RAINY DAYS
RELATIVE HUMIDITY
POPULATION
% OF PLANTS INFESTED
% OF LEAVES INFESTED
POPULATION/% OF INFESTATION
5
4
3
2
1
0
A '86
S '86
O '86
N '86
D '86
J '87
F '87
M '87
A '87
M '87
J '87
J '87
A '87

FIG. 6

Table 16. Population of minor pests observed on rose in Trivandrum Taluk from August 1986 to August 1987

	Mean number of insects observed during the month of												
	Aug. '86	Sep. '86	Oct. '86	Nov. '86	Dec. '86	Jan. '87	Feb. '87	Mar. '87	Apr. '87	May '87	June '87	Jul. '87	Aug. '87
. rubrocinctus	-	-	6	1	17	8	13	27	11	4	-	-	-
. cruentatus	-	1	-	2	12	5	-	16	9	3	-	-	-
. complanata	3	-	3	16	15	8	1	5	-	8	-	2	4
. mollis	5	2	7	12	1	4	3	-	2	4	7	7	1
. versicolor	-	-	2	-	3	1	3	-	1	-	-	-	-
. maculosus	-	-	-	6	5	-	1	-	6	6	8	2	3
seudococcus sp.	-	-	8	-	-	6	-	-	13	22	-	-	-
. rosaeformis	-	-	-	-	-	-	-	19	31	2	-	-	-
. anthracina*	-	-	4	14	-	-	-	2	12	7	-	-	-
gger wasp**	-	-	5	28	3	3	9	14	11	2	-	-	-
nocephalus sp.	-	-	-	-	3	2	-	-	-	1	-	-	-
obfuscata	-	2	-	-	-	1	-	-	-	1	4	4	-
litura	-	5	-	-	12	-	3	2	-	11	-	-	-
janata	-	-	-	-	3	-	-	-	1	5	-	-	-
fraterna	-	-	-	-	-	-	-	-	-	47	20	-	15
acuta	-	-	-	-	7	4	-	-	-	-	-	-	-
zelota	-	9	1	-	-	-	-	-	-	6	2	-	-

* The figure denotes total number of leaves damaged

** The figure denotes total number of stems damaged

The other pests recorded were the grass hopper Conocephalus sp. and the lepidopterans L. obfuscata, S. litura, A. janata, E. fraterna, C. acuta and E. zelota. The occurance of these pests were of minor importance only.

3.1.8. The correlation between the weather parameters and the varying levels of pest population/damage in rose observed in different gardens in Trivandrum during 1986-'87

Correlation between the varying levels of pest population/damage and each of the different weather parameters of the locality (maximum temperature, minimum temperature, relative humidity, rainfall and number of rainy days) were worked out and the results are presented in Table 17.

The population of R. syriacus was significantly correlated with maximum temperature (r = 0.899), relative humidity (r = -0.898), rain fall (r = -0.683) and number of rainy days (r = -0.814); maximum temperature alone had positive correlation with population build up of the thrips while the other three factors had negative relationship. Significant positive correlation was observed between maximum temperature and the percentage of plants infested (r = 0.790) as well as the percentage of leaves infested by the thrips (r = 0.904). Relative humidity, rainfall and number of rainy days also showed

Table 17. Correlation between the varying levels of pest populations/damages observed in the gardens during the different months (1986-87) in Trivandrum Taluk and the weather factors during the period

Pest population/ damage observed	Weather factor				
	Max. temp. (°C)	Mini. temp. (°C)	RH (%)	Rain fall (mm)	No. of rainy days
Population of *R. syriacus*	0.899*	0.186	-0.898*	-0.683*	-0.81
Percentage of plants infested by *R. syriacus*	0.790*	0.239	-0.768*	-0.589*	-0.70
Percentage of leaves infested by *R. syriacus*	0.904*	0.272	-0.834*	-0.599*	-0.75
Damage caused by *S. dorsalis* to leaves	0.485	-0.235	-0.653*	-0.585*	-0.64
Damage caused by *S. dorsalis* to flower buds	0.724*	-0.039	-0.808*	-0.644*	-0.73
Population of *A. aurantii*	-0.260	-0.456	0.017	0.169	0.09
Percentage of plants infested by *A. aurantii*	-0.099	-0.662*	-0.288	0.004	-0.12
Extent of damage by *Adoretus* sp	0.019	-0.464	-0.276	-0.260	-0.22
Percentage of plants damaged by *Adoretus* sp.	0.003	-0.507	-0.314	-0.288	-0.20
Population of *T. neocaledonicus*	0.752*	0.136	-0.706*	-0.499	-0.66
Percentage of plants infested by *T. neocaledonicus*	0.830*	0.074	-0.845*	-0.525	-0.70
Percentage of leaves infested by *T. neocaledonicus*	0.814*	0.047	-0.849*	-0.589*	0.74
Population of *T. cinnabarinus*	0.652*	0.128	-0.587*	-0.409	0.64
Percentage of plants infested by *T. cinnabarinus*	0.723*	0.171	-0.637*	-0.386	-0.68
Percentage of leaves infested by *T. cinnabarinus*	0.647*	0.115	-0.595*	-0.415	-0.65

CD at 5% level 0.553

significant negative correlation with percentage of plants infested (r = -0.768, -0.589 and -0.708 respectively) and percentage of leaves infested (r = -0.834, -0.599 and -0.757) by the thrips.

Relative humidity, rainfall and number of rainy days were negatively correlated with the varying levels of damage caused by S. dorsalis to the leaves of rose (r = -0.653 and -0.585 and -0.646 respectively) and were found to be significant. These three factors showed highly significant negative association with the different levels of damage done by the thrips to flower buds also (r = -0.808, -0.644 and -0.733 respectively) while maximum temperature showed a significant positive correlation (r = 0.724) with flower bud damage.

None of the weather factors showed any significant correlation with the varying levels of population/damage of the scale A. aurantii or that of chaffer beetle Adoretus sp except in the case of a significant negative correlation observed between the minimum temperature and the percentage of plants infested by A. aurantii (r = -0.662).

In the case of T. neocaledonicus, the correlation between maximum temperature and the levels of mite population was highly significant and positive (r = 0.752).

Similar relationships existed between maximum temperature and the percentage of plants infested as well as the percentage of leaves infested by the mite (r = 0.830 and 0.814 respectively). But relative humidity and number of rainy days showed highly significant negative correlation with the population of the mite (r = -0.706 and -0.668 respectively), percentage of plants infested (r = -0.845 and -0.704) as well as the percentage of leaves infested (r = -0.849 and 0.745). Rainfall showed a significant negative relationship with the percentage of leaves infested by T. neocaledonicus (r = -0.589) while its negative relationship with the mite population and the percentage of plants infested were statistically insignificant.

In the case of rose mite, T. cinnabarinus maximum temperature showed significant positive correlation with the varying levels of population (r = 0.652). Relative humidity and number of rainy days showed significant negative correlation (r = -0.587 and 0.647 respectively) with the population build up of the mite. Rainfall also showed a negative relationship with the population though the correlation coefficient was statistically insignificant. Similarly percentage of plants infested and percentage of leaves infested by the mite also were positively significantly correlated with maximum temperature (r = 0.723 and 0.647 respectively) and negatively

correlated with relative humidity (r = -0.637 and -0.595 respectively) and number of rainy days (r = -0.688 and -0.658 respectively).

3.2. Observations on the nature of damage by different pests on rose

The most important pests observed in the rose gardens of Trivandrum were the thrips, mites and scales. The other pests observed included the chaffer beetles mealy bug, aphid, leaf cutting bee, digger wasp, grass hoppers and caterpillars. The nature of damage by these different pests are given below.

3.2.1. Thrips

3.2.1.1. R. syriacus

The reddish nymphs gregarious in habit were seen on the under surface of the leaves. The nymphs lacerate the tissues and fed from the cell contents as a result of which bleached areas were seen on the leaf surface. The nymphal excretory material was seen as dried up small blackish patches on the under surface. When the population of the nymphs were more, they migrated to the upper surface also for feeding. As a result of heavy infestation by these thrips, the leaves showed bleached areas covered with excreta presenting a sickly appearance. The leaves finally dried up due to severe infestation. (Plate I (a).

PLATE I (a) Rose thrips *R. syriacus* on the under surface of a leaf

(b) Damage of *S. dorsalis* on flower buds and tender leaves

PLATE I (a)

PLATE I (b)

3.2.1.2. S. dorsalis (Plate II (a)

The orange yellow coloured thrips were found actively moving about on the plants. They used to feed on the sap from the tender leaves, flower buds and growing tips. As a result of their sucking the sap, the feeding areas first became dull coloured due to the depletion of the cell contents. Gradually the affected areas develop elongated brownish lesions and later became dark brownish patches on the under surface of the leaves nearer to the leaf margins. Marginal curling up and heavy crinckling of the leaves were seen, when the infestation was very serious. The younger leaves due to the damage, became under sized with the brownish lesions and patches. Often the infestation by these thrips resulted in brittleness of the leaves. When the thrips were seen feeding on the buds, they failed to open in heavy and early infestation, but they showed dark coloured lesions on the buds and even on the calyx. In the case of mature buds brownish patches were seen on the outer petals and the flowers which bloomed after the feeding of the thrips showed distorted petals.

In serious infestations the buds, the just opened flowers and the distorted flowers completely dried up showing sickly appearance of the plants. (Plate I (b).

PLATE II (a) Adult of *S. dorsalis*

(b) Different life stages of *R. cruentatus*

PLATE II (a)

PLATE II (b)

3.2.1.3. Rhipiphorothrips cruentatus

The blackish brown adults and the reddish nymphs (Plate IIb) were seen feeding on the under surface of the leaves. The attacked leaves showed brownish patches. The leaves due to heavy infestation finally withered and dropped down. The flower production of the plants were seen affected due to the attack.

3.2.1.4. S. rubrocinctus (Thripidae)

The adult was dark brown in colour and its second instar larva had characteristic red cross bands across the first two and last abdominal segments. The damaged leaves became bleached and filled with excreta, presenting a sickly appearance and finally drying up. The nature of damage was similar to R. syriacus.

3.2.2. Mites

3.2.2.1. T. neocaledonicus (Tetranychidae) (Plate III (a)

The pale yellow mites with two dorsal spots with body oval and sparsely covered with spines, lived gregariously on the under surface of the leaves protected with in silken webbings. Mostely seen on the under surface on the interveinal areas clustering in large

PLATE III (a) Adult and egg of *T. neocaledonicus*

(b) Adults of *T. cinnabarinus*

PLATE III (a)

PLATE III (b)

numbers, closer to the midrib. The feeding sites were clearly seen as yellowish patches in between the lateral veins on the leaves. When the population increased, they disbursed to whole of the leaf lamina on the under surface causing severe damage. Drying started from leaf tip and leaf margins extending inwards resulting in severe yellowing and drying up of the whole leaf.

3.2.2.2. T. cinnabarinus (Tetranychidae) (Plate III b)

These reddish mites were seen on the under surface of the leaves protected by silken webbings. The feeding of the mites resulted in speckled appearance on the upper surface due to the extraction of the chlorophyll and other plant pigments from the tissues. Later on these speckled areas became larger and larger in size as the intensity of feeding increased resulting in complete bleaching of the leaves presenting a sickly appearance. Finally browning and drying of the leaves were seen leading to leaf fall.

3.2.3. Scales

A. aurantii (Diaspididae) (Plate IV a, b)

The reddish brown waxy scale were found infesting the stem in colonies. The insect after roaming about for some time in its younger stage settled permanently on a portion of the stem. It was seen piercing its mouth

PLATE IV (a) Red scale, A. aurantii on the stem of rose

(b) Dried up stems of plant severely infested by A. aurantii

PLATE IV (a)

PLATE IV (b)

parts into the plant tissue and sucking out the plant sap for its nourishment and growth. Female scales were comparatively large and more or less round; males were comparatively smaller and capable of flying. The female produced a number of young crawlers which moved on to portions of fresh growth. Due to the continuous desapping by these scales, the stem portions completely dry up. In case of severe infestations, the plants often succumbed to these tiny insects.

3.2.4. Chaffer beetles

3.2.4.1. A. versutus (Melolonthidae) (Plate V a, b)

This reddish chestnut coloured beetle measuring 9 to 12 mm long and 5 to 6 mm broad, were found feeding on the leaves. The damage was seen as irregular cuts on the leaf lamina; the outer margins were left intact while feeding. In case of severe damage by these beetles, these feeding holes coalesced resulting in heavy defoliation, as a result of which the plant became unhealthy leading to considerable reduction in the flower bud formation. The beetle was nocturnal in habit; occasionally it destroyed the flowers also by feeding on the petals.

3.2.4.2. Adoretus lasiophygus Burm. (Melolonthidae) (Plate VIa

The beetle was 10 to 12 mm in length and 5 to 6 mm in breadth and was slightly darker in colour than the

PLATE V (a) Adults of *A. versutus*

(b) A plant severely attacked by *A. versutus*

PLATE V (a)

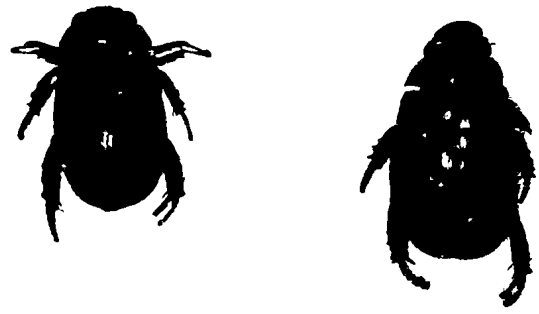


PLATE V (b)

PLATE VI (a) Adults of *A. lasiophygus*

(b) Adult of *A. mollis*

PLATE VI (a)

PLATE VI (b)

other species. The damage caused by this beetle was also similar to that of A. versutus.

3.2.4.3. Popillia complanata Newn. (Melolonthidae)

The beetles were light brown in colour with metallic green thorasic shield and brownish elytra. They were found feeding on the flowers remaining inside the basal portion and the damage was seen only when the petals dropped down.

3.2.4.4. Ascerica mollis Wlk. (Cetonidae) (Plate VI b)

The brown coloured beetle measured 7 to 8 mm in length and 5 to 6 mm in breadth. It was seen nocturnal in habit feeding on the tender leaves and flower buds.

3.2.4.5. Oxycetonia versicolor F. (Cetonidae)

Colour variations were seen in this species. Mostely they were metallic blue with white markings or blackish with red and white markings. The beetles fed on the flowers and flower buds.

3.2.4.6. Myllocerus maculosus Desb. (Curculionidae)

The greenish white to ashy grey coloured weevils were found feeding on the leaves of rose plants mostly confining to older leaves.

3.2.5. Mealy bug

Pseudococcus sp. (Coccidae) (Plate VII a, b)

The mealy bugs were plump, oval purplish and seen in colonies on tender stalks of buds and flowers. As a result of their feeding, the buds did not open and flowers withered away.

3.2.6. Aphid

M. rosaeformis Das. (Aphididae)

The insect was more or less globular and blackish, occurring in clusters on tender shoots, buds and flowers. Due to attack by aphids the beauty and lasting capacity of the flowers and the vitality of the tender shoots were lost.

3.2.7. Leaf cutting bee

Megachile anthracina Smith (Megachilidae) (Plate VIII a)

It was a hairy medium sized dark insect with the base of the abdomen tinged with reddish brown. It was seen cutting neat circular or oval patches from leaf margins.

PLATE VII (a) Mealy bug colony on stem of rose

(b) Mealy bug of rose

PLATE VII (a)

PLATE VII (b)

PLATE VIII (a) Leaf damage by *M. anthracina*

(b) Stem of rose opened showing the life stages of digger wasp

PLATE VIII (a)

PLATE VIII (b)

3.2.8. Digger wasp (unidentified) (Plate VIII b)

The wasp burrowed into the pith of the stem through the cut end for building its nest. This was usually seen soon after pruning. The burrow was found with a length of 12 to 17 cm remaining open at the cut end. The different stages of the wasp were seen in well separated compartments within this hollowed out stem. As a result of the digging, fungus causing die back disease also might make its entry.

3.2.9. Grasshopper

Conocephalus sp. (Tettigonidae) (Plate IX a)

The grasshopper was found feeding on the leaves and buds of rose. The females were seen mostly feeding on the buds, whereas the males preferred to feed on the tender leaves.

3.2.10. Lepidopteran pests

3.2.10.1. Lymantria obfuscata Wlk. (Lymantriidae)

The hairy caterpillar (PlateIXb) was found feeding on the leaves and caused defoliation.

PLATE IX (a) Nibbling of *Conocephalus* sp. on an unopened flower bud

(b) Larvae of *L. obfuscata* feeding on tender leaves

PLATE IX (a)

PLATE IX (b)

3.2.10.2. Spodoptera litura Fb. (Noctuidae)

The caterpillar (Plate Xa) was seen feeding on the leaves and some times on the flower buds also.

The other caterpillar pests included the castor semilooper Achaea janata L. and the hairy caterpillar, Euproctis fraterna feeding on rose leaves and Chiloloba acuta Wiedmann on the flowers. The larva of Eucosa zelota was found webbing together a number of leaves and feeding from within.

3.3. Biology of R. syriacus on rose (Plate XI b)

3.3.1. Mating

The adults were found to mate during morning and evening hours starting from the first day after emergence The copulation lasted for 10 to 12 minutes. Both males and females were observed to mate several times before oviposition.

3.3.2. Oviposition

Oviposition commenced one or two days following mating. The female raised the body with the tip pointing downwards and then inserted the ovipositor into the plant tissues for laying the eggs. Two to three eggs were laid by a female in a day and the egg laying continued for about 10 to 12 days.

PLATE X (a) Skeletonisation of a leaflet by *S. litura*

(b) Larvae of *E. fraterna* on the leaves

PLATE X (a)

PLATE X (b)

PLATE XI (a) Nymph of *R. syriacus* with droplet of excreta

(b) Life stages of *R. syriacus*

PLATE XI (a)

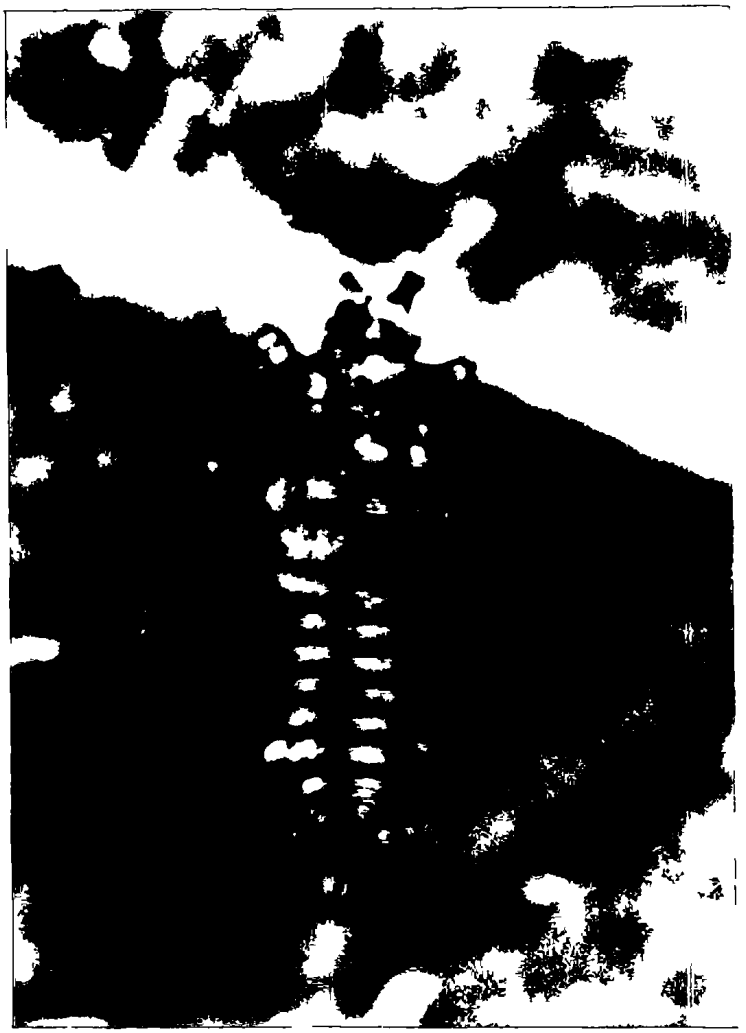


PLATE XI (b)

3.3.3. The egg

The eggs observed were bean shaped, slightly narrow at one end and pale white in colour.

3.3.4. Hatching of the eggs

The incubation period of the egg varied from 6 to 7 days with a mean of 6.4 days. The nymphs hatched out by pushing open the egg shell and were seen coming out by gentle backward and forward twisting movements. On full emergence the nymph was seen falling on its back, then attaining the upright position and started moving slowly. Newly hatched nymphs were pale yellowish in colour, gradually turning to red. The first instar nymph measured 0.86 mm long and 0.31 mm broad across the thorax; the head width was 0.22 mm with the antennal length 0.62 mm. The nymphs were seen feeding gregariously. The posterior region of the body was seen held up and the brownish excretory material oozing out of the anus as small droplets was getting larger in size as feeding advanced (Plate XIa). The nymph was seen moving about with the excretory material for some time and latter dropping it on to the leaf surface; which appeared as irregular spots on drying. The duration of the first instar was seen to vary from 3 to 4 days, with an average of 3.5 days. Soon after moulting, colour of the nymph was lighter in shade, which gradually changed to the

characteristic reddish colour. The second instar nymph measured 1.81 mm long and 0.70 mm broad across the thorax. The head width was 0.30 mm with antennal length 0.64 mm. The average duration of the second instar also varied from 3 to 4 days, with a mean duration of 3.4 days. Unlike in the case of the first instar nymphs, the second instar nymphs were seen scattered on the leaves feeding on the under surface (Table 18).

3.3.5. Pre-pupa

The second instar nymphs just before moulting to pre pupal stage, searched for a suitable place for pupation, usually preferring the webbings seen on the under surface of the leaves made by spiders or mites. The pre-pupa also was reddish in colour, measuring 1.79 mm long and 0.93 mm across the thorax, It could be easily recognised by the antennae being directed forwards and by the wing pads reaching almost to the third abdominal segment in the latter part of this stage. The pre-pupal period extended only for a day.

3.3.6. Pupa

The pupa was also reddish in colour measuring 1.8 mm long and 0.95 mm broad. The antennae were directed backward over the head reaching to three quarters of the

Table 18. Biometric observations/duration of the different stages of *R. syriacus* reared on different host plants

Host plant	Biometric observation	First instar	Second instar	Prepupa	Pupa	Adult	Total duration in days
Rose	Head width (mm)	0.22	0.30			0.46	
	Thoracic width (mm)	0.31	0.70	0.93	0.95	0.96	
	Total length (mm)	0.86	1.81	1.79	1.80	1.87	
	Antennal length (mm)	0.62	0.64			0.49	
	Duration in days	3-4 (3.5)	3-4 (3.4)	1	2-3 (2.6)		10-12 (10.2)
Castor	Head width (mm)	0.22	0.29			0.57	
	Thoracic width (mm)	0.49	0.67	0.98	0.97	0.99	
	Total length (mm)	0.97	1.88	2.07	2.05	2.34	
	Antennal length (mm)	0.65	0.68			0.46	
	Duration in days	3-4 (3.6)	3-5 (3.6)	1	3-4 (3.4)		10-14 (11.2)
Subabul	Head width (mm)	0.21	0.31			0.41	
	Thoracic width (mm)	0.32	0.59	0.83	0.85	0.87	
	Total length (mm)	0.91	1.93	1.99	1.96	2.23	
	Antennal length (mm)	0.51	0.50			0.47	
	Duration in days	3-4 (3.5)	3-5 (3.2)	1	3-4 (3.5)		10-15 (11.4)
Cassava	Head width (mm)	0.27	0.35	0.46	0.47	0 62	
	Thoracic width (mm)	0.53	0.64	1.24	1.20	1.22	
	Total length (mm)	0.98	2.13	2.18	2.20	2.55	
	Antennal length (mm)	0.59	0.65			0.48	
	Duration in days	3-5 (3.4)	3-5 (3.8)	1	2-3 (2.4)		9-12 (9.6)

prothorax, while the wing buds were much longer, reaching to the eighth abdominal segment. The pupal period varied from 2 to 3 days with an average of 2.6 days.

3.3.7. The adult (Plate XII)

The adult was blackish brown in colour with a mean body length of 1.87 mm and 0.96 mm across the thorax; the head width and antennal length were 0.46 and 0.49 mm respectively.

The adults were seen moving on the under surface and were sluggish during the day. They were found to be more active in the morning and evening hours.

The life cycle from egg to adult was completed in about 16.9 days.

3.3.8. The biology of R. syriacus on other alternate hosts

The observations on the biology of R. syriacus on other alternate hosts like castor, cassava and subabul showed minor variations in the biometric observations and durations of the different stages which are given in Table 18.

R. syriacus reared on cassava showed maximum head width of 0.27 mm and 0.35 mm, thoracic width of 0.53

PLATE XII Adult of *R. syriacus*

PLATE XII

and 0.64 mm, total body length of 0.98 and 2.13 mm and antennal length of 0.59 and 0.65 mm for the first and second instar nymphs respectively, when compared to those reared on the other hosts. Biometric observations on the thrips reared on castor and subabul were similar to those reared on rose.

The measurements taken on the pre-pupae and pupae of insects reared on different hosts showed variations in thoracic width (0.83 to 1.24 mm) and body length (1.79 to 2.20 mm).

In the case of adults, the maximum length of 2.55 mm was recorded in the insects reared on cassava followed by those reared on castor (2.34 mm) and those on subabul (2.23 mm).

The druation of nymphs were found to be 3.6, 3.4 and 3.9 days for the first instar nymphs and 3.6, 3.2 and 3.8 days for the second instar, when reared on castor, subabul and cassava respectively, whereas the pre-pupal period was one day in all the crops. The pupal period was 3.4 days in castor, 2.4 in cassava and 3.5 in subabul. The total life cycle was found to be the maximum in subabul (11.4 days) followed by castor (11.2 days) and cassava (9.6 days).

3.4. Chemical control of pests of rose

A series of pot culture experiments were conducted to evaluate insecticides for the control of major insect and mite pests of rose.

3.4.1. Effect of insecticide application on the population build up of *R. syriacus* on rose

The data on the effect of applying insecticides at different doses on the nymphal and adult population of *R. syriacus* and the results of the statistical analysis are presented in Table 19.

The pretreatment population of nymphs and adults of *R. syriacus* in the different treatments ranged from 26.33 to 32.67 and 4 to 10.67 respectively and they did not show heterogeneity.

Seven days after spraying with the lowest dose of insecticides, the nymphal population of the rose thrips was brought down to zero level on plants sprayed with monocrotophos, 0.0125% and fenthion, 0.0125% emulsions. These were closely followed by dimethoate, 0.0125% (0.33) and quinalphos, 0.0125% (6.33) and the populations in these treatments were significantly lower than in the control plants which recorded a mean nymphal population of 53.3. Among the insecticide treated plants, highest

Table 19 Effect of insecticides applied at different doses on the population of R syriacus on rose

Treatments	Mean population of R. syriacus observed on ten leaves/plant															
	7								14							
	Nymph				Adult				Nymph				Adult			
	L_1	L_2	L_3	Mean	L_1	L_2	L_3	Mean	L_1	L_2	L_3	Mean	L_1	L_2	L_3	Mean
Endosulfan	41 00 (6 13)	14.33 (3 50)	15 67 (3 98)	23 67 (4 54)	0 33 (1 14)	0 00 (1 00)	0 00 (1 00)	0 11 (1 05)	31 67 (5 03)	21 67 (4 75)	33 33 (5 17)	28 89 (4 98)	9 67 (4 30)	3 00 (1 40)	1 33 (1 52)	4 66 (2.57)
Fenithion	0 00 (1 00)	0 00 (1 00)	0 00 (1.00)	0 00 (1.00)	0 00 (1.00)	0 00 (00)	0 00 (1.00)	0 00 (1 00)	0 67 (1 24)	0 00 (1 00)	0 00 (1 00)	0.22 (1 08)	1 33 (1 52)	0 00 (1 00)	0 00 (1 00)	0 44 (1 17)
Methyl parathion	14 67 (3 83)	5 67 (2 35)	11.33 (2 89)	10 56 (3.02)	0 33 (1 14	1 00 (1 38)	0 33 (1.14)	0 55 (1 22)	30 70 (5 13)	32 00 (5 68)	15 30 (3 80)	26 00 (4 87)	0 00 (1 00)	0 67 (1 28)	1 00 (1 38)	0 56 (22)
Quinalphos	6 33 (2 37)	4 67 (2 15)	2 67 (1 82)	4 56 (2 12)	0 00 (1 00)	0 00 (1 00)	0 00 (1 00)	0.00 (1 00)	11 30 (3 37)	14 30 (3 70)	11 00 (3 44)	12 20 (3 50)	1 00 (1 38)	0 33 (1 14)	0 00 (1 00)	0 44 (1 17)
Dimethoate	0 33 (1 14)	1 00 (1 33)	0 00 (1.00)	0 44 (1 16)	0 83 (1.14)	0 00 (1 00)	0 00 (1 00)	0 11 (1 05)	10 00 (3 30)	2 33 (1 73)	0 00 (1 00)	4 11 (2 01)	0 67 (1 28)	1 00 (1 38)	0 00 (1 00)	0 56 (1 22)
Monocrotophos	0 00 (1 00)	0 00 (1 00)	0 00 (1.00)	0 00 (1 00)	0 00 (1 00)	0 00 (1 00)	0 00 (1 00)	0 00 (1 00)	0 00 (1 00)	0 00 (1 00)	0 00 (1 00)	0 00 (1 00)	0 00 (1 00)	0 00 (1 00)	0 00 (1 00)	00 (00)
Phosphamidon	13 67 (3 81)	20 67 (3 72)	4 67 (1 48)	12 00 (3 00)	0 67 (1 24)	0 00 (1 00)	0 33 (1 14)	0 33 (1 13)	7 67 (4 58)	7 33 (4 43)	2 67 (1 91)	15 22 (3 64)	0 67 (1 24)	6 00 (2 77)	0 67 (1 28)	2 45 (1 63)
Phorate	49 00 (6 32)	39 00 (5 15)	11 33 (3 50)	33 11 (5 59)	2 00 (1 55)	3 67 (2 08)	3 67 (2 08)	3 11 (1 92)	17 00 (4 05)	49 33 (6 76)	17 33 (3 85)	27 89 (4 89)	2 00 (1 73)	6 00 (2 54)	7 33 (2 87)	5 11 (2 38)
Carboruran	45 70 (5 79)	10 00 (3 20)	7 00 (2 73)	20 90 (3 91)	2 00 (1.69)	4 00 (2 05)	5 67 (2 34)	3 89 (2 03)	43 30 (6 33)	10 00 (3 12)	5 33 (2 49)	19 54 (3 98)	2 33 (73)	2 33 (1 82)	2 33 (1 79)	2 33 (1 78)
Control			53.30 (6 71)				7 67 (2 67)				62 00 (6 97)				6 00 (2 36	
CD for comparison of mean under L_1 L_2 or L_3			2 98				0 81				2 94				0 99	
CD for comparison or mean of three doses				1 72				0 47				1 69				0 57

	L_1	L_2	L_3
Phorate and carbofuran	0 25 kg ai/ha	0 5 kg ai/ha	0 75 kg ai/ha
Other treatments	0 0125%	0 0 25%	0 05%

Figures in parentheses are transformed values $(\sqrt{x+1})$

nymphal count was recorded in plants treated with phorate at 0.25 kg ai/ha (49.0) and this was followed by endosulfan, carbofuran, methyl parathion and phophamidon (mean population of 13.67 to 45.7 nymphs) all of which came on par with control.

At the medium dose of insecticides also, the lowest nymphal count was recorded in monocrotophos and fenthion sprayed plants (zero level in both treatments) which were followed by dimethoate (1.0), quinalphos (4.67), methyl parathion (5.67), carbofuran (10.0), endosulfan (14.33) and phosphamidon (20.67) and the differences among these treatments were statistically insignificant. But all these treatments were significantly superior to control (53.3). Phorate (0.5 kg ai/ha was the only treatment which came on par with control and the mean population in the treatment was 39.0.

At the recommended level (L_3) of the insecticides applied, 100% nymphal mortality was recorded on plants sprayed with monocrotophos, fenthion and dimethoate when observed at the seventh day and the extent of control obtained in all other treatments (phosphamidon, quinalpho carbofuran, methyl parathion, phorate and endosulfan) also came on par with the above treatments with a mean nymphal population of 1.67 to 15.67 while the count was 53.3 on untreated plants.

There was no significant difference among the three different concentrations of the insecticides except in the case of carbofuran. The population observed at the recommended dose of carbofuran at 0.75 kg ai/ha (7.0) was significantly lower than that of the lowest dose of 0.25 kg ai/ha (45.7). When the means of the three doses each of the other insecticides were compared, monocrotophos fenthion, dimethoate and quinalphos were found to be the most effective, which were followed by phosphamidon and methyl parathion. Mean effects of carbofuran, endosulfan and phorate were significantly lesser than the above treatments among which phorate (33.11) came on par with control (53.3).

The adult population also showed significant reduction over control. At the lowest dosage (L_1), all the treatments were equally effective in reducing the population of *R. syriacus* to significantly lower levels when compared with control (7.67); but there was no significant difference among the different insecticides, the mean population ranging from 0 to 2.0 only.

At higher two levels (0.0125 and 0.025% concentrations), monocrophos, fenthion, quinalphos, dimethoate, phosphamidon, endosulfan and methyl parathion significantly reduced the population over that of untreated

control with no significant difference among the treatments. But phorate and carbofuran treatments at these dosages had population on par with that of control.

With reference to the mean effect of different doses of the insecticides also, the same trend was observed and monocrotophos, fenthion, quinalphos, dimethoate, phosphamidon, endosulfan and methyl parathion were found to be the best insecticides irrespective of the doses tested, while phorate and carbofuran failed to control the pest. When the population in each treatment was compared with that in other concentrations tested, none of them were found to differ significantly.

Fourteen days after application of insecticides at lowest dose, 100% kill of the nymphal population was obtained on plants sprayed with monocrotophos 0.0125% and it was followed by fenthion, dimethoate and quinalphos (0.67, 10.0 and 11.3 nymphs respectively) with no significant difference among the four treatments. Phorate, phosphamidon, endosulfan, methyl parathion and carbofuran showed significantly lesser extent of control when compared with monocrotophos and the mean population in the treatments ranged from 17.0 to 43.3 nymphs/plant.

The populations on these five treatments came on par with that of control which recorded a mean nymphal count of 62/plant.

At the medium dose of the insecticides tested, nymphal population was brought down to zero level on monocrotophos and fenthion treated plants; dimethoate, carbofuran and quinalphos (2.33, 10.0 and 14.3) also came on par with the former treatments. The population in phosphamidon (21.33), endosulfan (21.67), methyl parathion (32.0) and phorate (49.33) were also on par with control (62.0).

At the highest dose, significant reduction in the nymphal population of thrips was obtained in monocrotophos, fenthion, dimethoate, phosphamidon, carbofuran, quinalphos, methyl parathion and phorate and the population in these treatments ranged from 0 to 17.33 with no significant difference among them, as against 62.0 nymphs in control. Endosulfan was the only treatment which recorded a population level (33.33) on par with that of control.

When the different doses of each insecticide were compared, no significant difference could be observed among the doses, except for carbofuran which recorded significantly higher population at 0.25 kg ai/ha than

when applied at 0.5 or 0.75 kg ai/ha. In the case of mean level of control obtained over the three concentrations, monocrotophos, fenthion and dimethoate were found to be the best treatments in reducting the population.

Adult population observed at 14th DAT showed that application of monocrotophos, methyl parathion, phosphamidon and dimethoate at the lowest dose brought about significant reduction in the population of thrips (0 to 0.67 insects/plant) when compared with that of control (2.36) and the difference among themselves was statistically insignificant. Quinalphos, fenthion, phorate and carbofuran came on par with control with a mean population ranging from 1.0 to 2.33. Highest population (9.67) was recorded in endosulfan sprayed plants.

In the case of treatments done at the medium dosage levels, 100% control of the adult population was recorded on plants sprayed with monocrotophos and fenthion and these came on par with quinalphos (0.33), methyl parathion (0.67), dimethoate (1.0), carbofuran (2.33) and endosulfan (3.0). But the latter two treatments showed parity with control. Phosphamidon and phorate recorded the same population level (6.0) as that of untreated control (6.0).

When the insecticides were applied at the recommended dose (L_3), significant reduction in the adult population of thrips was obtained with 100% kill in fenthion, quinalphos, dimethoate and monocrotophos sprayed plants. Phosphamidon, methyl parathion, endosulfan and carbofuran also significantly reduced the population of the adults, the values ranging from 0.67 to 2.33. Phorate showed lesser population than the untreated control but was on par statistically.

Considering the mean population of different concentrations of the insecticides, monocrotophos, fenthion, quinalphos, dimethoate and methyl parathion were found to give maximum reduction of the pest. Phorate (5.11) and endosulfan (4.66) were the least effective insecticides in controlling the adult stage of thrips even when applied at the recommended concentrations. Carbofuran and phosphamidon were having intermediary effects on the population, the values being 2.33 and 2.45 respectively.

When the three doses of the insecticides were compared, there was no significant difference among the different doses except in the case of phorate and endosulfan. In endosulfan the lowest dose (9.67) and in phorate the highest dose (7.33) were supporting higher population levels.

3.4.2. Effect of insecticide application on the extent of damage caused by *S. dorsalis* on rose

The data relating to this experiment were assessed in terms of percentage of damage on tender leaves as well as on flower buds, the results of statistical analysis of which are presented in Table 20 and 21 respectively.

Seven days after application, the data on the extent of damage on leaves showed significant variations. The lowest intensity of damage was observed in plants sprayed with methyl parathion 0.05% (40%) and it was followed by methyl parathion 0.1%, phosphamidon 0.05%, 0.1%, monocrotophos 0.1% and quinalphos 0.05%, the difference among the six treatments being statistically insignificant. Endosulfan at 0.05 and 0.1% ranked next with a mean per cent damage of 20 and 32% respectively. The mean percentage of damaged leaves in the remaining treatments (range 24 to 42%) came on par with control (74%).

On the fourteenth day after application also there was significant variation among the different treatments. Minimum level of damage (10%) was observed in plants treated with dimethoate at 0.1% concentration and this was on par with the treatments done with monocrotophos at both the levels of 0.05 (30%) and 0.1% (26%), endosulfan 0.1% (28%) and quinalphos 0.1% (34%).

Table 20. Extent of damage caused by *S. dorsalis* on the leaves of rose plants treated with different insecticides at two doses

Treatments	Pre-treatment population	Mean percentage of damage on five tender leaves/plant observed at different intervals after spraying (days)	
		7	14
Endosulfan			
0.05%	42	20 (6.68)	44 (6.02)
0.1%	34	32 (6.83)	28 (5.04)
Fenthion			
0.05%	70	42 (7.16)	40 (6.05)
0.1%	52	24 (7.17)	42 (6.21)
Methyl parathion			
0.05%	38	40 (4.36)	64 (7.54)
0.1%	52	52 (5.13)	42 (5.25)
Quinalphos			
0.05%	34	14 (6.13)	60 (6.85)
0.1%	54	26 (7.24)	34 (4.82)
Dimethoate			
0.05%	84	42 (8.02)	60 (6.91)
0.1%	76	34 (8.33)	10 (2.49)
Monocrotophos			
0.05%	54	16 (7.96)	30 (4.52)
0.1%	46	34 (5.73)	26 (4.16)
Phosphamidon			
0.05%	46	36 (5.18)	50 (6.59)
0.1%	48	38 (5.72)	46 (6.38)
Control	52	74 (9.13)	84 (9.42)
CD (at 5% level)		(2.15)	(2.70)

Figures in parentheses are values adjusted for pre-count after $\sqrt{x}$ transformation.

Table 21. Extent of damage caused by S. dorsalis on the flower buds of rose plants treated with different insecticides at two dosages

Treatments	Pre-treatment population	Mean percentage of damage on flower buds observed at different intervals after spraying (days)	
		7	14
Endosulfan			
0.05%	40.0	50.0 (4.59)	75.0 (8.29)
0.1%	54.5	34.8 (6.49)	42.5 (5.18)
Fenthion			
0.05%	61.6	54.7 (6.32)	69.9 (8.22)
0.1%	68.2	55.0 (7.15)	74.0 (8.55)
Methyl parathion			
0.05%	22.5	21.6 (3.85)	63.5 (6.76)
0.1%	45.0	43.3 (5.36)	84.6 (8.83)
Quinalphos			
0.05%	55.0	38.3 (6.01)	70.9 (8.04)
0.1%	91.0	44.6 (9.15)	65.0 (7.73)
Dimethoate			
0.05%	42.1	40.0 (5.36)	20.7 (3.41)
0.1%	42.5	7.5 (5.73)	15.0 (8.0)
Monocrotophos			
0.05%	35.0	30.0 (3.07)	33.5 (4.55)
0.1%	47.0	10.0 (6.58)	16.0 (2.10)
Phosphamidon			
0.05%	40.0	20.0 (5.04)	65.0 (6.78)
0.1%	30.0	19.1 (4.15)	39.2 (4.71)
Control	33.3	87.3 (5.87)	87.5 (9.83)
CD (at 5% level)		(2.37)	(2.15)

Figures in parentheses are values adjusted for the pre-count, after $\sqrt{x+1}$ transformation.

Phosphamidon and fenthion at both the doses of 0.05 and 0.1%, methyl parathion 0.1% and endosulfan 0.05% were also effective in reducing the damage significantly over control. But no significant reduction in the damage was noticed in plants treated with the lower dose of dimethoate (60%) and lower doses of quinalphos (60%) and methyl parathion (64%).

In the case of damage caused by S. dorsalis to the flower buds (vide Table 21), it was seen that 7 days after application the variation among the treatments were statistically insignificant and the mean per cent damage ranged from 7.5 to 54.7 per cent.

At 14th day after treatment, the data on flower bud damage showed significant variation. Application of dimethoate 0.1% caused highest reduction of damage to a mean level of 15%, which was on par with the damage observed in monocrotophos 0.1% (16%) and dimethoate 0.05% (20.7%), while it was 87.5 per cent in control. Monocrotophos 0.05%, phosphamidon 0.1% and endosulfan 0.1% ranked next with no significant difference among them (33.5 to 42.5%). The remaining treatments were also on par among themselves, the range of the damage level extending from 63.5 to 75%.

3.4.3. Effect of insecticidal sprays on the control of A. aurantii on rose

The data relating to this experiment and the results of statistical analysis are presented in Table 22.

The population of A. aurantii was significantly reduced at seven days after spraying in all treatments when compared with control. The least population of the scale was observed on plants sprayed with monocrotophos 0.05% (0) and it was on par with those in fenthion 0.05 and 0.1%, monocrotophos 0.1%, dimethoate 0.05 and 0.1% and endosulfan 0.05%; the population range being 0 to 0.8. Among the different insecticide treatments, quinalphos 0.1% recorded the highest population and it was on par with quinalphos 0.05%, methyl parathion 0.05%, phosphamidon 0.05 and 0.1% and endosulfan 0.1% (range 0 to 0.8).

At 14th day after spraying, the population in control (5.8) was significantly reduced from 7 DAT and methyl parathion at 0.05 and 0.1% came on par with control. In dimethoate and monocrotophos (0. 1%) treated plants the populations were zero. Population in the remaining treatments were also significantly lower than that of control and the mean number of scales observed in the treatments ranged from 0.1 to 1.3.

Table 22. Population of *A. aurantii* on rose plants treated with different insecticides at two doses

Treatments	Pre-treatment population	Mean number of scale insects observed on 3 cm length of stem at different intervals after spraying (days)	
		7	14
Endosulfan			
0.05%	12.7	0.4 (3.15)	0.2 (1.16)
0.1%	17.9	0.2 (3.73)	0.8 (1.11)
Fenthion			
0.05%	6.3	0.2 (2.32)	0.2 (1.04)
0.1%	11.1	0.0 (2.98)	0.1 (0.91)
Methyl parathion			
0.05%	24.6	0.0 (4.14)	4.1 (1.63)
0.1%	18.7	1.0 (3.01)	9.6 (2.46)
Quinalphos			
0.05%	8.9	0.0 (4.14)	1.0 (1.11)
0.1%	25.3	0.0 (4.64)	1.3 (1.03)
Dimethoate			
0.05%	8.4	0.8 (2.51)	0.4 (1.19)
0.1%	13.2	0.0 (3.06)	0.0 (0.87)
Monocrotophos			
0.05%	5.4	0.0 (2.30)	1.0 (1.15)
0.1%	24.1	0.0 (2.84)	0.0 (0.79)
Phosphamidon			
0.05%	18.9	0.8 (3.73)	0.7 (1.20)
0.1%	21.2	0.4 (3.93)	0.3 (1.01)
Control	4.1	4.6 (7.29)	5.8 (2.69)
CD (at 5% level)		(1.40)	(1.12)

Figures in parenthesis are values adjusted for pre-count after $\sqrt{x+1}$ transformation.

3.4.4. Effect of insecticidal sprays on the control of P. neocaledonicus on rose

The data relating to this experiment and the results of statistical analysis are presented in Table 23.

Seven days after spraying with the different insecticides, maximum reduction in the mite population was observed in plants treated with dimethoate 0.1% emulsion and the mean number of mites observed was 2.1. This was closely followed by monocrotophos 0.05%, fenthion 0.1%, monocrotophos 0.1%, fenthion 0.05% and dimethoate 0.05% and there were no significant difference among the six treatments which were superior to control and the mean mite population in the treatments ranged from 14.2 to 7.9. Phosphamidon 0.1%, methyl parathion 0.05%, endosulfan 0.05%, methyl parathion 0.1%, phosphamidon 0.05% and quinalphos 0.1% were next in the rank significantly suppressing the mite population (2.9 to 11.3) when compared with the population on control plants (11.6). Quinalphos 0.05% and endosulfan 0.1% were the least effective treatments which recorded mean populations of 5.7 and 5.3 respectively, both treatments being statistically on par with control.

When the population was observed at 14 days after application, none of the treatments showed significant variation from control and the mean number of mites ranged from 5.2 to 38.3.

Table 23. Population of *T. neocaledonicus* on rose plants treated with different insecticides at two doses

Treatments	Pre-treatment population	Mean number of mites observed on five leaves at different intervals after spraying (days)	
		7	14
Endosulfan			
0.05%	7.8	2.9 (2.92)	5.2 (3.08)
0.1%	15.5	5.3 (3.60)	7.7 (2.90)
Fenthion			
0.05%	5.6	8.4 (2.24)	22.2 (4.40)
0.1%	14.5	7.9 (2.10)	27.5 (4.36)
Methyl parathion			
0.05%	9.8	8.2 (2.90)	34.4 (4.92)
0.1%	12.2	11.0 (3.21)	21.6 (3.96)
Quinalphos			
0.05%	11.8	5.7 (3.40)	26.3 (4.96)
0.1%	16.7	11.3 (3.37)	21.3 (3.60)
Dimethoate			
0.05%	8.7	7.9 (2.26)	38.3 (5.38)
0.1%	7.5	2.1 (1.71)	23.3 (3.45)
Monocrotophos			
0.05%	6.3	14.2 (2.03)	37.4 (5.10)
0.1%	6.6	9.9 (2.20)	20.2 (4.37)
Phosphamidon			
0.05%	9.3	4.7 (3.22)	19.1 (4.29)
0.1%	8.3	10.0 (2.83)	28.0 (4.61)
Control	7.3	11.6 (4.45)	20.3 (4.03)
CD (at 5% level)		(1.02)	NS

Figures in parentheses are values adjusted for pre-count after $\sqrt{x+1}$ transformation.

3.4.5. Effect of carbofuran applied at different doses on the control of insect and mite pests of rose

The data on the effect of carbofuran applied for the control of *R. syriacus*, *S. dorsalis*, *A. aurantii* and *T. neocaledonicus* are presented in Table 24.

At seventh day after application, the population of *R. syriacus* on the plants treated with carbofuran at the higher two levels of 0.15 and 0.18 g ai/plant (17.2 and 13.1 respectively) were significantly lower than the untreated control whereas the population in all the other doses were on par with that of control which recorded a mean population of 44.32. A more or less same trend was observed on fourteen day after application also.

Data on the effect of different doses of carbofuran in the population of *A. aurantii* at seven days after treatment showed that carbofuran could control the pest effectively only at the highest dose (0.18 g ai/plant) whereas the population in all the other doses (9.33 to 11.33) came on par with that of control. By fourteenth day after treatment even the highest dose failed to reduce the population significantly over control.

As in the case of *A. aurantii*, the population of *T. neocaledonicus* was also reduced significantly over

Table 24. Effect of carbofuran applied at different doses on the control of insect and mite pests of rose

Dose g ai/pot	Mean population observed at different intervals after spraying (days						Mean per cent damage observed at different intervals after spraying (days)			
	R. syriacus		A. aurantii		T. neocaledonicus		S. dorsalis		S. dorsalis	
							Leaf		Flower bud	
	7	14	7	14	7	14	7	14	7	14
0.03	37.00 (5.81)	46.10 (6.68)	9.33 (3.11)	14.67 (3.81)	23.67 (4.72)	39.33 (6.19)	72.33 (8.56)	80.00 (8.82)	69.33 (8.30)	81.67 (8.92)
0.06	42.80 (6.37)	39.20 (6.14)	11.33 (3.19)	11.67 (3.26)	26.67 (5.21)	32.67 (5.76)	68.67 (8.21)	57.33 (7.46)	72.00 (8.38)	89.33 (9.39)
0.09	31.30 (5.46)	29.60 (5.28)	9.67 (3.08)	12.33 (3.40)	18.67 (4.20)	36.10 (5.91)	70.33 (8.31)	48.00 (6.86)	61.67 (7.78)	67.00 (8.08)
0.12	36.10 (6.01)	23.10 (4.96)	10.33 (3.24)	13.67 (3.59)	21.33 (4.60)	27.33 (5.14)	49.33 (6.95)	61.67 (7.84)	52.67 (7.14)	75.33 (8.56)
0.15	17.20 (4.10)	10.25 (3.32)	9.33 (3.17)	10.67 (3.06)	13.33 (3.59)	20.67 (4.46)	26.32 (5.07)	42.67 (6.44)	81.33 (9.06)	87.00 (9.28)
0.18	13.10 (3.57)	2.30 (1.44)	6.33 (2.40)	7.33 (2.66)	9.67 (3.06)	15.33 (3.91)	28.67 (5.33)	37.33 (6.10)	68.33 (8.19)	43.33 (6.51)
Control	44.32 (6.67)	39.21 (6.18)	12.67 (3.48)	13.33 (3.61)	22.33 (4.81)	28.67 (5.28)	80.00 (8.88)	86.67 (9.28)	92.00 (9.46)	100.00 (9.68)
CD (at 5% level)	1.85	1.92	0.61	NS	1.72	1.81		1.73	NS	1.32

Figures in parentheses are transformed values ($\sqrt{x+1}$)

control when treated at the highest dose of 0.18 g ai/plant, the mean population being 9.67. The same trend was noticed on fourteenth day after treatment also.

In the case of the leaf damage by S. dorsalis, the treatments with carbofuran at the higher three doses of 0.12, 0.15 and 0.18 g ai/plant could reduce the damage on tender leaves significantly over control at the seventh day after application but the lower levels of 0.03, 0.06 and 0.09 g ai/plant failed to exert any significant effect on the damage. At fourteenth day after treatment the leaf damage in the plants treated with carbofuran at the higher four doses were significantly lower than the lower two doses and untreated control.

In the case of the flower damage by S. dorsalis, no significant reduction in the damage could be seen even in the highest doses of 0.18 g ai/plant at seven days after treatment. But from the data at the fourteenth day after treatment it is seen that the percentage of damage was significantly lower in plants treated at the dose of 0.09 and 0.18 g ai/plant, the damage being 67.0 and 43.33% respectively while 100% damage was observed in control.

DISCUSSION

Survey on the pests of roses in Trivandrum

A detailed survey was conducted in six locations of Trivandrum Taluk to study the distribution pattern of the pests affecting rose. The survey was carried out for a period of 13 months starting from August 1986. The study was confined to the households in urban areas of Trivandrum Taluk since the management practices followed by the growers were more or less uniform and number of plants of same variety required for the observations were not available in villages. The studies were hence restricted to six locations within the taluk.

The distribution of the various pests of rose in the different locations surveyed is given in Fig.7. The percentage of plants damaged by the pests *R. syriacus*, *Adoretus* spp, *A. aurantii*, *T. neocaledonicus* and *T. cinnabarinus* and percentage of flower buds damaged by *S. dorsalis* are presented. Pooled means obtained for the period of 13 months in each location were utilised for this comparison. It was observed that *T. neocaledonicus* was the most predominant pest of rose in all the locations surveyed (33.89 to 56.00 per cent damage). *T. cinnabarinus* was found to be the least important one (1.49 to 4.27) in all the locations surveyed.

Fig. 7. Distribution of major pests of rose in different locations of Trivandrum Taluk.

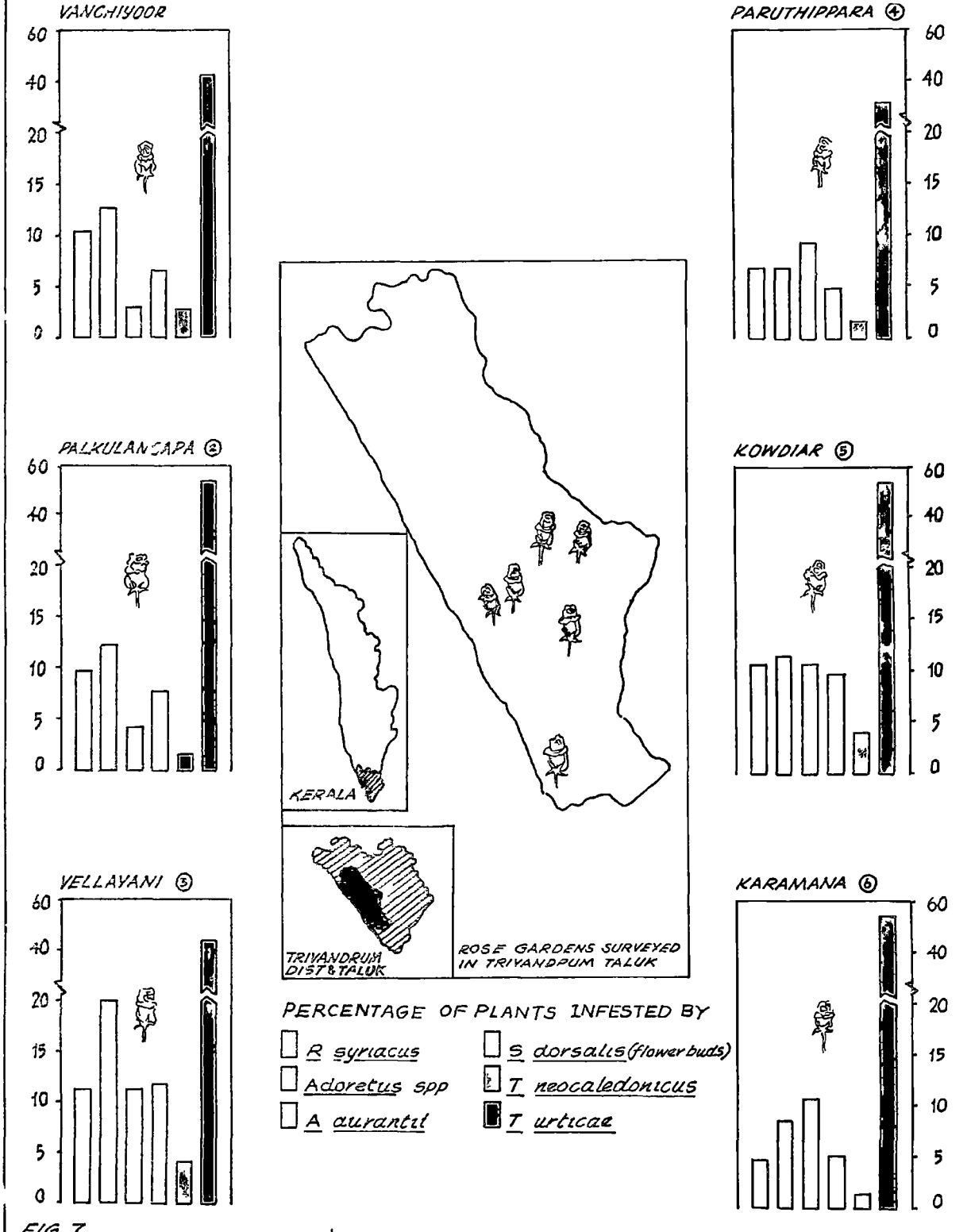

VANCHIYOOR
PARUTHIPPARA ④
PALKULANGARA ②
KOWDIAR ⑤
VELLAYANI ③
KARAMANA ⑥
0
5
10
15
20
40
60
KERALA
TRIVANDRUM DIST & TALUK
ROSE GARDENS SURVEYED IN TRIVANDRUM TALUK
PERCENTAGE OF PLANTS INFESTED BY
R syriacus
Adoretus spp
A aurantii
S dorsalis (flower buds)
T neocaledonicus
T urticae

FIG. 7

The damage done by the beetle Adoretus spp was of next importance in Vellayani, Vanchiyoor, Palkulangara and Kowdiar (20.52 to 11.89) where as in Paruthippara and Karamana the scale insect A. aurantii ranked next in the order of importance.

In Vellayani, Vanchiyoor, Palkulangara and Kowdiar, there was a more or less uniform pattern of infestation (10.0 to 11.3%) by R. syriacus compared to the low magnitude in Paruthippara and Karamana. The damage caused by flower thrips of rose was comparable in Vellayani, Kowdiar, Palkulangara and Vanchiyoor while it was lesser in Karamana and Paruthippara.

The incidence of A. aurantii was fairly high and more or less same in Vellayani and Kowdiar, in comparison to other locations surveyed. Similarly, the distribution of Adoretus spp was in general lower in Karamana and Paruthippara when compared to other locations.

Seasonal variations of these commonly occurring pests of rose were also studied in the different locations surveyed. The thrips R. syriacus, was seen more serious from December to May and the population was low from August to November and from June to August. The percentage of leaves infested and the plants infested also showed a similar trend.

The flower thrips S. dorsalis was found to inflict heavy damage to flower buds during the months of August to November reaching a peak level of infestation in December. A declining trend was noticed in the extent of damage from April onwards. This variation in the damage may be due to the higher production of flower buds from November onwards.

The seasonal distribution of the rose scale A. aurantii in the different gardens, revealed that the pest is more or less uniformly present throughout the year, thereby showing the persistent nature of the pest in the field.

The damage caused by the leaf beetle Adoretus spp was higher during the months of November to January followed by a declining trend from February onwards. Subsequently a second peak level of damage was also seen during the period from July to August. These two peaks in the damage caused, synchronised with post monsoon periods (North East and South West).

In the case of the mite, T. neocaledonicus population and the extent of damage observed in the rose gardens showed an increasing trend from November onwards reaching the peak in April, the other months recorded only lower levels of the population. Relatively higher

temperature prevailed during these months may be the factor contributing for the population build up of the mites in the field.

T. cinnabarinus appeared to be of minor pest status in all the locations surveyed. An overall picture of the results revealed that the thrips and the mites were of serious proportions during the months of December to May. The beetles were seen to cause heavy damage from November to January, whereas scale insect was seen throughout the year. The variations in the distribution of these pests over the period of the survey revealed that weather parameters are the important factors contributing for these fluctuations.

The association between the pest population/extent of damage and the weather paràmeters showed that maximum temperature was significantly and positively correlated with the population build up of R. syriacus, P. neocaledonicus and T. cinnabarinus infesting rose and also with the varying levels of damage caused by them. Such an association was also noticed with the level of damage done by S. dorsalis on flower buds. Direct influence of dry season (Cotterell, 1930) and high temperature during summer season (Reyne, 1929) were found to favour the development of thrips in the field. Ananthakrishnan (1956) also reported that the abundance

of R. syriacus was seen from March to July depending upon the weather conditions.

Relative humidity, rainfall and number of rainy days showed highly significant negative correlation with the population build up of thrips R. syriacus and S. dorsalis as well as with the extent of damage caused by them on the leaves/flower buds. Such a negative relation with humidity and rainfall and a positive relation with temperature was reported earlier in the case of R. syriacus (Ananthakrishnan, 1956).

In the case of the two species of mites (T. neocaledonicus and T. cinnabarinus) also relative humidity and number of rainy days showed a similar negative association with the population build up as well as the intensity of damage caused by them; while total rainfall did not exert any significant influence. Contrary to this, Butani (1974) observed that the mite population appeared with the onset of monsoon and thereafter the activity declined till April with the increase in temperature. Pillai and Jolly (1986) found that the population of T. equatorius was highest between March and July, when a higher range of temperature (28-33^{o}C) coupled with a low humidity (40-50%) favoured the breeding of the mites. The present observation was in agreement with this.

In general, the peak population of thrips and mites observed during the months of December-January to April-May in the different rose gardens of Trivandrum Taluk may be attributed to the higher maximum temperature, low relative humidity and number of rainy days during the period while the very low populations observed during the other months during the period of survey may be attributed to the higher relative humidity, rainfall and number of rainy days. Hence a close monitoring is necessary for the different species of pests, infesting roses during the summer season (December to May) so that early control measures may be initiated.

Nature of damage done by different pests attacking rose

Rose flowers and the different plant parts are prone to attack by many pests; about 50 species of insects and a few species of mites and nematodes have been recorded causing damage to rose, of which eight species were of major importance (Butani, 1974). In the present study, the most important pests observed in the rose gardens of Trivandrum were the thrips, mites, scale insects and the leaf feeding beetles. The thrips R. syriacus was observed causing serious damage to the rose leaves where as S. dorsalis attacked both the leaves and flower buds reducing the flower setting and even the commercial value of the flowers. Other species of thrips R. cruentatus

S. rubrocinctus were also found to cause serious damage to the leaves occassionally.

The two species of mites T. cinnabarinus and T. neocaledonicus were seen on the under surface of the leaves inflicting heavy damage and presenting a sickly appearance to the plants leading to reduction in the formation of the flower buds (Butani, 1974). The mites recorded during the survey were T. neocaledonicus and T. cinnabarinus both of which were polyphagous feeders and the former was more predominant than the latter.

The scale insect A. aurantii was observed as a persistent pest of rose throughout the season in the rose gardens surveyed causing heavy damage often leading to total drying of the whole plant. This was considered as a serious menace of rose cultivation (Butani, 1974).

The leaf beetles A. versutus, A. lasiophygus and A. mollis were also seen in the gardens feeding on the leaves causing defoliation and P. complanata damaging the flowers during certain seasons.

Besides these, jassids, mealy bugs and aphids sucking the plant juice, grass hoppers, caterpillars and leaf cutting bees damaging the leaves by defoliation, digger wasp causing damage to the pruned stems and the flower beetles feeding on the petals were also recorded in the survey.

From the available data, the latter group of pests can be considered as of minor importance since the damage caused was not as extensive as the former ones. But the changes in the ecological niche of these insects may shift their status to major ones. So, a surveillance on the damages done by these pests should also form an integral part of plant protection in rose gardens.

Biology of *R. syriacus* on different host plants

The biology of *R. syriacus* was studied in detail on rose and also on its alternate hosts castor, cassava and subabul, for the first time. The biometric observations of the different instars reared on different hosts showed that they were more or less of a uniform size on rose, castor and subabul while they were relatively bigger in size on cassava.

The duration of the life stages of *R. syriacus* on different hosts showed that the life cycle was shortest on cassava (9.6 days) when compared to other hosts. A better nutritional status offered by cassava might have helped the insect to develop faster and produce bigger nymphs. Similar studies conducted by Ananthakrishnan (1980) showed that the life cycle of *R. syriacus* was completed in 9-13 days on castor while it took only

9-11 days on rose. Hence the availability of a more preferred host plant like cassava in the niche may influence the population build up of the thrips and carry over of generations.

Chemical control of insect and mite pests of rose

1. R. syriacus

A field experiment was conducted to study the bioefficacy of using low dosages of insecticides commonly available in the markets in controlling R. syriacus. Seven insecticides were evaluated at the recommended, half and one fourth of recommended doses each.

The results of the experiment (vide para 3.4.1.) showed that monocrotophos, dimethoate and fenthion were the most effective insecticides for the control of thrips resulting in 100% reduction of the nymphal and adult population even at the lowest concentration (0.0125%) tried. In general, phosphamidon and quinalphos ranked next in their order of bioefficacy. Carbofuran and phorate failed to control the pest even at the recommended dose (0.75 kg ai/ha) tested. Better efficacy of dimethoate, methyl demeton and methyl parathion for control of the pest at lower doses of 0.025, 0.025 and 0.03% respectively was reported by Ananthakrishnan (1973).

There were no significant differences among the different doses of the insecticides tested. This indicated the possibility of reducing the dose of the insecticides even to one fourth level of the recommended dosage for the control of leaf thrips which will reduce the cost of plant protection considerably.

2. S. dorsalis

The results of the experiment presented on para, 3.4.2. revealed that the incidence of S. dorsalis assessed in terms of damage on tender leaves could effectively be controlled by spraying monocrotophos, quinalphos or phosphamidon at the recommended dose (0.05%). Dimethoate also controlled the pest up to two weeks after spraying even though initial control (7 DAT) was relatively low.

For the effective suppression of flower bud damage caused by S. dorsalis, spraying with systemic insecticides like dimethoate, monocrotophos or phosphamidon at higher dose (0.1%) was necessary. This might be due to the concealed nature of the insects which remained inside the unopened flower buds, for the control of which a translocated insecticide will be more effective.

3. A. aurantii

The results presented in para 3.4.3. showed that monocrotophos, quinalphos, fenthion, endosulfan, dimethoate

and phosphamidon at the recommended concentration (0.05%) gave effective control of the scale insect. Methyl parathion also showed a good initial control of the pest (7 DAT) but, the population increased significantly at 14 days. Application of monocrotophos 0.05% (Govindarajan et al., 1977), dimethoate and phosphamidon 0.05% (Nandakumar et al., 1988) were found to be most effective insecticides in controlling A. aurantii on rose. The results of the present studies were in agreement with these results.

4. T. neocaledonicus

Results presented (vide para 3.4.4.) showed that dimethoate, monocrotophos and fenthion were the most promising insecticides which showed good acaricidal properties also. However, these insecticides could protect the plants from mite infestation only up to seventh day after treatment. At 14 days after spraying none of the insecticides were effective in controlling the pest.

Considering the effect of varying doses of carbofuran in controlling different pests of rose (vide para 3.4.5.) it may be concluded that application of carbofuran was effective only at doses higher than 0.15 g ai/plant. Significant suppression of the major pests of rose including mites could be achieved by

application of carbofuran at 0.18 g ai/plant, but carbofuran was not effective in controlling R. syriacus in the previous experiment (vide para 3.4.1) even at the recommended dose of 0.75 kg ai/ha, because the dosage calculated on per hectare basis was quite insufficient.

Carbofuran at 1.5 kg ai/ha gave the best control of scale insect Lindingaspis rossi (Sreenivasan et al., 1974).

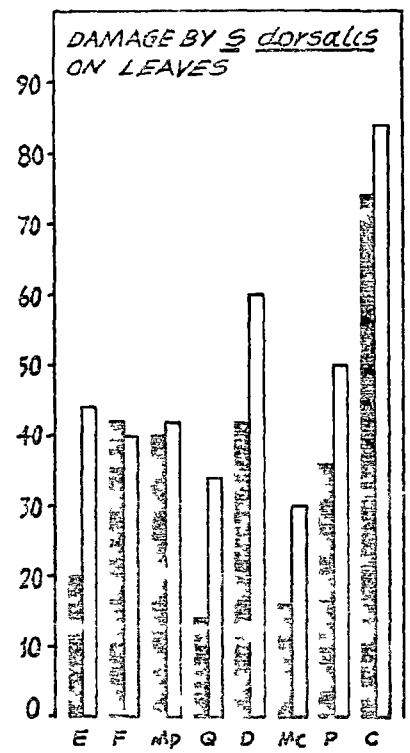
Carbofuran at 0.3 g ai/plant was reported to be the most effective insecticide for the control of A. aurantii on rose (Nandakumar et al., 1988).

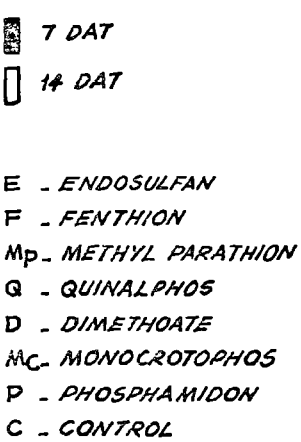
In homestead gardens with 25 to 50 potted plants, a systemic, broad spectrum insecticide like carbofuran will be the most ideal insecticide because of the convenience and safety of application. However, fixing of optimum dose of carbofuran in relation to the pot size and the frequency of application are also important aspects to be investigated, which could not be covered in the present investigation.

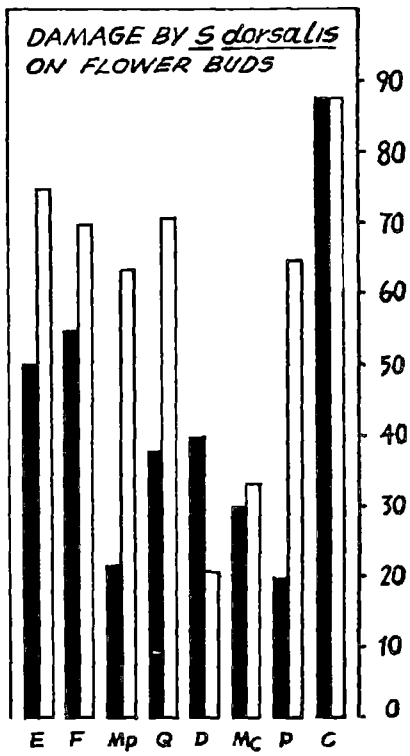
The results of the experiments on chemical control (except the experiment 3.4.5.) are presented in Fig.8.

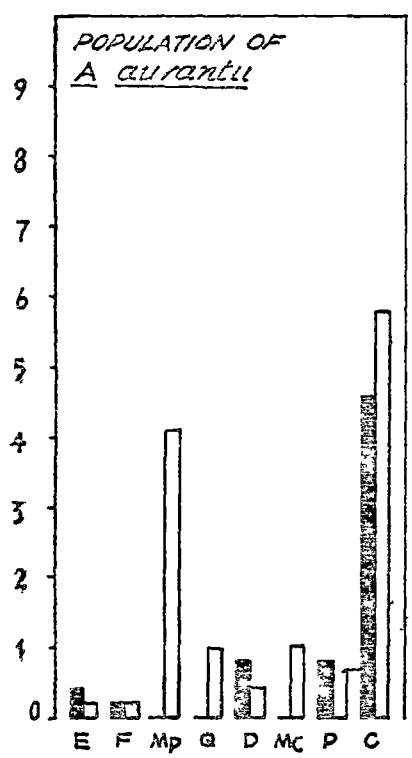
An overall analysis of the results of different control experiments, showed that spraying with monocrotophos,

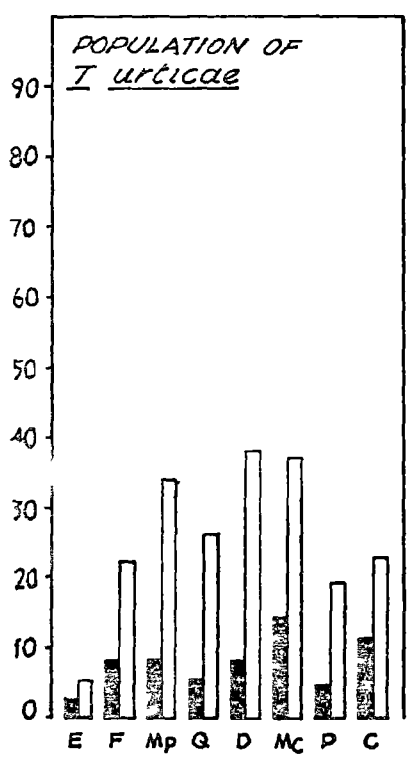
Fig. 8. Effect of different insecticides on the population of *A. aurantii*, *T. urticae* and *R. syriacus* and on the extent of damage caused by *S. dorsalis* on rose plants.

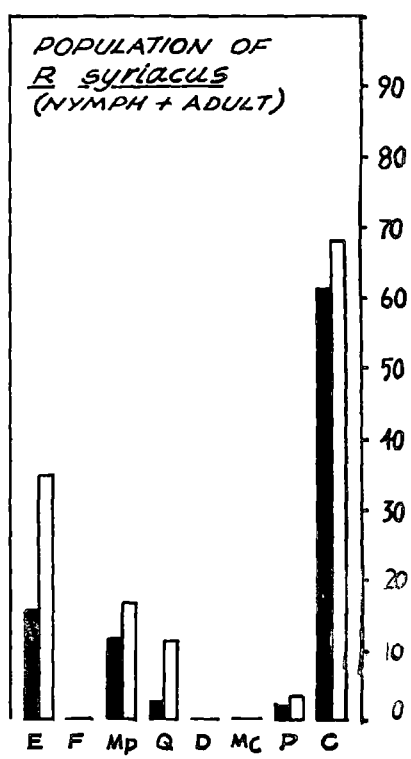

DAMAGE BY S dorsalis ON LEAVES
90
80
70
60
50
40
30
20
10
0
E F Mp Q D Mc P C


7 DAT
14 DAT
E - ENDOSULFAN
F - FENTHION
Mp - METHYL PARATHION
Q - QUINALPHOS
D - DIMETHOATE
Mc - MONOCROTOPHOS
P - PHOSPHAMIDON
C - CONTROL


DAMAGE BY S dorsalis ON FLOWER BUDS
90
80
70
60
50
40
30
20
10
0
E F Mp Q D Mc P C


POPULATION OF A aurantii
9
8
7
6
5
4
3
2
1
0
E F Mp Q D Mc P C


POPULATION OF T urticae
90
80
70
60
50
40
30
20
10
0
E F Mp Q D Mc P C


POPULATION OF R syriacus (NYMPH + ADULT)
90
80
70
60
50
40
30
20
10
0
E F Mp Q D Mc P C

dimethoate or fenthion at 0.05% or application of carbofuran at 0.18 g ai/ha effectively controlled the different species of insects, even though certain extent of species variations in the response to different insecticides were observed. In the case of S. dorsalis, higher doses may be necessary for effective control. However, in gardens suffering from regular incidence of S. dorsalis, close monitoring of the leaf and flower bud damage will lead to better management of these insects in the rose gardens.

Summary

SUMMARY

A detailed survey was conducted on pests affecting rose in six locations (Kowdiar, Paruthippara, Karamana, Palkulangara, Vanchiyoor and Vellayani) of Trivandrum Taluk during August 1986 to August 1987. The pest population and the extent of damage caused by the pests were assessed in four gardens in each of the six locations covered in the survey. The salient findings are the following:

1. The major pests observed in the survey were the thrips, R. syriacus, S. dorsalis, the scale A. aurantii, the leaf feeding beetle Adoretus spp and the mites T. cinnabarinus and T. neocaledonicus.

2. The population of R. syriacus and the extent of damage caused by the pest were significantly high from December to May, in all the locations. The infestations were of the same intensity and higher at Vellayani, Kowdiar, Palkulangara and Vanchiyoor (10 to 11.3%) than at Paruthippara and Karamana.

3. The damage caused by S. dorsalis on tender leaves and the flower buds were more intense from December to April in the different locations. The damage was more severe at Vellayani (12.02%) and it was followed by Kowdiar, Palkulangara and Vanchiyoor which were

comparable among themselves. In other locations the incidence of the pest was low.

4. The incidence of rose scale A. aurantii and the extent of damage caused by the pest were found serious throughout the period of the survey in the different locations and the data did not show significant variations.

5. The damage caused by the leaf beetles Adoretus spp was more intense from November to January and from July to August. The incidence of the pest was more at Vellayani, Varchiyoor, Palkulangara and Kowdiar than at Karamana and Paruthippara.

6. T. neocaledonicus was predominent from November to April. Higher level of damage was seen in Karamara, Vellayani, Kowdiar and Palkulangara compared to Varchiyoor and Paruthippara.

7. The population of T. cinnabarinus and extent of damage done by the pest were very low in all the locations surveyed though incidence was relatively higher from November to May.

8. Maximum temperature was significantly and positively correlated with the population and the damage caused by both the species of thrips and mites while the

relative humidity as negatively and significantly correlated. Rainfall also showed negative correlation but the association was significant with the population of the thrips only.

9. None of the weather factors showed any significant correlation with the population levels/damage of A. aurantii or with Adoretus spp.

10. Detailed observations on the nature of damages caused by different pests of rose revealed the following:

(a) The thrips R. syriacus, S. rubrocinctus and R. cruentatus fed on the under surface of the leaves and caused drying and falling of the leaves.

(b) S. dorsalis damaged tender leaves and buds and caused heavy damage in the latter case.

(c) The chafer beetles and the caterpillar pests occasionally caused serious defoliation of the plants.

(d) The digger wasp damaged the pruned stems after causing its drying.

(e) The mites T. cinnabarinus and T. neocaledonicus fed on the under surface or older leaves as a

result of which the leaves completely dried and withered away.

11. Investigations in the biology of *R. syriacus* on rose showed that the egg, nymphal, pre-pupal and pupal periods were 6.4, 6.9 1.0 and 2.6 days respectively.

12. The biology of *R. syriacus* on its alternate hosts viz. castor, cassava and subabul showed that castor and subabul were as good as rose for the development of the pest while the insects reared on cassava were bigger and the life cycle was shorter on the host.

13. Field experiment to study the bio-efficacy of seven insecticides for the control of *R. syriacus* revealed that monocrotophos, dimethoate and fenthion were more effective giving 100 per cent reduction of the nymphs and adults even at the lowest concentration of 0.0125 per cent.

14. Monocrotophos, quinalphos or phosphamidon at the recommended dose of 0.05 per cent was found effective in controlling the damage caused by *S. dorsalis*, where as dimethoate, monocrotophos or phosphamidon 0.1 per cent was effective against the flower bud damage caused by the pest.

15. The scale insect A. aurantii could be controlled effectively with monocrotophos, fenthion, endosulfan or dimethoate at 0.05 per cent emulsion.

16. Dimethoate, monocrotophos and fenthion (0.1 per cent) were promising against T. neocaledonicus.

17. Carbofuran at 0.18 g ai/plant was found effective against the major pests of rose.

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Appendices

The weather data of Trivandrum from August '86 to August '87

Months	Weather factors				
	Max. temp. (°C)	Min. temp. (°C)	RH (%)	Rain fall (mm)	No. of rainy days
August '86	29.6	22.6	82.0	210.0	10
September '86	30.5	23.6	81.0	77.5	13
October '86	30.9	23.9	82.0	90.4	12
November '86	30.9	22.7	77.0	220.4	11
December '86	32.3	23.5	74.0	16.6	4
January '87	32.6	22.7	65.0	2.1	3
February '87	32.7	22.8	68.0	0.0	0
March '87	33.4	24.2	68.5	7.9	2
April '87	33.4	25.2	75.5	116.2	7
May '87	33.3	25.2	77.0	196.5	9
June '87	30.9	24.0	83.0	176.1	22
July '87	31.4	24.1	77.5	48.5	8
August '87	30.1	23.5	85.0	353.8	17

Source : Meteorological observatory, Trivandrum

BIOECOLOGY AND CONTROL OF PESTS OF ROSE

BY

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ABSTRACT OF A THESIS

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ABSTRACT

The distribution of the major insect and mite pests of rose in Trivandrum taluk and the damages caused by them were studied in a survey. The survey was conducted in six locations in the taluk (Kowdiar, Paruthippara, Karamana, Palkulangara, Vanchiyoor and Vellayani) at monthly intervals for a period of 13 months starting from August 1986, adopting standard sampling techniques. The results of the survey revealed that the major pests of rose in the area were the thrips, *R. syriacus*, *S. dorsalis*, the scale *A. aurantii*, the leaf feeding beetles *Adoretus* spp and the mites, *T. neocaledonicus* and *T. cinnabarinus*.

The mean levels of population/damage found during the period of the survey showed that *T. neocaledonicus* was the most important pest in all the locations and it caused more than 50 per cent of the plants damaged in some locations. It was followed by *Adoretus* spp, *A. aurantii*, *R. syriacus*, *S. dorsalis* and *T. cinnabarinus* in a descending order of importance with apparent variations in pest status at different locations.

An overall assessment of the seasonal incidence of the pests revealed that the thrips and mites were seen in serious proportions during the months of December

to May and the beetles caused heavier damage from November to January whereas the scale insect was seen damaging the plants throughout the year.

Between the population of thrips and mites and maximum temperature there was significant positive association. While the relative humidity and number of rainy days showed significant negative correlation. Rainfall also had significant negative correlation with the thrips and mites, but it was statistically insignificant in the case of T. cinnabarinus only.

The nature of damage caused by various pests of rose was studied in detail. It was seen that the thrips, mites and the scales were causing serious damage to leaves causing its drying and withering. The other sucking pests and the defoliators noted were of minor importance except the leaf beetles Adoretus spp which was found to cause serious defoliation of the plants.

The investigation on the biology of R. syriacus on rose showed that the life cycle was completed in 16.9 days. When they were reared on castor and subabul the duration and size of various stages were same as those of rose while those reared on cassava were bigger in size and the life cycle was shorter.

The experiments on chemical control of pests of rose showed that monocrotophos, dimethoate or fenthion

at 0.05 per cent spray was effective in controlling the different species of pests. But in the case of flower bud damage caused by S. dorsalis, a higher concentration of 0.1 per cent of the insecticides was necessary for getting proper control.