# STUDIES ON THE ECOLOGY AND CONTROL OF THE CUCURBIT MITE, *TETRANYCHUS NEOCALEDONICUS* ANDRE ( TETRANYCHIDAE : ACARINA )



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THESIS

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CERTIFICATE I

This is to certify that Mr B.L. Sharma has successfully completed the preliminary examination held on October 7, 1977, as required under the regulations for Doctor of Philosophy.

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CERTIFICATE II

This is to certify that this thesis entitled "Studies on the ecology and control of the cucurbit mite, *Tetranychus neocaledonicus* Andre (Tetranychidae : Acarina)" submitted for the degree of Doctor of Philosophy in the subject of Entomology of the University of Udaipur is a bonafide research work carried out by Mr B.L. Sharma under my supervision and that no part of this thesis has been submitted for any other degree, The assistance and help received during the course of investigation have been fully acknowledged.

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This is to certify that the thesis entitled "Studies on the ecology and control of the cucurbit mite, Tetranychus neocaledonicus Andre (Tetranychidae : Acarina)" submitted by Mr B.L.Sharma to the University of Udaipur in partial fulfilment of the requirements for the degree of Doctor of Philosophy in the subject of Entomology has been approved by the students advisory committee after an oral examination on the same in collaboration with an external examiner.

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# INTRODUCTION

Mites are of great economic importance as pests of crops, storedgrains and animals; as biological control agents; and also as agents of humus breakdown. In spite of such importance, mites have attracted little attention in India and their studies are still in embryonic stage of development.

Phytophagous mites inflict many types of injury. Direct injury may be due to feeding, which increases leaf and fruit drop; decreases fruit size; reduces plant vigour or causes various types of malformation and deformities. Aside from the feeding, they have been found to transmit plant viruses.

During the past two decades, incidence of phytophagous mites has been reported on increase in India. The main contributing factor to their increase has been stated to be the widespread and injudicious use of nonselective pesticides mainly of the chlorinated hydrocarbon and organophosphorus groups. In addition to yielding successful control of insect-pests and diseases, these pesticides have adversely affected the population of parasites and predators of these mites. Moreover, for increasing the farm yield, high yielding varieties are being introduced, more irrigation facilities are available and more and more fertilizers are added in the soil. All these intensive systems have led to the luxuriant growth of several organisms including mites. Mites' success in increasing their population may also be probably due to their small size, short life-cycle and wide host range that enables them to survive and remain active throughout the year.

Considering the phytophagous mites to be non-insect pests they were left to the mercy of Zoologists who hardly studied them from applied side for they possessed little know-how of agricultural technology. In this confusion their study did not receive its due either from crop protectionists or zoologists. The ever increasing damage caused by phytophagous mites has recently attracted the attention of our Agricultural Entomologists, which is evident from the ever increasing number of research papers published, the formation of Acarological Society of India in 1974, and the commencement of the publication of Acarological News Letter and Indian Journal of Acarology.

All the phytophagous mites belong to sub-order Prostigmata, order Acarina (also called Acariformes) and class Arachnida. Out of a number of families, the members of which are exclusively plant feeders, the spider mites belonging to family Tetranychidae are very common on various plants including a large number of agricultural and horticultural crops.

One of the victims of phytophagous mites is a group of cucurbits, one of the most common vegetable crops in India. They are grown as kitchen garden or field crops throughout the year. The red cucurbit mite, *Tetranychus neocaledonicus* Andre (Tetranychidae : Acarina), which has been described earlier under synonyms *T. cucurbitae* Rahman and Sapra and *T. equatorius* McGregor was observed to attain pest status on cucurbits in Udaipur area. They inflicted heavy injury to foliage by sucking the sap with their stylets, leading to poor yield. A review of the available published literature revealed that no work on this species has been carried out in Rajasthan. This species is not even on record from this part of the country. The present knowledge about this species in other parts of the country is still in fragmentary state. The perusal of available literature also revealed that no fool-proof technique has yet been devised for rearing Tetranychid mites. The present investigation was, therefore, undertaken to devise a suitable technique for rearing and to study in detail the ecology and chemical control of this species. The results are presented in the following write-up.

## REVIEW OF LITERATURE

### Nomenclature

*Tetranychus neocaledonicus* Andre, commonly known as the vegetable mite, the red vegetable mite or the cucurbit mite has undergone several nomenclatural changes at the specific level. It was recorded for the first time by Andre (1933) from cotton in New Caledonia Island, and christened it as *T. neocaledonicus* Andre. In Indian subcontinent it was first collected in 1934 from *desi sem* (*Canavalia ensiformis*) at Lyallpur (Pakistan) by Rahman and Sapra (1940) who subsequently described it as *T. cucurbitae* (Rahman and Sapra, 1945). McGregor (1950) named this species *T. equatorius* as a new species which was synonymized with *T. cucurbitae* R.& S. by Pritchard and Baker (1955) while revising the family Tetranychidae. Andre (1959) reported that *T. neocaledonicus* preoccupied *T. cucurbitae*. Its current scientific name, according to Prasad (1974) is *T. neocaledonicus* Andre.

Distribution and host range

*T. neocaledonicus* is a polyphagous and cosmopolitan pest. It has so far been reported infesting 60 different plants in Pakistan (Rahman and Sapra, 1940, 1945), seven plant species in Hawaii (McGregor, 1950), four plant species in Madagascar (Gutierrez, 1974), and one plant species each in New Caledonia (Andre, 1933), Tahiti (Millard, 1952), Mauritius (Moutia, 1958), and U.A.R. (Soliman *et al.*, 1974). In India, this species has been recorded from Delhi on 38 plant species by Khot and Patel (1956); from Punjab on several ornamental plants by Bindra and Singh (1970), on six plant species by Gupta *et al.* (1971), and on 21 plant species by Sidhu and Singh (1972); from Haryana on five plant species by Fotedar (1978); from Rajasthan on one plant species by Pande and Yadava (1976); from Gujarat on eight plant species by Bharodia and Talati (1976); and on one plant species each from Karnataka (Puttaswamy *et al.*, 1976), and Tamil Nadu (David, 1958). This species has also been recorded from Meghalaya and Assam by Gupta and Gupta (1977). Among these, various species of cucurbitaceous and cruciferous plants, brinjal, cotton, *bhindi* (*Abelmoschus esculentus*), castor, beans, hollyhock, tomato, coriander, sunnhemp, lucern, groundnut, citrus, peach, jasmine, rose and an exotic weed, *Pertherium hyterophorus* are reported to be its important hosts. Most of these records are, however, based on the simple presence of mites. The only critical evaluation of different plants as hosts suitable for the rearing of the mite has been done by Sidhu and Singh (1972).

Sampling techniques and sample size

Gupta et al. (1975a) tested five principal methods, viz. direct counting, imprinting, flotation, jarring and brushing for their efficiency and precision in determining the population of T. cucurbitae on brinjal in Punjab. All the methods were reported to be equally efficient but significant difference existed in respect of time taken. The brushing method was significantly better than direct counting but not better than the jarring and the imprinting methods. Direct counting was as good as imprinting and jarring. The flotation technique took the maximum time, which significantly differed from other treatments. Because of convenience and simplicity the imprinting method was preferred for determining the population density of this mite.

Gupta et al. (1975b) further tested six sample sizes, viz. 1, 2, 3, 4, 6 and 8 sq cm for their precision and efficiency and found 1 $cm^2$ (1 cm X 1 cm) sample size to be most efficient in this regard. The dispersion studies revealed that 53 leaves/field was the minimum number of sample required to determine the population density of this mite in the field.

Seasonal incidence

Rahman and Sapra (1945) studied the seasonal incidence of this pest at Lyallpur (Pakistan). The incidence was observed to start in March after over-wintering gravid females became active and started laying eggs. The first generation was reported to last for about three weeks. However, successive generations overlapped and followed in quick succession and their population reached its peak by June. Monsoon rains killed all stages, except the eggs. After cessation of rains, the mite multiplied rapidly until the cool weather in November, when their numbers began to decrease. Males were recorded to be as numerous as females from May to September, but more numerous in October. The periods of maximum injury were reported to be May-July and September-October. In all, 32 generations were completed in laboratory in a year.

Bharodia and Talati (1976a) studied the seasonal incidence of this mite species on cotton in Junagarh (Gujarat). The incidence started in October. A five-fold increase in population was recorded in the next month, reaching its peak. In December, however, a reduction of over 50 per cent in the population was observed and the population level remained almost the same in January. The lowest population was recorded in February and after that the pest disappeared from the crop.

Effect of biotic and abiotic factors on the mite abundance

Abiotic factors: No published information is available on the effect of temperature and humidity on the seasonal incidence of *T. neocaledonicus*. Similarly, effect of rain and wind in reducing the population has not been worked out.

Biotic factors: (a) Food - Gupta *et al*. (1972) reported food to be an important factor in the population build-up of *T. cucurbitae*. (b) Predators and parasites - Rawat and Modi (1969a,b) reported predaceous bug, *Geocoris tricolar* Fabr. and a number of other coccinellids as general predators of *Tetranychus* spp. from Jabalpur. Gupta *et al*. (1971) recorded predatory mite, *Amblyseius hibisci* Chant on cotton at Ludhiana feeding upon *T. cucurbitae*. Chazeau (1974) reported coccinellid beetle, *Stethorus madecassus* Chazeau as an effective predator of *T. neocaledonicus* in Madagascar and studied the host-predator relationship. Blommers (1976) determined the reproductive parameters for the phytoseiid mite, Amblyseius bibens Bloomers when provided with ample T. neocaledonicus as prey at different temperatures in Madagascar. Osman and Zohdi (1976) reported from Egypt that release of 15 Amblyseius gossipi El-Badry per plant suppressed the population of T. neocaledonicus while the release of 10 predators per plant afforded fair control and five predators per plant yielded unsatisfactory results.

Rearing techniques

Rearing of Tetranychid mites has received considerable attention of the research workers. Rahman and Sapra (1945) reported the techniques used by McGregor and McDonough (1917) and Floyd-Smith (1931) as unsatisfactory and employed the apparatus evolved by Storey (1928) after some modification. The most widely used method of culturing mites is the use of Huffaker type of cages (Huffaker,1948), which have been used after modifying them by a large number of workers (Ries,1935; Ballard,1953; Petersen,1953; Khot and Patel,1956; Kramer,1956; Chant,1959; Henneberry and Shriver,1964; Bano,1974; among them). The leaf flotation technique, which consists of small excised leaves on a moist base in petridishes, has been employed after some modifications by a host of workers under laboratory conditions (Rodriguez,1953; ~~Munger, 1955;~~ Hussey et al., 1957; Lall and Dutta, 1959; Srivastava and Mathur, 1962; Munger and Gilmore, 1963; Siddig and El-Badry, 1970; McMurtry and Scriver, 1964; Banu and ChannaBasavanna, 1972; Gupta et al., 1972, 1974; Bharodia and Talati, 1976a; among others).

Biology

Life-history: Rahman and Sapra (1940) described adult females and males of T. cucurbitae in detail and later (1945) studied the life-history of this pest at Lyallpur (Pakistan) on Canavalia ensiformis and described the various developmental stages and their measurements. According to them the males matured before the females which passed through a deutonymphal stage and fertilized them as they emerged from it. The unmated males outlived the mated ones. The life span of unmated male adults varied with season—more during March and October-December (9 to 20 days) than in April-September (5 to 8 days). The females always outlived the males and their longevity, like males, also varied from 10 to 12 days and 14 to 25 days during the corresponding periods, respectively. The preoviposition period varied from less than 24 hours during May-September to a fortnight in December-January. The oviposition period lasted 8 to 20 days and the number of eggs laid by fertilized and unfertilized females was 61 to 93 and 33 to 59 respectively. The duration of the egg stage varied from 2.5 to 3 days during April-September to 30 days during January-February. The duration of immature stages varied from 1.5 days in males and 2.5 to 3 days in females during May-September to 20 days in males and 27 days in females during January-February.

McGregor (1950) described the morphological characters of T. equatorius, and Khot and Patel (1956) studied its biology on Gladiolus and Ipomoea in Delhi. In cage tests, the duration of egg, larval, protonymphal and deutonymphal stages was 3 to 9, 3 to 5, 3 to 4 and 2 to 5 days respectively. The longevity of adult females and males was reported to last 6 to 28 and 8 to 12 days respectively. The number of eggs laid by each female varied from 24 to 55. Parthenogenetic females generally gave rise to male progeny. Arrhenotokus parthenogenesis was also reported. Different stages of the mite were described and measurements of leg segments and body length and width were recorded.

Gutierrez and Chazeau (1972) reported from Madagascar that in a mean generation time of 12.3 days, T. neocaledonicus multiplied 37.45 times. Soliman et al. (1974) studied the biology of T. neocaledonicus on citrus under laboratory conditions in U.A.R.

Bharodia and Talati (1976a) studied the biology of T. neocaledonicus on cotton in Gujarat. They described the life-history and various stages of development. The number of eggs laid by mated and unmated females ranged from 35 to 85 and 2 to 31 respectively. The incubation period varied from 2 to 7 days. The duration of larval, protonymphal and deutonymphal periods varied from 0.75 to 8 days, 1 to 8.75 days and 0.75 to 9 days respectively. The longevity of mated males and females varied from 2 to 9 and 9 to 21 days respectively, while the longevity of unmated females ranged from 6 to 46 days. One complete life-cycle, from the laying of the egg to the emergence of the adult, occupied 8.25 to 22 days. The sex ratio between male and female, both in the field and in the laboratory was reported to be almost equal being 1:15.

Effect of temperature and humidity on the life-cycle of the pest on various hosts: Gupta et al. (1972) studied the effect of 20°, 25°, 30° and 35°C on the rate of development, fecundity and longevity of T. cucurbitae on four hosts, viz. horse gram, okra, brinjal and muskmelon and found that at 30°C the life-cycle was completed in the shortest time and the fecundity of fertilized and unfertilized females was maximum. Among the various hosts, the fastest growth was recorded on muskmelon.

Host preference and varietal susceptibility: No published information is available for *T. neocaledonicus* on the varietal susceptibility as affected by nitrogen, phosphorus and potash contents in the cucurbit leaves. The only reference available on the host preference as influenced by food and temperature is that of Gupta *et al.* (1972) who found maximum fecundity and shortest life-cycle on muskmelon in comparison to horsegram, okra and brinjal and considered it to be the most preferred host.

Nature and extent of damage

Rahman and Sapra (1945), Khot and Patel (1956) and Bharodia and Talati (1976*a*) have described in brief the nature of damage caused by this species. According to them, it injured the leaves not only by sucking the sap but also by covering them with a thick web which became filled with soil particles in windy weather. Their places of feeding appeared as white spots on the leaf surface which, with the increase in the intensity of attack, increased in number and gradually coalesced with each other finally producing large patches. Such leaves dried up in due course of time and dropped off, which affected growth and flowering adversely and usually prevented the formation of fruits.

No published information is available on the extent of damage caused by this species to its host crops under different natural environmental set-ups.

## Chemical control

Atwal et al. (1969) evaluated sprays containing 0.025 and 0.05 per cent malathion, methyl parathion, mevinphos and phosphamidon, 0.05 and 0.075 per cent dimethoate and 0.05 and 1.0 per cent wettable sulphur against T. cucurbitae on brinjal in Punjab. The mortality percentage was found to vary from 64.7 to 100 per cent among nymphs and 90 to 100 per cent with adults. Phosphamidon at 0.025 per cent and dimethoate at 0.05 per cent gave constantly higher mortality at all stages combined together. Malathion and methyl demeton at 0.05 per cent proved inferior but could be advantageous in treating vegetables due to their short residual action.

Eight pesticides, viz. chlorobenzilate, dimethoate, methyl demeton and thiometon 0.025 per cent each, dicofol 0.03 per cent, binapacryl 0.04 per cent, tetradifon 0.08 per cent and malathion 0.08 and 0.1 per cent were tested as high volume sprays against T. cucurbitae infesting brinjal in Punjab by Sidhu and Singh (1971). Forty-eight hours after the treatment, chlorobenzilate and methyl demeton proved better than all the other treatments except thiometon, which was at par with dimethoate, malathion (0.1 per cent) and tetradifon. Except that of malathion, there was further reduction in the population of mites in all treatments upto one week after spraying. However, they recommended the use of chlorobenzilate 0.025 per cent in view of its greater efficacy and low mammalian toxicity. Use of malathion 0.08 per cent was advocated in case crop was infested by jassids simultaneously.

Gupta et al. (1972) compared 17 pesticides, viz. amidithion, binapacryl, carbofuran, carbophenothion, chlorobenzilate, chlorphenamidine, dicofol, dicrotophos, dimethoate, fenitrothion, fenthion, malathion, monocrotophos, phosalone, tetradifon, thiometon and vamidothion in laboratory in three concentrations, viz. 0.025, 0.05 and 0.075 per cent, against the eggs of *T. cucurbitae*. Fenitrothion and malathion at 0.025 and 0.05 per cent concentration did not show any ovicidal action. Chlorphenamidine and dicofol at 0.025, 0.05 and 0.075 per cent and tetradifon at 0.05 and 0.075 per cent killed a hundred per cent eggs. Binapacryl and carbophenothion at all the concentrations and dimethoate and monocrotophos only at 0.075 per cent concentration also proved promising and gave over 96 per cent kill.

They also carried out two tests against the mobile stages of this species. In the first, carbofuran, dicrotophos, dimethoate and dioxathion 0.025 per cent each, binapacryl and monocrotophos 0.04 per cent each, amidithion, carbophenothion, chlorphenamidine, endosulfan, fenitrothion, phosalone and vamidothion, all at 0.05 per cent and malathion at 0.08 per cent concentration sprays were tested. The efficacy of all these treatments varied from 93.5 to 100 per cent. In the second experiment, all but dioxathion were tested. On the fifteenth day of treatment a hundred per cent kill was obtained by amidithion, chlorphenamidine, dimethoate, phosalone and vamidothion. The remaining compounds, except malathion, gave more than 96 per cent kill when sprayed at 0.025 per cent. Malathion at 0.1 per cent gave 88 per cent control.

Krishnaiah and Tandon (1975) evaluated seven pesticides, viz. dicofol 0.028 per cent, chlordimeform, cyhexatin, dimethoate and monocrotophos all at 0.05 per cent, tetradifon 0.05 per cent and Tranid 0.075 per cent on okra against *T. neocaledonicus* in Bangalore and reported tetradifon and Tranid as the most effective achieving 82.14 per cent and 77.57 per cent kill respectively after 14 days of treatment. Chlordimeform gave the least (39.49 per cent) kill. In another experiment, they tested six pesticides, viz.

tetradifon 0.025 per cent, chlordimeform, cyhexatin, dimethoate and phosalone, all at 0.05 per cent, and Tranid 0.075 per cent on brinjal against the same species and again found Tranid as highly effective which registered 95.9 per cent kill after 14 days of treatment. Cyhexatin proved to be the next best effective in achieving 92.8 per cent kill. Phosalone proved to be the least effective giving 56.8 per cent kill.

Singh et al. (1975) compared 19 pesticides for the control of T. neocaledonicus infesting brinjal in Haryana. These included quinomethionate 0.01 per cent, binapacryl, carbophenothion, diazinon, dicofol, dimethoate, dioxathion, endosulfan, fenitrothion, formothion, manazon, methyl parathion, monocrotophos, oxydemeton-methyl, phosphamidon, tetrachlolorovinphos and thiometon, all at 0.025 per cent, malathion 0.05 per cent and wettable sulphur. Carbophenothion, diazinon, dimethoate, formothion, monocrotophos, phosphamidon, thiometon and wettable sulphur were found effective in controlling this mite both at 3 and 7 days after spraying and they recommended the use of any one of these compounds for the control of the mite. No effect of any chemical could be observed after 15 days as the mite population was found homogenously distributed.

Bharodia and Talati (1976b) reported that dichlorvos, dimethoate, methyl demeton-S, monocrotophos, phosphamidon and thiometon at 0.03 per cent concentration and dinocap at 0.05 per cent concentration gave a hundred per cent kill of *T. neocaledonicus* infesting cotton in Gujarat.

Puttaswamy and ChannaBasavanna (1976) tested the toxicity of five acaricides at various concentrations to *T. neocaledonicus* and its predator *Stethorus pauperculus* Weise on castor plants in Karnataka. Although, all the chemicals evaluated were effective against mites, carbophenothion, dicofol and quinomethionate (oxythioquinox) proved significantly better than others. The first two pesticides were reported to be harmless to the coccinellid.

# MATERIAL AND METHODS

This study was carried out in and around Udaipur during the period ensuing from June, 1976 to June, 1978. The laboratory studies were conducted in the Department of Agricultural Zoology & Entomology, and the field studies were mainly on the Horticulture Farm of the Rajasthan College of Agriculture, Udaipur. The various aspects of the study of *Tetranychus neocaledonicus* Andre covered under the present investigation were:

1. The host range.
2. The seasonal incidence in relation to various cucurbit crops and their varieties.
3. The effect of biotic and abiotic factors on their abundance.
4. The effects of certain temperature and humidity regimens and also different hosts on the biology of the mite species.
5. The nature and extent of damage caused by the pest species.
6. The evaluation of bioefficacy of some pesticides against the pest species.

The bioefficacy of these pesticides on the natural enemies of the pest species was also under the plan of the present studies, but could not be undertaken in view of their low population.

## Distribution and host range

Initially, a survey was undertaken in and around Udaipur in search of principal host plants of *Tetranychus neocaledonicus*. The leaves of fruit trees, ornamentals, vegetable crops, and other field crops including weeds suspected to be infested by this mite species were brought to the laboratory for microscopic examination. The mites were collected with the help of a fine camel hair brush and were preserved in 70 per cent alcohol in the specimen tubes (vials). A survey of its natural enemies was also undertaken. The mite species was identified by the Taxonomists of the Zoological Survey of India, Calcutta; and the Department of Entomology, University of Agricultural Sciences, Bangalore.

## Sampling techniques and sample size

Before recording the seasonal incidence, the experiment was conducted to know the sampling technique and the appropriate sample size. Five sample sizes, *viz*. 0.5 $cm^2$

(0.5 cm x 0.5 cm), 1 $cm^2$ (1 cm x 1 cm), 1.5 $cm^2$ (1.5 cm x 1.5 cm), 2 $cm^2$ (2 cm x 2 cm), and 2.5 $cm^2$ (2.5 cm x 2.5 cm) were tested on the leaves of a local variety of pumpkin by direct counting under a binocular microscope. In each replicate, six leaves were observed for the mite infestation (two upper, two middle and two lower leaves), while three spots each of $cm^2$ size were randomly selected and taken into account for mite population on each leaf. Statistical analysis of data indicated that the estimate of between leaves variation increased with size of the unit and became stable for the unit size 2 $cm^2$ and similarly unit to unit variation within leaves also became stable for unit size 2 $cm^2$. The overall precision of sampling (per cent standard error) was more or less same for unit sizes 1 $cm^2$ and bigger units. From practical convenience and stability of sampling point of view the unit size 2 $cm^2$ was adopted for this study.

Seasonal incidence and varietal susceptibility

In order to study the seasonal incidence of the pest, seeds of 13 varieties of cucurbits were procured from various sources (Table 1).

Five cucurbits embracing 13 varieties (bottle gourd, 6; sponge/ridge gourd,3; cucumber,2; pumpkin and bitter gourd, 1 each) were considered for the study. The names of the crops, their varieties and source of availability are presented in Table 1.

TABLE 1. Information about crops and varieties

| Name of the crop/variety | Source of availability |
|---|---|
| Bottle gourd (*Lagenaria siceraria* L.) | |
| 1. Kalyanpur long green (summer) | Vegetable Research Centre, CSA University of Agric.& Tech., Kanpur |
| 2. Pusa selection prolific long | Division of Veg. Crops, IARI, New Delhi |
| 3. Pusa selection prolific round | - do - |
| 4. Pusa manjari | - do - |
| 5. Long white prolific | Sutton & Sons (India) Pvt. Ltd., 13 D, Russell Street, Calcutta. |
| 6. Local (Udaipur) | Udaipur |
| Cucumber (*Cucumis sativus* L.) | |
| 7. Cucumber Japanese long green | IARI Research Station Jorhat (Assam) |
| 8. Cucumber local (Udaipur) | Udaipur |
| Sponge gourd (*Luffa cylindrica* Roem.) | |
| 9. Luffa pusa chikni | Division of Vegetable Crops, IARI, New Delhi |
| Ridge gourd (*L. acutangula* Roxb.) | |
| 10. Local (Udaipur) | Udaipur |
| 11. Jhinga Tori | Sutton & Sons (India) Pvt.Ltd., 13 D, Russell Street, Calcutta |
| Pumpkin (*Cucurbita moschata* Duch.) | |
| 12. Local (Udaipur) | Udaipur |
| Bitter gourd (*Momordica charantea* L.) | |
| 13. Local (Udaipur) | Udaipur |

<u>Layout</u>: The trial was laid out in the Randomised Block Design on the Horticulture Farm of the College. Each treatment was replicated thrice. Plot size was 7.5 m X 6 m in which five plants were grown. Distance between plant to plant was 1.5 m. Thus, 15 plants were available in all the three replications of each treatment. All the cultural operations were made according to the recommendations and necessity. Farm yard manure (1 kg/hill) was applied at the time of sowing. Sowing of the first crop was done on 4th March, 1977, and the second on 20th July, 1977. Two or three seeds were sown/hill.

<u>Population counts</u>: After one month of sowing, when incidence started, weekly observations were taken. The method of sampling adopted was on the basis of counting mites on six leaves from each plant—two each from lower, middle and upper portion of one plant—selected randomly out of five plants grown in each plot. The mites were mainly confined to the lower (dorsal) surface of the leaves and only negligible population was recorded on the upper surface. Hence, the population counts were confined to the lower surface only. On each leaf, three spots, each of 2 $cm^2$ were selected at random and the population counts were made under the binocular microscope (25x). For each treatment 18 leaves from three plants were considered, and

a total number of 54 spots were examined weekly, and the number of individual stages (eggs, immatures, and adults) were counted. The population of natural enemies was also recorded. Data were recorded upto 15th August, 1977, in the first crop and observations started again in the second crop from 22nd August, 1977.

The weekly meteorological data pertaining to temperature, humidity and rainfall were collected from the meteorological observatory of the University and were correlated statistically with the population.

Varietal susceptibility: The varieties of 13 different cucurbits were tested for the effect of nitrogen, phosphorus and potash under the field conditions. The leaves were analysed by modified Kjeldhal's method for the estimation of these elements.

Statistical analysis: The varietal susceptibility of different stages was worked out statistically. For this analysis of variance was done on the basis of maximum increased population of different stages (eggs, immatures, adults and total population).

Effect of abiotic factors on the reduction of mite population: (a) Rain - The effect of total rainfall on the dislodgement of various stages of mites attacking different cucurbit species was studied under natural conditions prevailing at Udaipur. Thirteen cucurbit varieties grown for studying the seasonal incidence were included in the experiment.

This study is based on population counts taken immediately before and after rains. Weather reports and forecasts rendered tremendous help in setting-up the experiments.

Population records reported in the present study pertain to the four dates, viz. 13th June, 26th July, 1st August and 8th August on which the rainfall to the extent of 11.2 mm, 20.6 mm, 36.0 mm and 19.0 mm respectively were recorded.

The population density of mites on bitter gourd during the course of the present studies was found to be very low and it was because of this handicap that it was not considered worthwhile to study dislodgement with rain. As such the data incorporated in this regard relate to 12 varieties of four cucurbit species.

(b) **Wind:** An experiment was set up to study the effect of wind on the dislodgement of the mite population. The eggs and the immatures were not taken into account in the present observations. These stages being difficult to transfer on new leaves, were thus dropped out. Mites released on two susceptible hosts, viz. pumpkin (local) and bottle gourd (Kalyanpur long green, summer) were exposed to different wind velocities. In order to study this effect, 30 leaves of each host in lots of 10 each from three plants were tagged randomly. One hundred unsexed mites almost of a uniform size were released on each of these leaves with a fine camel hair brush. Care was taken to select those mites showing active movements and not to injure them during the process of transferance. The mites were allowed to settle down on these leaves for a period of half an hour before they were exposed to six different wind velocities, viz. 10.8, 19.8, 25.2, 30.6, 34.2 and 37.8 Km/hour. The wind velocities created by a winnowing machine fan, were measured by a hand anemometer. The plants were exposed for 30 minutes to each wind velocity and the reduction in the population was recorded. A control was simultaneously run, in which potted plant leaves were exposed to the open air currents in the nearby field area (away from the effect of artificial wind). The conclusions drawn out are based on six treatments, each one replicated thrice. The data thus obtained (based on 30 observations) were subjected to statistical analysis for precise interpretations.

Effect of biotic factors on the mite abundance: Food - The seasonal incidence of the mite species on 13 cucurbit varieties under natural conditions was undertaken and the effect of food on the mite abundance was recorded.

Predators and parasites: The population of natural enemies was also recorded on 13 different varieties of cucurbit crops against the mite species.

Development of a rearing cage

For studying the biology of *T. neocaledonicus*, the rearing cage was developed. The materials used for preparing the cage were as follows:

1. Wrist watch dial glasses about 3 cm in diameter.
2. Cork sheet round pieces (4 cm in diameter).
3. Rubber foam (MM Foam) or cotton wool.
4. Clips.
5. Grooved wooden sticks.

The cages were prepared in the manner as described below:

Two 5 cm diameter discs were cut from a 1 cm thick rubber foam sheet. In one piece a hole of 1.5 cm diameter was cut. Similarly, a 4 cm round disc was cut out from a cork sheet. A dial glass having a diameter of about 3 cm was placed on the rubber foam ring. Dorsal leaf surface was now held delicately against this supporting frame with fingers. Similarly, on the ventral surface a supporting frame made of foam and cork discs was placed, held tight with a clip (Fig. 1). The purpose of using foam was to avoid the leaf injury which could be caused by dial glass and the cork sheet piece. This also ensured sufficient aeration within the cage. In place of foam cotton wool was also tested and was found to be equally efficient. Overall performance of the cage was quite good giving adequate protection from the mite escape with least injury to the leaf and assured ventilation to the mite species.

Biology

Life-history: On each potted plant three cages representing three replicates were fitted and there were five plants each of bottle gourd (Kalyanpur long green, summer), cucumber (Japanese long green), sponge gourd (Luffa pusa chikni), pumpkin (local) and bitter gourd (local). From bottle gourd, cucumber, and sponge gourd only the most susceptible varieties were studied. The effect of these host plant species was studied at 20°, 25°, 30°, 35°, 37° and 40°C temperatures at two humidity levels—one ranging between 45-55 per cent and the other 75-85 per cent.

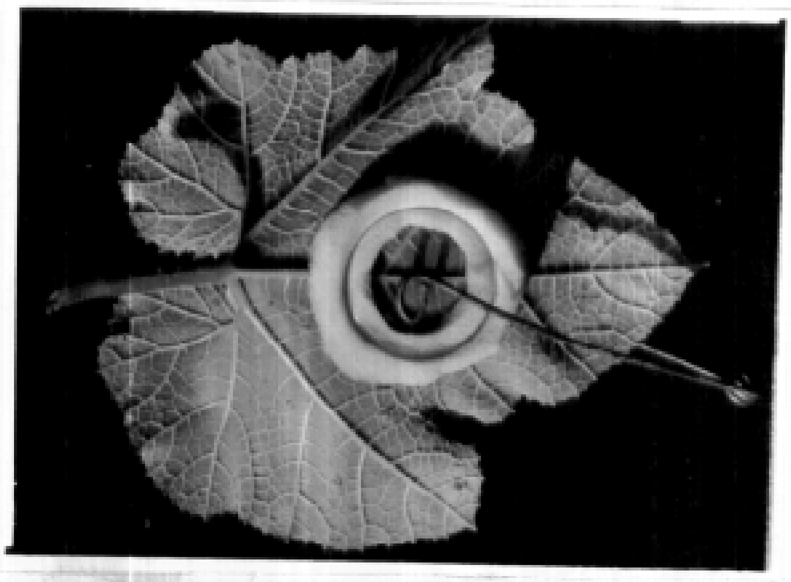


Figure 1 - Cage with foam, cork and clip

These studies were exclusively carried out in the controlled room (Fig. 2). The effect of food plants at various regimens of temperature and humidity were studied for one generation of the mites.

The adult mites were collected from the field and reared on these host plant species raised in pots for maintaining laboratory stock culture.

Before starting the experiment on the biology, the temperature and humidity were regulated in control room. The humidity was maintained with automatic humidifier. An electric rod heater was connected to the energy regulator for maintaining the temperature (Fig. 2). The temperature was recorded with a maximum and minimum thermometer and humidity was recorded by hair hygrometer.

In each cage a large number of female mites were released from the stock culture maintained on the potted plant of the same host with the help of a fine camel hair brush. The mites were released on 1.5 cm diameter leaf area marked by foam ring held with fingers against the dorsal leaf surface. Remaining appendages of the cage were replaced and clipped. The cage laden branch was supported by a grooved stick (Fig. 3).

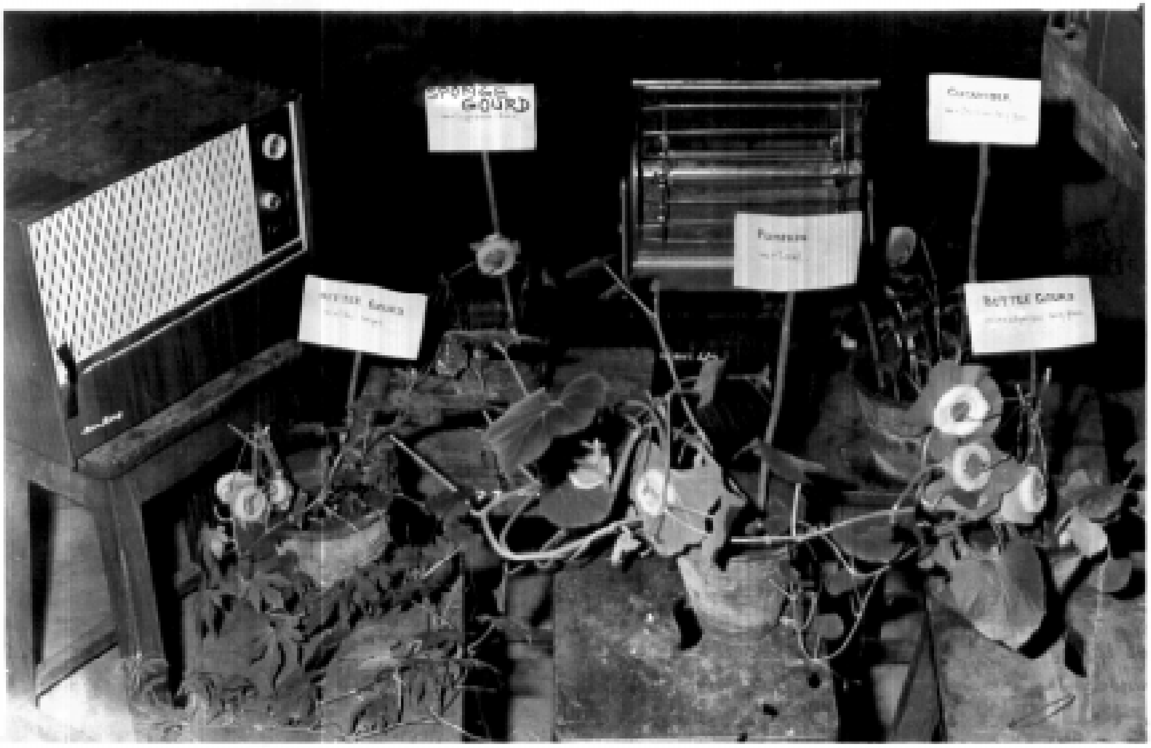



Figure 2 - View of controlled room

Figure 3 - Cage with supporting stick

The adult mites were removed from the cages, the next morning, using a fine camel hair brush and it was ensured that each cage contained only 50 eggs. The eggs in excess were removed. The study of the biology was started from the egg to the adult stage and continued till the eggs were laid by the adults of a single generation. The observations were, in order to find out their fecundity, recorded at six-hourly intervals.

The duration of various life-stages and fecundity were studied.

A binocular microscope was used for the study. The data were analysed statistically.

Nature and extent of damage

A potted experiment was also set up to study the nature and extent of damage on pumpkin (local) and bottle gourd (Kalyanpur long green, summer), which were found to be most susceptible to this mite species.

Visual observations were made to assess the nature of damage. For studying the extent of damage, two month old plants with 8 to 10 leaves were employed for release of mites at four different rates, viz. 100, 250, 500 and 1000 and a check was run simultaneously for valid comparisons.

The population of mites was recorded after 1, 2, 3, 4, 5, 6, 7 and 8 weeks. The population of mites per 2 $cm^2$ was also counted after 8th week and the scale of severity was prepared.

Effect of the site: The pot experiment was set-up to study the effect of site on the mite infestation. Three sets of potted plants, which were susceptible to the mites, *viz*. pumpkin (local) and bottle gourd (Kalyanpur long green, summer) were placed at three different locations, namely Horticulture Farm, college insectary and farmers' fields. Each treatment was replicated three times. The plants were about three months old when the first observation was taken on 6th June 1977. The next observation was made on 10th September, 1977. The sample size was constantly maintained as already mentioned in the seasonal incidence studies being 54 x 2 $cm^2$. The data thus recorded showed wide differences with regard to locations and it was, therefore, considered not worthwhile to subject them to statistical analysis. In other words, it may be said that data showed apparent differences.

Efficacy of pesticides

Field experiment: The two cucurbits, *viz*. pumpkin (local) and bottle gourd (Kalyanpur long green, summer) which were tested and found most susceptible were chosen for the pesticide efficacy studies.

The trial was laid in a Randomised Block Design to test the efficacy of 14 pesticides, which formed 14 treatments. In addition to these, plain water spray and a check formed 16 treatments in all. Each treatment was replicated three times. Plot size was 7.5 m X 6 m in which five plants were grown. In all, 15 plants were treated in three lots of five each. Thus, there were five plants in each replicate.

Pesticidal application: The details of pesticides with their technical, trade and chemical names, source of availability, amount/concentration used and price are given in Table 2. These pesticides were tested for their efficacy on two different crops in different seasons. On the pumpkin (local) pesticides were applied in the month of October, 1977, when the mite infestation was heavy while on the bottle gourd (Kalyanpur long green, summer) the pesticides were applied in the month of June, 1978, when mite infestation was again quite high. Both sprayings and soil treatments (side dressing) were given simultaneously. The granules were hoed into the soil evenly on either side of the plants standing in a row. In case of foliar application plants were sprayed with pesticides by means of a foot sprayer upto a dripping level.

TABLE 2. Information concerning pesticides

| Technical name | Chemical name | Trade name and formulation | Source of availability | Amount/ concentration used | Current market price (Rs/kg or lit) |
|---|---|---|---|---|---|
| Phorate | OO-diethyle S-(ethylthiomethyl) phosphorodithioate | Thimet 10 G | Cynamid India Ltd PO Box 9109 Bombay 400025 | 1.5 kg ai/ha | 18.00 |
| Aldicarb | 2-Methyl-2-(methylthio) propylideamino methyl carbamate | Temik 10 G | Union Carbide India Ltd Bhopal 462001 | 1.5 kg ai/ha | 27.00 |
| Disulfoton | OO-diethyl S-2-ethylthioethyl phosphorodithioate | Solvirex 5 G | Sandoz India Ltd 3 Wetlet Road Bombay 400018 | 1.5 kg ai/ha | 15.00 |
| Carbofuran | 2,3-dihydro-2,2-dimethylbenzofuran-7-ylmethylcarbamate | Furadan 3 G | Rallis India Ltd 87 Richmond Road PB No. 2536 Bangalore 560025 | 1.5 kg ai/ha | 15.00 |
| Dinobuton | 2-Sec-butyl-4,6-dinitrophenyl isopropyle carbonate | Acrex 30 EC | IDL Chemicals Ltd 11th Floor Hindustan Times House, 18-20 Kasturba Gandhi Marg, N. Delhi-1 | 0.03% (210 ml ai/ha) | 70.00 |

Continued Table 2

| | | | | | |
|---|---|---|---|---|---|
| Cyhexatin | Tricyclohexylin hydroxide | Plictran 50 W | Dow Chemicals International Ltd 11th Floor, Hindustan Times House 18-20 Kasturba Gandhi Marg New Delhi 110001 | 0.05% (350 gm ai/ha) | 135.00 |
| Sulphur | Sulphur | Microsul | Bharat Pulverising Mills Pvt Ltd Hexamar House Sayani Road Bombay 400020 | 0.5% (3.5 kg ai/ha) | 14.40 |
| Methamidophos | OS-dimethyl phosphoramido thioate | Monitor 50 EC | Rallis India Ltd 87 Richmond Road Bangalore 560025 | 0.05% (350 ml ai/ha) | * |
| Dicofol | 2,2,2-trichloro-1,1-di(4-chlorophenyl) ethanol | *Hilfol 55 EC | Hindustan Insecticides Ltd, Hans Bhawan, Gr. Floor Bahadur Shah Zafar Marg, New Delhi-2 | 0.03% (210 ml ai/ha) | 80.00 |
| Phenthoate | S-α-ethoxycarbonyl benzyl OO-dimethyl phosphorodithioate | Phendal 50 EC | Bharat Pulverising Mills Ltd, Hexamar House, Sayani Road Bombay 400020 | 0.05% (350 ml ai/ha) | 80.00 |

* Monitor & Hilfol; their rates have not been fixed by the manufacturers in India

contd......

Continued Table 2

| | | | | | |
|---|---|---|---|---|---|
| Malathion | S-(1,2-dicarbethoxy ethyl) OO-dimethyl phosphorodimethoate | Malathion 50 EC | Cynamid India Ltd PB No. 9109 Bombay 400025 | 0.05% (350 ml ai/ha) | 30.00 |
| Endosulfan | 6,7,8,9,10,10-hexachloro-1,5,5b,9a-hexahydro-6,9-methano-2,4,3 benzodi-oxathiopin 3 oxide | Thiodan 35 EC | Hoechst Pharmaceu-ticals Ltd PB No. 273 Bombay 400025 | 0.05% (350 ml ai/ha) | 60.00 |
| Dimethoate | O,C-dimethyl-S (N-methyl carbomoyl methyl) phos-phorodithioate | Rogar 30 EC | Rallis India Ltd 87 Richmond Road Bangalore 560 025 | 0.03% (210 ml ai/ha) | 58.70 |
| Phosphami-don | 2-Chloro-2-diethyl-carbomoyl-1-methyl vinyl dimethyl phosphate | Dimecron 100 EC | Ciba-Geigy of India Ltd P.B.No. 11014 Bombay 400020 | 0.03% (210 ml ai/ha) | 150.00 |

Note: Amount of spray material used: 1.75 l/5 plants; 2000 plants/ha; 700 lit of spray material/ha

Population counts: The population of mites was recorded before the treatment (pretreatment), and 1, 2, 3, 5, 7, 10, 15 and 21 days after treatment. Population counts were made under a binocular microscope. In each replicate, six leaves were observed for mite infestation (two upper, two middle and two lower leaves) while three spots of 2 $cm^2$ each were randomly selected and taken into account for mite population on each leaf.

Statistical analysis: The analysis of variance was done after transforming pre- and post-treatment population values by the formula $\sqrt{X + 0.5}$ and mean population was retransformed by the same formula $(X)^2 - 0.5$. The reduction percentage was calculated by the formula $\frac{P - P'}{P} \times 100$

Where, P - Pre-treatment population
P' - Post-treatment population

Residual toxicity of pesticides: Pot experiment - Most susceptible variety of bottle gourd (Kalyanpur long green, summer) was sown in the pots. For granular application sowing was done in 15 cm X 15 cm X 15 cm pits which were dug in the insectary.

Application of pesticides: Pesticides were applied on three month old plants by Ganesh hand sprayer. The rate of application of pesticides was maintained at the level applied in the field (Table 2). Twenty adult mites were released per leaf in three replications and mortality was recorded after 2, 3, 5, 7, 10, 15 and 21 days after application. Mortality counts were made 48 hours after the release of mites.

Statistical analysis: After calculating corrected mortality percentage with Abbott's (1925) formula, the PT values were calculated as developed and elaborated by Pradhan and Venkatraman (1962). According to them, the product (PT) of average residual toxicity (T) and period (p) for which toxicity persisted was used as an index for persistent toxicity.

## RESULTS AND DISCUSSION

### Host range

A field survey was conducted in Udaipur and its surrounding areas to scan *Tetranychus neocaledonicus* Andre among the other mite species infesting flora. Preliminary identification was undertaken in the Entomological laboratory of the Department in accordance with the taxonomic key of the mites. Thereafter, some of the specimens were sent for identification to the Zoological Survey of India, Calcutta and to the Department of Entomology, University of Agricultural Sciences, Bangalore for the confirmation.

The survey for the mite species has thus revealed that there were forty-one plant species belonging to 18 families which harboured all the stages of *T. neocaledonicus* (Table 3). Usually the mites were observed confining to the dorsal surface of the leaves of these plants. However, during serious infestation they crawled over the ventral surface also.

TABLE 3. Host range of T. *neocaledonicus* Andre

| S.No. | Family | Botanical name | Common name |
|---|---|---|---|
| 1 | Caricaceae | *Carica papaya* | Papaya |
| 2 | Compositae | *Bidens pilosa* | Bidens (weed) |
| 3 | -do- | *Helianthus annus* | Sunflower |
| 4 | -do- | **Xanthium strumarium* | Cockle-bur |
| 5 | Convolvu-laceae | *Ipomoea batatas* | Sweet potato |
| 6 | -do- | *Ipomoea palmata* | Railway creeper |
| 7 | Cruciferae | *Brassica campestris* | Sarson |
| 8 | -do- | *Brassica oleracea* | Cabbage |
| 9 | -do- | *Raphanus sativus* | Radish |
| 10 | Cucurbitaceae | **Cucurbita moschata* | Pumpkin |
| 11 | -do- | *Cucumis sativus* | Cucumber |
| 12 | -do- | *Lagenaria siceraria* | Bottle gourd |
| 13 | -do- | *Luffa acutangula* | Ridge gourd |
| 14 | -do- | *Luffa cylindrica* | Sponge gourd |
| 15 | -do- | *Momordica charantia* | Bitter gourd |
| 16 | Euphorbiaceae | **Acalypha triculour* | Acalypha |
| 17 | -do- | *Euphorbia hirrta* | Euphorbia |
| 18 | -do- | *Ricinus communis* | Castor |
| 19 | Geraniaceae | *Pelargonium grandi-florum* | Gerinum |
| 20 | Graminae | *Pennisetum typhoides* | Bajra |
| 21 | Labiatae | *Ocimum sanctum* | Tulsi |

* New host recorded

Contd.....

Table 3 continued

| | | | |
|---|---|---|---|
| 22 | Leguminosae | *Dalbergia sissoo* | *Shisham* |
| 23 | -do- | *Melilotus parviflora* | *Senji* |
| 24 | -do- | *Pisum sativum* | Pea |
| 25 | Malvaceae | *Althea rosea* | Hollyhock |
| 26 | -do- | *Gossypium hirsutum* | Cotton |
| 27 | -do- | *Hibiscus esculantus* | *Bhindi* |
| 28 | Meliaceae | *Melia azadarach* | Melia |
| 29 | Moraceae | *Ficus carica* | Fig |
| 30 | Nyctaginaceae | *Bougainvillea spectabilis* | Bougainvillea |
| 31 | Onagraceae | *Clarkia elegans* | Clarkia |
| 32 | Papilionaceae | *Cajanus cajan* | *Arhar* |
| 33 | -do- | *Glycine max* | Soybean |
| 34 | -do- | *Medicago sativa* | Lucerne |
| 35 | -do- | *Phaseolus* spp. | Beans |
| 36 | -do- | *Phaseolus mungo* | Black gram |
| 37 | Papveraceae | *Papaver orientale* | Poppy |
| 38 | Rosaceae | *Rosa indica* | Rose |
| 39 | Solanaceae | *Lycopersicum esculantum* | Tomato |
| 40 | -do- | *Solanum melongena* | Brinjal |
| 41 | -do- | *Solanum tuberosum* | Potato |

Note: All the above mentioned hosts, except brinjal, have been recorded for the first time in Rajasthan.

Seasonal incidence

The seasonal incidence (Table 4; Fig. 4 A,B) of the mite species was recorded on the 13 cucurbit varieties grown in two different seasons—the first set was sown on 4th March, 1977 and the second on 20th July, 1977. Observations were taken at weekly intervals throughout the first crop season. By the time, these crops were harvested, the population had already built up on the second set, thus the data on the incidence were recorded from March to the end of December, 1977 and, thereafter the data could not be collected as the crop was lost with the frost bite.

The incidence of the mite started on bottle gourd (Kalyanpur long green, summer) in the second week of April. In other varieties it started a little later, i.e. in the 3rd and 4th week of April, 1977. Thereafter, the population started increasing abruptly till June, although due to rains in the last week of May, a setback in the population was recorded. The rainfall reduced the mites to varying low levels on different varieties and only constantly heavy rains reduced the population considerably. The morphological characters of the leaves of an individual variety helped in offering resistance to dislodgement. This aspect has been discussed in detail under the

TABLE 4. Seasonal incidence of T. neocaledonicus on different cucurbit varieties (population/54 x 2 $cm^2$)

| Month and date | | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| March sown crop (4-3-77) | | | | | | | |
| April | 4 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 11 | 6 | 0 | 0 | 0 | 0 | 0 |
| | 18 | 86 | 4 | 0 | 0 | 0 | 0 |
| | 25 | 156 | 14 | 10 | 2 | 2 | 0 |
| May | 2 | 236 | 54 | 130 | 5 | 0 | 0 |
| | 9 | 312 | 158 | 159 | 6 | 8 | 54 |
| | 16 | 242 | 212 | 92 | 49 | 24 | 70 |
| | 23 | 450 | 230 | 152 | 176 | 148 | 4 |
| | *30 | 213 | 103 | 25 | 30 | 54 | 0 |
| June | 6 | 408 | 275 | 163 | 175 | 166 | 10 |
| | **13 | 549 | 283 | 290 | 173 | 250 | 92 |
| | 20 | 686 | 303 | 220 | 217 | 253 | 111 |
| | *27 | 267 | 94 | 124 | 119 | 152 | 94 |
| July | *4 | 294 | 54 | 165 | 56 | 130 | 93 |
| | 11 | 470 | 76 | 249 | 113 | 278 | 191 |
| | 18 | 481 | 14 | 217 | 125 | 217 | 224 |
| | 25 | 537 | 161 | 222 | 122 | 196 | 228 |
| August | ** 1 | 218 | 106 | 155 | 103 | 119 | 167 |
| | ** 8 | 219 | 105 | 91 | 22 | 132 | 118 |
| | 15 | 297 | 228 | 184 | 115 | 267 | 235 |
| July sown crop (20-7-77) | | | | | | | |
| | 22 | 474 | 368 | 304 | 229 | 342 | 242 |
| | *29 | 316 | 239 | 220 | 110 | 212 | 65 |
| September | * 5 | 169 | 118 | 184 | 166 | 176 | 95 |
| | 12 | 266 | 233 | 260 | 222 | 243 | 230 |
| | 19 | 425 | 291 | 271 | 379 | 297 | 329 |
| | 26 | 635 | 438 | 331 | 397 | 378 | 311 |
| October | 3 | 783 | 400 | 311 | 434 | 446 | 297 |
| | 10 | 680 | 487 | 380 | 400 | 426 | 377 |
| | 17 | 709 | 454 | 318 | 397 | 411 | 336 |
| | 24 | 700 | 503 | 335 | 458 | 441 | 265 |
| | 31 | 600 | 440 | 340 | 360 | 447 | 274 |
| November | 7 | 724 | 382 | 246 | 410 | 342 | 291 |
| | 14 | 683 | 456 | 244 | 424 | 254 | 238 |
| | 21 | 555 | 440 | 226 | 444 | 354 | 200 |
| | 28 | 546 | 418 | 234 | 346 | 331 | 192 |
| December | 5 | 497 | 344 | 249 | 231 | 262 | 232 |
| | 12 | 504 | 354 | 224 | 270 | 310 | 124 |
| | 19 | 340 | 230 | 166 | 282 | 163 | 122 |
| | 26 | 144 | 311 | 138 | 0 | 239 | 0 |
| | 28 | 0 | 0 | 0 | 0 | 0 | 0 |

contd.......

| Month and date | | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|
| | | | | March sown crop (4-3-77) | | | | |
| April | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 18 | 0 | 2 | 6 | 0 | 6 | 7 | 0 |
| | 25 | 4 | 6 | 16 | 0 | 2 | 26 | 0 |
| May | 2 | 8 | 8 | 10 | 0 | 6 | 75 | 0 |
| | 9 | 14 | 16 | 42 | 6 | 10 | 115 | 2 |
| | 16 | 0 | 36 | 130 | 6 | 20 | 147 | 4 |
| | 23 | 36 | 25 | 172 | 14 | 16 | 192 | 2 |
| | *30 | 0 | 10 | 64 | 0 | 0 | 106 | 0 |
| June | 6 | 77 | 19 | 197 | 24 | 10 | 198 | 0 |
| | **13 | 163 | 73 | 240 | 61 | 168 | 315 | 0 |
| | 20 | 201 | 113 | 230 | 113 | 274 | 289 | 6 |
| | *27 | 109 | 94 | 104 | 90 | 98 | 273 | 0 |
| July | * 4 | 130 | 109 | 120 | 105 | 108 | 217 | 4 |
| | 11 | 179 | 131 | 232 | 143 | 192 | 297 | 4 |
| | 18 | 224 | 170 | 308 | 142 | 182 | 397 | 9 |
| | 25 | 197 | 111 | 151 | 147 | 162 | 337 | 6 |
| August | ** 1 | 142 | 60 | 106 | 88 | 136 | 220 | 5 |
| | ** 8 | 64 | 11 | 62 | 54 | 74 | 135 | 8 |
| | 15 | 74 | 56 | 76 | 16 | 86 | 225 | 2 |
| | | | | July sown crop (20-7-77) | | | | |
| | 22 | 232 | 193 | 139 | 14 | 133 | 358 | 3 |
| | *29 | 173 | 116 | 106 | 10 | 76 | 320 | 5 |
| September | 5 | 143 | 79 | 73 | 8 | 18 | 185 | 0 |
| | 12 | 163 | 105 | 73 | 25 | 10 | 312 | 3 |
| | 19 | 232 | 208 | 146 | 71 | 92 | 506 | 20 |
| | 26 | 332 | 169 | 312 | 49 | 111 | 654 | 42 |
| October | 3 | 366 | 237 | 300 | 114 | 228 | 703 | 88 |
| | 10 | 467 | 255 | 329 | 182 | 237 | 736 | 87 |
| | 17 | 520 | 329 | 347 | 260 | 252 | 742 | 110 |
| | 24 | 386 | 339 | 340 | 288 | 335 | 731 | 97 |
| | 31 | 434 | 387 | 506 | 343 | 345 | 755 | 110 |
| November | 7 | 378 | 404 | 444 | 270 | 277 | 595 | 80 |
| | 14 | 308 | 449 | 459 | 292 | 362 | 734 | 0 |
| | 21 | 421 | 370 | 411 | 375 | 270 | 541 | 5 |
| | 28 | 302 | 243 | 414 | 302 | 336 | 543 | 2 |
| December | 5 | 278 | 268 | 431 | 303 | 358 | 559 | 7 |
| | 12 | 287 | 249 | 421 | 228 | 303 | 514 | 0 |
| | 19 | 274 | 136 | 328 | 131 | 289 | 335 | 0 |
| | 26 | 188 | 130 | 226 | 100 | 185 | 272 | 0 |
| | 28 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Bottle gourd: 1, Kalyanpur long green (summer); 2, Pusa selection prolific long; 3, Pusa ~~selection~~ prolific round; 4, Pusa mangari; 5, Long white prolific; 6, Local; Cucumber: 7, Japanese long green; 8, Local; Sponge gourd: 9, Luffa pusa chikni; Ridge gourd: 10, Local; 11, Jhinga tori; Pumpkin: 12, Local; Bittor gourd: 13, Local.

* Rains ** Data recorded before rains

FIG. 4 (A) SEASONAL INCIDENCE OF *Tetranychus neocaledonicus* André ON 13 DIFFERENT CUCURBIT VARIETIES

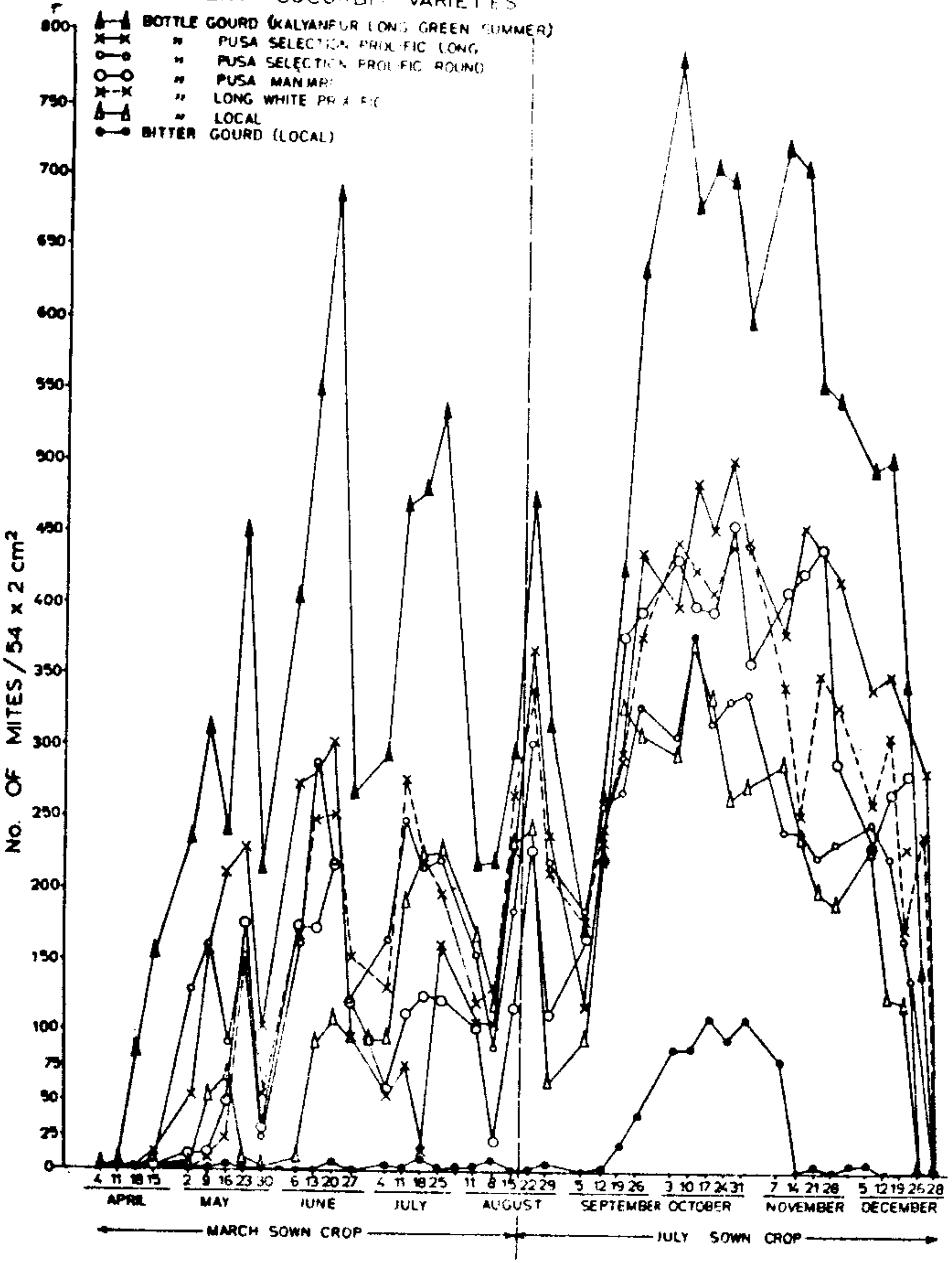
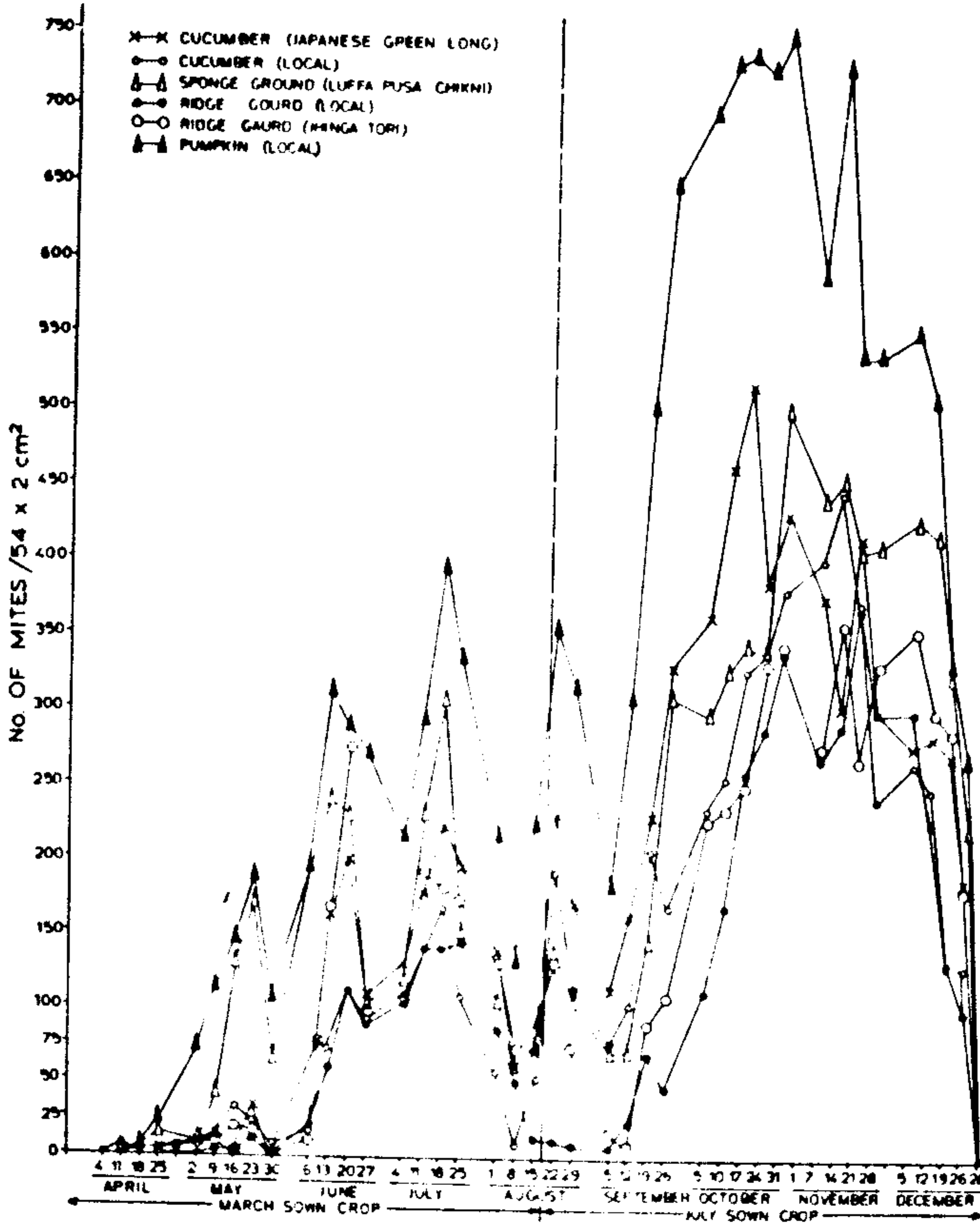


FIG. 4 (B)



CUCUMBER (JAPANESE GREEN LONG)
CUCUMBER (LOCAL)
SPONGE GROUND (LUFFA PUSA CHIKNI)
RIDGE GOURD (LOCAL)
RIDGE GAURD (JHINGA TORI)
PUMPKIN (LOCAL)
No. OF MITES /54 x 2 cm²
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
MARCH SOWN CROP
JULY SOWN CROP

sub-heading "Effect of rain on the reduction of mite population." After the first week of July no rains occurred for the next three weeks and thus the population reached to a moderate level by the end of July. The rains reduced the population again in the first week of August.

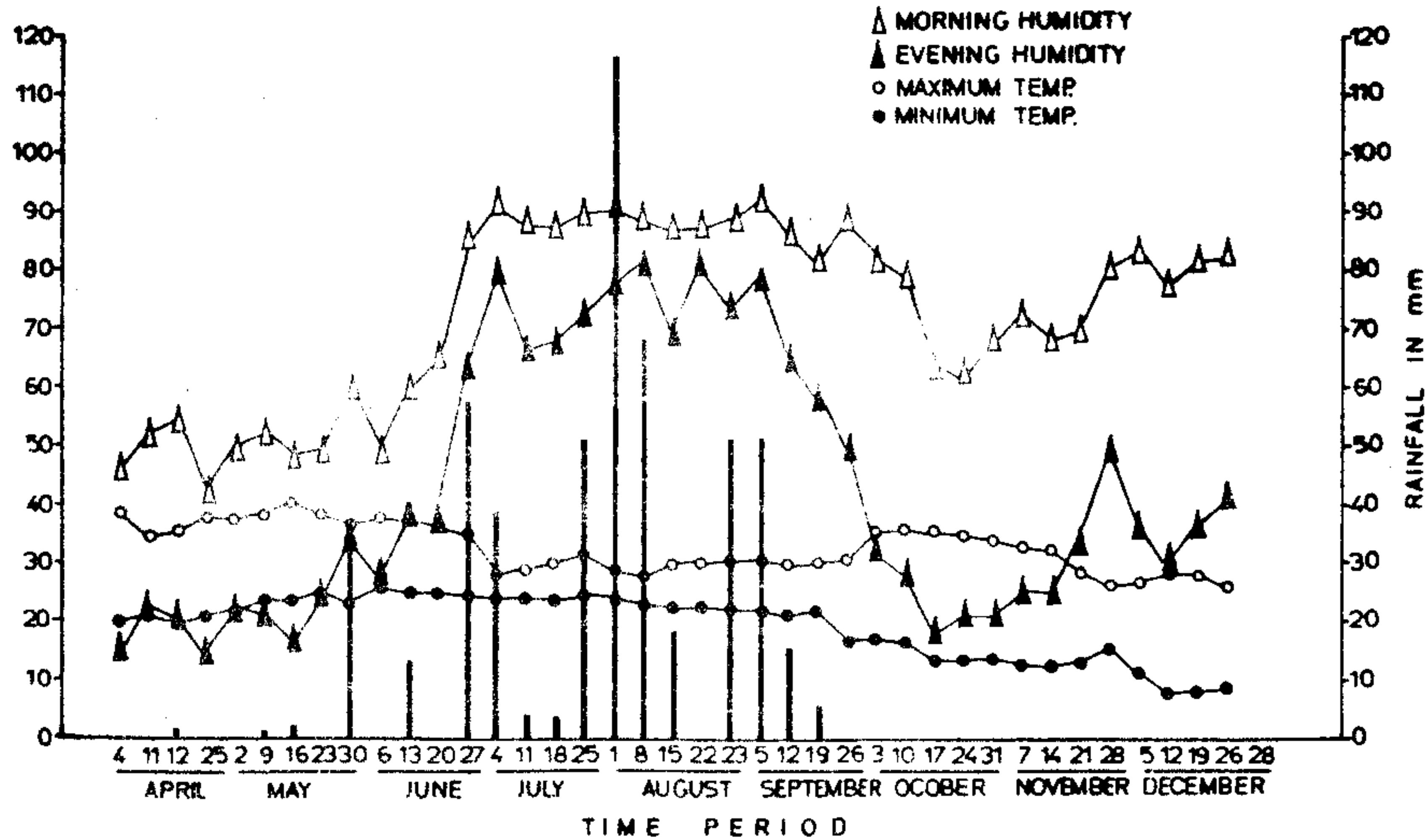
When the first observation on July sown crops was taken in the third week of August, a substantial increase in the population was recorded because there were no rains from 9th to 21st August (past two weeks) and high temperature and high relative humidity (Table 5; Fig.5) were prevailing, which are known to be conducive to the population build up of the mites. Thereafter, the population continued to increase and its peak was recorded during October-November. The population after attaining peak started decreasing abruptly perhaps due to the fall in temperature and relative humidity. By the end of December, plants could not survive due to frost and so also the mite population was affected.

This trend of population fluctuations as influenced by climatic factors, in general, remained almost the same on all the varieties. However, some variations were observed as regards attaining the maxima on different varieties.

TABLE 5. Weekly weather record during seasonal incidence of the pest

| Month and date | | Average temp. (°C) | | Average humidity (%) | | Total rainfall (mm) |
|---|---|---|---|---|---|---|
| | | Max. | Min. | 730 hrs | 1430 hrs | |
| April | 4 | 38.1 | 19.1 | 46 | 15 | - |
| | 11 | 33.8 | 20.5 | 52 | 23 | - |
| | 18 | 34.2 | 18.9 | 54 | 20 | 1.2 |
| | 25 | 37.1 | 20.0 | 42 | 14 | - |
| May | 2 | 36.7 | 21.2 | 49 | 23 | - |
| | 9 | 37.2 | 23.0 | 52 | 21 | 1.2 |
| | 16 | 39.7 | 22.9 | 48 | 16 | 2.2 |
| | 23 | 38.0 | 25.2 | 49 | 24 | - |
| | 30 | 36.1 | 22.6 | 60 | 34 | 32.7 |
| June | 6 | 37.3 | 25.9 | 49 | 27 | - |
| | 13 | 36.0 | 24.3 | 60 | 37 | 13.0 |
| | 20 | 36.1 | 24.6 | 65 | 36 | 0.2 |
| | 27 | 34.1 | 24.0 | 85 | 63 | 57.2 |
| July | 4 | 27.6 | 23.4 | 91 | 80 | 38.9 |
| | 11 | 28.4 | 23.5 | 88 | 66 | 4.1 |
| | 18 | 29.6 | 23.4 | 87 | 67 | 3.4 |
| | 25 | 31.6 | 24.3 | 89 | 72 | 51.2 |
| August | 1 | 28.1 | 23.2 | 90 | 77 | 116.6 |
| | 9 | 27.4 | 22.6 | 88 | 81 | 68.2 |
| | 15 | 28.7 | 22.2 | 87 | 69 | 18.0 |
| | 22 | 29.3 | 22.7 | 87 | 81 | - |
| | 29 | 30.8 | 22.2 | 88 | 73 | 50.6 |
| September | 5 | 30.1 | 22.5 | 92 | 79 | 51.4 |
| | 12 | 29.1 | 20.5 | 86 | 64 | 15.8 |
| | 19 | 29.7 | 21.1 | 81 | 58 | 5.4 |
| | 26 | 30.3 | 17.3 | 89 | 50 | - |
| October | 3 | 34.2 | 17.3 | 81 | 32 | - |
| | 10 | 34.1 | 16.6 | 79 | 28 | - |
| | 17 | 34.8 | 13.6 | 63 | 18 | - |
| | 24 | 34.5 | 13.6 | 62 | 21 | - |
| | 31 | 34.1 | 13.4 | 68 | 21 | - |
| November | 7 | 32.8 | 12.3 | 72 | 25 | - |
| | 14 | 32.1 | 12.5 | 68 | 25 | - |
| | 21 | 28.5 | 12.8 | 69 | 33 | - |
| | 28 | 26.6 | 15.5 | 81 | 49 | - |
| December | 5 | 26.6 | 10.5 | 83 | 36 | - |
| | 12 | 27.6 | 7.7 | 77 | 30 | - |
| | 19 | 27.9 | 7.9 | 81 | 36 | - |
| | 26 | 25.9 | 7.9 | 82 | 41 | - |
| | 28 | 25.3 | 1.2 | 80 | 54 | - |

FIG.5 WEEKLY WEATHER RECORD OF AVERAGE MAX, MIN. TEMPERATURE, AVERAGE MORNING, AFTERNOON RELATIVE HUMIDITY AND TOTAL RAINFALL



In March sown crops, the peak period of their activity was recorded in June on the varieties, viz. Kalyanpur long green (summer), Pusa selection prolific round, Pusa manjari, Long white prolific and Local varieties of bottle gourd, and Luffa Pusa chikni of sponge gourd and Jhinga tori of ridge gourd; on the remaining crops the maximum numbers were obtainable in the month of July. In July sown crops, the maximum numbers were recorded in October on Kalyanpur long green (summer), Pusa selection prolific long, Pusa selection prolific round, Pusa manjari, Long white prolific and Local varieties of bottle gourd, cucumber (Japanese long green), sponge gourd (Luffa Pusa chikni), pumpkin (Local), and bitter gourd (Local); while in case of cucumber (Local) and ridge gourd (Jhinga tori) the maxima were observed in November.

Some of the factors which may be supposed to be of importance in determining the seasonal fluctuations have been discussed in the following account.

It would be worthwhile to mention first the conclusions reported by earlier workers. Rahman and Sapra (1945) found maximum numbers of Tetranychus cucurbitae in June and November and their low population in between these months. They further attributed this decline in the population to rains. Bharodia and Talati (1976a) also recorded maximum population of T. neocaledonicus in November and observed a decline in December and thereafter. Thus, the maxima recorded in the present investigation are in agreement with the findings of these workers.

The high egg population during rainy season recorded in the present investigation was due to the fact that they are less prone to the dislodgement by rains (Appendix I). This observation is in conformity with the work of Sandhu et al. (1975). Their more numbers during winter may be attributed to low percentage hatchability and prolonged incubation period.

In the present investigation high population was recorded in summer months. Srivastava and Mathur (1962) have reported T. telarius to undergo aestivation which is contrary to the present findings. Several other workers, however, lend support to their maximum activity in summer months (Gupta et al., 1972; Som Choudhury and Mukherjee, 1971; Pande and Yadava, 1976b).

It seems to have been widely accepted that the climatic factors are mainly responsible for population fluctuations. During the month of May, when temperature was high and relative humidity low, the population did not show any appreciable increase. In June, the temperature was as high as during May, but due to comparatively more relative humidity the population reached its peak. It shows that high temperature and moderately high humidity are more favourable for population build up than the high temperature and low relative humidity. The peaks observed in October and November confirm this conclusion. The decline in the population in December suggests that the low temperature and high humidity are not conducive to the population build up of the mite species. The favourable effect of high temperature and high humidity in the population build up is upset by heavy rains which destroy considerable number of immatures and adults.

In order to determine the effect of maximum temperature and relative humidity on the mite population it was considered befitting to correlate these factors with the population increase. In order to arrive at reasonably correct conclusions, it was considered necessary to pool the stage-wise population of the mites infesting different varieties of each cucurbit species and then testing them for correlation with maximum temperature and relative humidity. From the data presented in Table 6, it is evident that the population build up on ridge gourd showed highly significant correlation with maximum temperature. Same was found true in case of bottle gourd. In case of cucumber population build up of eggs and immatures was significantly correlated with maximum temperature, while adults and total population did not exhibit any significant correlation with it. The population of the eggs on pumpkin was found significantly correlated with maximum temperature, while the other stages did not exhibit any significant correlation.

When the population build up was correlated with the relative humidity the results were almost similar in effect to that of high temperature. The difference was, however, recorded in case of cucumber in which the highly significant correlationship was established between increase in individual stages of mite as well as the total population and high relative humidity.

The rainfall and minimum temperature decreased the mite population and hence it was felt justifiable to correlate them. It is evident from the data presented in

TABLE 6. Correlation (r) between increase in population of eggs (e), immatures (i), adults (a), and total(t) with average maximum temperature(M) and relative humidity (H)

| Crops | No. of observations | $r_{eM}$ | $r_{iM}$ | $r_{aM}$ | $r_{tM}$ |
|---|---|---|---|---|---|
| | | Maximum temperature | | | |
| Pumpkin | 8 | 0.747* | 0.437 | 0.377 | 0.073 |
| Ridge gourd | 24 | 0.760** | 0.531** | 0.604** | 0.447* |
| Cucumber | 16 | 0.533* | 0.514* | 0.435 | 0.490 |
| Bottle gourd | 48 | 0.523** | 0.553** | 0.554** | 0.404** |
| | | $r_{eH}$ | $r_{iH}$ | $r_{aH}$ | $r_{tH}$ |
| | | Maximum humidity | | | |
| Pumpkin | 8 | 0.796* | 0.675 | 0.549 | 0.236 |
| Ridge gourd | 24 | 0.726** | 0.656** | 0.577** | 0.461* |
| Cucumber | 16 | 0.755** | 0.748** | 0.574* | 0.651** |
| Bottle gourd | 48 | 0.570** | 0.515** | 0.505** | 0.415** |

* Significant at 5 per cent level
** Significant at 1 per cent level

TABLE 7. Correlation (r) between decrease in population of eggs (e), immatures (i), adults (a), and total(t) with average minimum temperature (M) and total amount of rainfall (R)

| Crops | No.of observations | $r_{eR}$ | $r_{iR}$ | $r_{aR}$ | $r_{tR}$ |
|---|---|---|---|---|---|
| | | Amount of rainfall | | | |
| Pumpkin | 4 | 0.915 | 0.976* | -0.665 | 0.908 |
| Ridge gourd | 12 | 0.810** | 0.428 | 0.167 | 0.625* |
| Cucumber | 8 | 0.778* | 0.541 | 0.572 | 0.453 |
| Bottle gourd | 24 | 0.705** | 0.045 | 0.086 | 0.175 |

| | | $r_{eM}$ | $r_{iM}$ | $r_{aM}$ | $r_{tM}$ |
|---|---|---|---|---|---|
| | | Minimum temperature | | | |
| Pumpkin | 4 | 0.468 | 0.481 | -0.446 | -0.834 |
| Ridge gourd | 12 | 0.450 | 0.436 | 0.585* | 0.326 |
| Cucumber | 8 | 0.918** | 0.656 | 0.599 | 0.799* |
| Bottle gourd | 25 | 0.401* | @0.578** | 0.726** | 0.484* |

* Significant at 5 per cent level

** Significant at 1 per cent level

@ Number of observations 24 in this case

Table 7 that with the increase in amount of rainfall decrease in egg population of ridge gourd and bottle gourd was found to increase at 1 per cent level of significance, while in case of cucumber this relationship proved to be significant only at 5 per cent level and no significant relationship could be found in case of pumpkin.

In case of immatures, this relationship was found to be significant in case of pumpkin only at the 5 per cent level of significance. In the adults no significant correlation was found with any of the crops. When the total population was taken into account this relationship was found to be significant in case of ridge gourd only. The decrease in mite population due to minimum temperature was found to increase significantly in case of the egg populations present on cucumber and bottle gourd, the immature populations in case of bottle gourd, and the adult populations in case of ridge gourd and bottle gourd. When the total population of mites was taken into account this correlation was found significant in case of cucumber and bottle gourd only.

In bitter gourd the correlation coefficient was not worked out due to the presence of extremely low mite population.

It can be concluded that abundance and seasonal fluctuations of the mite species are governed by the interaction of several factors which are often difficult to investigate separately. In the present investigation temperature, relative humidity, rainfall and food have had their considerable impact in this regard.

Varietal susceptibility

As already mentioned in the chapter on 'Material and Methods', 13 different varieties of cucurbits (bottle gourd, 6; ridge gourd, 2; sponge gourd, 1; cucumber, 2; pumpkin and bitter gourd, 1 each) were grown on the Horticulture Farm of the College, and the population of the mites infesting them were recorded at weekly intervals. The two sets of crops were grown during the period from beginning of March to December, 1977. The first set of crops were sown on 4th March and harvested on 15th August and the population counts were started from 4th April. Similarly, the second set of crops was sown on 20th July, and continued till 26th December when suddenly with the impact of the frost, plants shrivelled to death. On the second set of crops, observations started on 22nd August (after a month of sowing). The data thus recorded during the period were plotted on the graph (Fig. 4 A,B) and the population peaks derived in this manner were taken into account to determine the susceptibility of the host. Those varieties which harboured highest population of eggs, immatures or adults at any stage of growth and development of plants were included to find out the susceptibility. The highest populations of different stages were recorded during both the crop seasons. These data were then subjected to analysis of variance and critical difference, calculated at 5 per cent level of significance, was employed to compare the total population means (Table 8). It is evident from the data presented in Table 8 that two varieties, viz. pumpkin (Local) and bottle gourd (Kalyanpur long green, summer) sustained maximum mean population, being respectively 251 and 261 per 18 x 2 $cm^2$ leaf area. Next in order of significance were sponge gourd (Luffa pusa chikni), cucumber (Japanese long green) and bottle gourd (Pusa selection prolific long), harbouring a mean population of 167 to 173 mites per 18 x 2 $cm^2$ leaf area. However, bitter gourd, a local variety, harboured a meagre population, being only 36 per 18 x 2 $cm^2$. Among the cucurbits, thus, pumpkin (Local) which had hairy and broad leaves and bottle gourd (Kalyanpur long green, summer) with smooth and broad leaves were almost equally susceptible. The external characters of the leaf,

TABLE 8. Mean population of different stages of *T. neocaledonicus* on various cucurbits

| Crops/varieties | Eggs | Immatures | Adults | Total |
|---|---|---|---|---|
| Bottle gourd | | | | |
| Kalyanpur long green summer | 84.00 | 101.33 | 98.67 | 261.00 |
| Pusa selection prolific long | 57.67 | 61.66 | 65.00 | 167.67 |
| Pusa selection prolific round | 51.67 | 45.67 | 44.33 | 126.67 |
| Pusa manjari | 51.67 | 60.67 | 54.67 | 152.67 |
| Long white prolific | 56.33 | 55.00 | 53.67 | 149.00 |
| Local | 36.33 | 46.33 | 44.00 | 125.67 |
| Cucumber | | | | |
| Japanese long green | 50.33 | 62.33 | 60.67 | 173.33 |
| Local | 45.00 | 51.67 | 60.00 | 149.67 |
| Sponge gourd | | | | |
| Luffa pusa chikni | 57.67 | 63.33 | 62.33 | 168.67 |
| Ridge gourd | | | | |
| Local | 44.33 | 51.33 | 50.67 | 125.00 |
| Jhinga tori | 45.33 | 44.67 | 48.33 | 120.67 |
| Pumpkin | | | | |
| Local | 82.00 | 110.00 | 97.67 | 251.67 |
| Bitter gourd | | | | |
| Local | 26.00 | 11.33 | 9.33 | 36.67 |
| SEm ± | 4.9822 | 4.7465 | 4.4034 | 6.9930 |
| CD at 5% | 14.5429 | 13.8550 | 12.8534 | 20.4123 |
| CD at 1% | 19.7076 | 18.7751 | 17.4177 | 27.6614 |

however, do not seem to have any bearing on the susceptibility. The nitrogen content of the leaves of different varieties of cucurbits also support these results with regard to susceptibility discussed above on the basis of population they sustained (Table 9).

A significant correlation was found between the nitrogen content and the population of the mites(Table 10). Bitter gourd (Local) and ridge gourd (Local) supporting meagre population of pest were also found to contain about 1 per cent nitrogen as against the susceptible hosts like bottle gourd (Pusa selection prolific long, Kalyanpur long green, summer and Local), pumpkin (Local) and sponge gourd (Luffa pusa chikni), which had more than 2 per cent nitrogen content in their leaves. However, ridge gourd (Jhinga tori) supporting almost equivalent mite population to that of ridge gourd (Local) contained about 2.2 per cent nitrogen which is contrary to the results interpreted above. It is difficult to explain this lone exception on any experimental evidence, but can only be explained if the work is extended to other different varieties to precisely explain the relationship derived herein. These results are in agreement with the findings of previous authors (Hamstead, 1957; Henneberry, 1962) who also worked on Tetranychid mites.

TABLE 9. Analysis of N,P,K contents of 13 cucurbit varieties

| Crops/varieties | Mean percentage | | |
|---|---|---|---|
| | N | P | K |
| Bottle gourd | | | |
| Kalyanpur long green, summer | 2.242 | 0.467 | 3.733 |
| Pusa selection prolific long | 2.300 | 0.271 | 4.033 |
| Pusa selection prolific round | 1.625 | 0.196 | 1.033 |
| Pusa manjari | 1.867 | 0.252 | 4.067 |
| Long white prolific | 1.517 | 0.317 | 3.033 |
| Local | 2.117 | 0.196 | 4.133 |
| Cucumber | | | |
| Japanese long green | 1.950 | 0.187 | 0.967 |
| Local | 1.575 | 0.308 | 2.933 |
| Sponge gourd | | | |
| Luffa pusa chikni | 2.167 | 0.345 | 3.333 |
| Ridge gourd | | | |
| Local | 0.967 | 0.401 | 3.100 |
| Jhinga tori | 2.250 | 0.532 | 2.067 |
| Pumpkin | | | |
| Local | 2.175 | 0.317 | 3.167 |
| Bitter gourd | | | |
| Local | 0.925 | 0.289 | 3.833 |
| SEm ± | 0.1292 | 0.0447 | 0.1414 |
| CD at 5% | 0.3771 | 0.1305 | 0.4127 |
| CD at 1% | 0.5111 | 0.1768 | 0.5593 |

Potash and phosphorus contents of the leaves of different varieties ranged between 1.033-4.133 and 0.187-0.532 respectively. These two major nutrients did not bear any significant correlation with mite population as is evident from Table 10. The correlation coefficients were not significant even at 5 per cent level, however, they were found to be positively correlated with the mite population increase. Both bitter gourd (Local) and ridge gourd (Local) have been found to sustain quite low population of mites and as such their phosphorus and potash contents should also have been reasonably low. The phosphorus and potash contents of bitter gourd (Local) and ridge gourd (Local) were 0.29 and 3.8 and 0.401 and 3.1 respectively. This is, thus, evident from the Table 10 that no significant correlation exists between the potash and phosphorus contents of the leaves for the mite population.

TABLE 10. Correlation between N,P,K contents and maximum number of eggs and total population of _T. neocaledonicus_

| Nutrients | No.of observations | Eggs | Total population |
|---|---|---|---|
| N | 13 | 0.567* | 0.647* |
| P | 13 | 0.282 | 0.195 |
| K | 13 | 0.211 | 0.034 |

* Significant at 5 per cent level

## Natural enemies

At the time of studying the seasonal incidence of *T. neocaledonicus* on the 13 cucurbit varieties, the natural enemies of the pest species were also recorded. Though no parasite was recorded, a number of predators were found predating on the pest species (Table 11) but their population remained low throughout the crop season and did not exercise an effective role in checking the pest population.

TABLE 11. Predators found predating on *T. neocaledonicus*

| Predator species | Period of availability on cucurbits |
|---|---|
| Family Coccinellidae | |
| *Menochilus sexmaculatus* Fabr. | May-June |
| *Rodolia* sp. | May-June |
| *Stethorus* sp. | June-Oct. |
| *Illies cincta* Fabr. | June-July |
| *Chilocores* sp. | May-June-Oct. |
| *Brumus sataralis* Fabr. | May-June-Oct. |
| Family Phytoseiidae | |
| *Amblyseius* sp. | May-June-Oct. |
| *Phytoseius* sp. | May-Sept.-Oct. |

Some of these predators have been recorded feeding on the mites belonging to Family Tetranychidae (Rawat and Modi, 1969**b**; Sandhu *et al.*, 1973). Gupta *et al.* (1971)

reported *Amblyseius hibisei* Chant feeding upon *T. cucurbitae* infesting cotton. Chazeau (1974) reported *Stethorus madecassus* from Madagascar as an effective predator of *T. neocaledonicus*. Osman and Zohdi (1976) found this mite species predated by *A. gossipi* El-Badry.

The predators recorded in the present investigation are being reported for the first time on *T. neocaledonicus* infesting cucurbits.

## Effect of rain on the reduction of mite population

The data presented in Table 12 clearly indicate that different amounts of rainfall reduced the mite population considerably. From the data of various amounts of rains, it can be inferred that more number of the adults were dislodged in comparison to the immatures while the eggs were found to be most resistant to dislodging. This is quite logical for the eggs are glued on the plant surface. The adults are more mobile than the immatures and moreover, they are mostly located in the periphery of the web. These factors seem to have contributed to susceptibility of the adults to dislodging than the immatures. However, a slight increase in the egg population on ridge gourd (Local) and pumpkin (Local) was recorded after 11.2 mm rainfall. This increase may be due to the presence of more gravid females which laid the eggs and added to their number. Perhaps the environment created after the rain might have been more conducive to oviposition on these hosts. Sandhu *et al*. (1975) also recorded an increase in the total population of *Oligonychus indicus* on some varieties of maize due to the rains. Dislodgement of more immatures than the adults in ridge gourd (Local) after 11.2 mm rainfall, and bottle gourd (Kalyanpur long green, summer) after 36.0 mm rainfall (Table 12) is difficult to explain on any experimental evidence. Similarly in case of cucumber (Japanese long green) with 20.6 mm rainfall (Table 12) more eggs were recorded to have been dislodged than the immatures. Such exceptions are bound to occur under natural conditions and to explain such intricacies, experiments will have to be conducted under severely controlled conditions enabling to record the changes more precisely.

The amount of rainfall had a pronounced effect on the dislodgement of the mite population. Barring a few exceptions the reduction was the least with 11.2 mm rainfall and the maximum with 36.0 mm rainfall. Almost the same trend was observed on individual stages of the species. However, the amount of rainfall cannot be claimed to be the sole parameter exclusively responsible for the dislodgement of mites. As a general trend, more population

TABLE 12. Effect of rain on the population of *T. neocaledonicus* on different cucurbits (Mean numbers/54 x 2 cm²)

| Varieties | Eggs | | | Immatures | | | Adults | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | BR | AR | % | BR | AR | % | BR | AR | % | BR | AR | % |
| | | | | | **11.2 mm rainfall** | | | | | | | |
| 1 | 142 | 110 | 22.53 | 195 | 114 | 41.54 | 212 | 106 | 50.00 | 549 | 330 | 39.89 |
| 2 | 65 | 49 | 24.61 | 91 | 46 | 49.45 | 127 | 53 | 58.27 | 283 | 148 | 47.70 |
| 3 | 75 | 57 | 24.00 | 87 | 46 | 47.13 | 128 | 56 | 56.25 | 290 | 159 | 45.17 |
| 4 | 44 | 30 | 31.82 | 74 | 32 | 56.76 | 55 | 22 | 60.00 | 173 | 84 | 51.44 |
| 5 | 50 | 39 | 22.00 | 83 | 42 | 49.40 | 117 | 45 | 61.54 | 250 | 126 | 49.60 |
| 6 | 23 | 15 | 34.78 | 30 | 11 | 63.33 | 39 | 13 | 66.67 | 92 | 39 | 57.61 |
| 7 | 36 | 40 | +11.11 | 52 | 24 | 53.85 | 75 | 31 | 58.67 | 163 | 95 | 41.72 |
| 8 | 18 | 18 | 0.00 | 24 | 12 | 50.00 | 31 | 11 | 64.52 | 73 | 41 | 43.83 |
| 9 | 55 | 46 | 16.36 | 77 | 47 | 38.96 | 108 | 53 | 50.92 | 240 | 146 | 39.17 |
| 10 | 12 | 13 | +8.33 | 20 | 9 | 55.00 | 29 | 14 | 51.72 | 61 | 36 | 40.98 |
| 11 | 37 | 28 | 24.32 | 54 | 35 | 35.19 | 77 | 38 | 50.65 | 168 | 101 | 39.88 |
| 12 | 88 | 91 | +3.14 | 120 | 92 | 23.33 | 107 | 69 | 35.51 | 315 | 252 | 20.00 |
| 13 | | | | | No population | | | | | | | |
| | | | | | **19.0 mm rainfall** | | | | | | | |
| 1 | 77 | 56 | 27.27 | 100 | 42 | 58.00 | 42 | 11 | 73.81 | 219 | 109 | 50.23 |
| 2 | 35 | 24 | 31.43 | 44 | 11 | 75.00 | 26 | 5 | 80.77 | 105 | 40 | 61.90 |
| 3 | 80 | 57 | 28.75 | 7 | 1 | 85.71 | 4 | 0 | 100.0 | 91 | 58 | 36.26 |
| 4 | 6 | 6 | 100.0 | 14 | 3 | 78.57 | 2 | 0 | 100.0 | 22 | 9 | 59.09 |
| 5 | 53 | 39 | 26.42 | 42 | 15 | 64.29 | 37 | 7 | 81.08 | 132 | 61 | 53.79 |

Contd.......

Table 12 continued

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6 | 42 | 34 | 19.05 | 48 | 20 | 58.33 | 28 | 8 | 71.43 | 118 | 62 | 47.46 |
| 7 | 21 | 18 | 14.29 | 27 | 9 | 66.67 | 16 | 4 | 75.00 | 64 | 31 | 51.56 |
| 8 | 5 | 6 | +20.00 | 2 | 0 | 100.0 | 4 | 0 | 100.0 | 11 | 6 | 45.45 |
| 9 | 20 | 16 | 20.00 | 30 | 9 | 70.00 | 12 | 3 | 75.00 | 62 | 28 | 54.84 |
| 10 | 19 | 16 | 15.79 | 22 | 8 | 63.64 | 13 | 4 | 69.23 | 54 | 28 | 48.15 |
| 11 | 28 | 20 | 28.57 | 27 | 10 | 62.96 | 19 | 6 | 68.42 | 74 | 36 | 51.35 |
| 12 | 54 | 56 | +3.70 | 31 | 13 | 58.06 | 50 | 21 | 58.00 | 135 | 90 | 33.33 |
| 13 | 2 | 2 | 0.00 | 4 | 0 | 100.0 | 2 | 1 | 50.00 | 8 | 3 | 62.50 |

20.6 mm rainfall

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 150 | 112 | 25.33 | 209 | 110 | 47.37 | 178 | 62 | 65.17 | 537 | 284 | 47.11 |
| 2 | 49 | 32 | 34.69 | 47 | 24 | 48.94 | 65 | 25 | 61.54 | 161 | 81 | 49.69 |
| 3 | 84 | 63 | 25.00 | 82 | 39 | 52.44 | 56 | 17 | 69.64 | 222 | 119 | 46.40 |
| 4 | 37 | 22 | 40.54 | 44 | 18 | 59.09 | 41 | 15 | 63.41 | 122 | 55 | 54.92 |
| 5 | 99 | 75 | 24.24 | 64 | 31 | 51.56 | 33 | 12 | 63.64 | 196 | 118 | 39.80 |
| 6 | 73 | 49 | 32.88 | 73 | 30 | 58.90 | 82 | 32 | 60.98 | 228 | 111 | 51.32 |
| 7 | 51 | 18 | 64.71 | 59 | 25 | 57.63 | 87 | 24 | 72.41 | 197 | 67 | 65.99 |
| 8 | 35 | 27 | 22.86 | 36 | 19 | 47.22 | 40 | 13 | 67.50 | 111 | 59 | 46.85 |
| 9 | 29 | 22 | 24.14 | 57 | 30 | 47.37 | 65 | 25 | 61.54 | 151 | 77 | 49.01 |
| 10 | 47 | 42 | 10.64 | 47 | 24 | 48.94 | 53 | 22 | 58.49 | 147 | 88 | 40.14 |
| 11 | 49 | 36 | 26.53 | 58 | 29 | 50.00 | 55 | 27 | 50.91 | 162 | 92 | 43.21 |
| 12 | 118 | 100 | 15.25 | 128 | 70 | 45.31 | 91 | 48 | 47.25 | 337 | 218 | 35.31 |
| 13 | 5 | 0 | 100.0 | 0 | 0 | 0.00 | 1 | 0 | 100.0 | 6 | 0 | 100.0 |

Contd........

Table 12 continued

36.0 mm rainfall

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 67 | 28 | 58.21 | 78 | 23 | 70.51 | 73 | 9 | 87.67 | 218 | 60 | 72.48 |
| 2 | 32 | 12 | 62.50 | 61 | 19 | 68.85 | 13 | 2 | 84.62 | 106 | 33 | 68.87 |
| 3 | 65 | 22 | 66.15 | 71 | 14 | 80.28 | 19 | 11 | 42.11 | 151 | 47 | 69.68 |
| 4 | 45 | 13 | 71.11 | 46 | 10 | 78.26 | 12 | 0 | 100.0 | 103 | 23 | 77.67 |
| 5 | 48 | 22 | 54.17 | 54 | 13 | 75.93 | 17 | 2 | 88.24 | 119 | 37 | 68.91 |
| 6 | 61 | 25 | 59.02 | 59 | 15 | 74.58 | 47 | 2 | 95.74 | 167 | 42 | 74.85 |
| 7 | 37 | 18 | 51.35 | 67 | 14 | 79.10 | 38 | 0 | 100.0 | 142 | 32 | 77.46 |
| 8 | 22 | 8 | 63.64 | 30 | 5 | 83.33 | 8 | 0 | 100.0 | 60 | 13 | 78.33 |
| 9 | 13 | 6 | 53.85 | 72 | 16 | 77.78 | 21 | 4 | 80.95 | 160 | 26 | 75.47 |
| 10 | 37 | 18 | 51.35 | 38 | 8 | 78.95 | 13 | 1 | 92.31 | 88 | 27 | 69.32 |
| 11 | 59 | 32 | 45.76 | 49 | 15 | 69.39 | 28 | 4 | 85.71 | 136 | 51 | 62.50 |
| 12 | 99 | 56 | 43.43 | 83 | 26 | 68.67 | 38 | 11 | 71.05 | 220 | 93 | 57.73 |
| 13 | | | | | No population | | | | | | | |

Note: BR, before rain; AR, after rain; %, percent reduction; 1, bottle gourd: Kalyanpur long green, summer ; 2, Pusa selection prolific,long; 3, Pusa selection prolific, round; 4, Pusa manjari; 5, Long white prolific; 6, Local; 7,cucumber: Japanese long green; 8, Local; 9, sponge gourd: Luffa pusa chikni; 10, ridge gourd: Local; 11, Jhinga tori; 12, pumpkin: Local; 13, bitter gourd: Local.

\+ Increase in population

was recorded to be dislodged with 19.0 mm rainfall than with 20.6 mm, suggesting that other factors such as intensity of rain and the wind velocity might have been the contributing factors in the reduction of the mite population.

Contrary to our expectations, a varied response of the mite population to different varieties was observed with differing amounts of rainfall. Most probably, the morphological characters of the plant, particularly of the leaf which might have played important role in influencing the effectivity of rain on the mite population. Pumpkin (Local), which has broad, large, hard and hairy leaf surface (Table 13) was found to be most resistant to all the differing amounts of rain under study. This observation confirms the earlier findings of Khanna and Ramnathan (1947), who suggested that the presence of stomatal groove and the spinous outgrowth may afford suitable shelter for the mite; and the sugarcane variety with these characters may be resistant to dislodging due to rain. The mite population on bottle gourd (the leaves of which are smooth and non-hairy) was recorded to be more susceptible to rain than the pumpkin in the present study. This finding is in general agreement with Rahman and Sapra (1940), who reported that soft-leaved varieties of sugarcane were more susceptible. The mite population on cucumber and ridge gourd which have rough leaf surface (neither smooth as in case of bottle gourd nor hairy

TABLE 13. Morphological characters of different cucurbit varieties

| Vari-eties | Leaf size | Leaf surface | Fruits | Stem | Length of vines |
|---|---|---|---|---|---|
| 1 | Broad, large | Smooth | Long | Tender, smooth | More |
| 2 | Broad, large | Smooth | Long | Tender, smooth | More |
| 3 | Broad, large | Smooth | Round | Tender, smooth | More |
| 4 | Broad, large | Smooth | Round | Tender, smooth | More |
| 5 | Broad, large | Smooth | Long | Tender, smooth | More |
| 6 | Broad, large | Smooth | Long | Tender, smooth | More |
| 7 | Medium | Rough | Medium long | Tender, rough hairy | Medium |
| 8 | Medium | Rough | Medium long | -do- | Medium |
| 9 | Broad, large | Rough | Medium long | -do- | More |
| 10 | Broad, large | Rough | Medium long, (rough) | Tender, more rough hairy | More |
| 11 | Broad, large | Rough | Medium rough | Tender, more rough hairy | More |
| 12 | Broad, large | Hairy | Round | Tender, semihard hairs | More |
| 13 | Small | Smooth | Small, long | Tender, smooth | Shrubby |

Note: 1, Bottle gourd: Kalyanpur long green, summer; 2, Pusa selection prolific, long; 3, Pusa selection prolific, round; 4, Pusa manjari; 5, Long white prolific; 6, Local; 7, cucumber: Japanese long green; 8, Local; 9, sponge gourd: Luffa pusa chikni; 10, ridge gourd:Local; 11, Jhinga tori; 12, pumpkin: Local; 13, bitter gourd: Local.

as in case of pumpkin) and medium hard leaves (contrary to the leaves of bottle gourd which are tender, and pumpkin leaves which are hard) were generally found to be moderately susceptible to dislodgement due to rains. However, a wide range of susceptibility in relation to rain was recorded among the varieties of the same cucurbit species which is difficult to interpret on the basis of available morphological characters of individual varieties (Table 13).

The present findings are not in agreement with the general belief that the population change due to rain would affect a particular parameter on all the varieties and should serve as a point of caution for making such presumptions. Similar views have been expressed earlier by Sandhu et al. (1975) after studying the effect of rain on Oligonychus indicus on different varieties of maize.

Dislodgement of mites due to rain should be more so far as the ventral (upper) surface of the leaves is concerned in comparison to the dorsal (lower) surface. It would be worth while to point out here that the dislodgement of the cucurbit mite has been to a much lesser degree in view of the fact that it remains almost exclusively confined to the lower surface, which is an effective shelter for it.

Effects of wind on the reduction of the mite population

It is evident from the data presented in Table 14 that the wind contributes its mite in the dislodgement of mites. On pumpkin no significant differences were observed when mites were exposed to dislodgement studies at the wind speeds of 6.4 and 10.8 km/hr, however, at the latter wind velocity more number of mites were dislodged. The other wind velocities significantly dislodged the mite population. However, their extent of significance varied among each other. The differences between the wind velocities of 10.8 and 19.8 km/hr were found to be significant only at 5 per cent level while the remaining treatments proved to be highly significant among each other (at 1 per cent level). Unlike pumpkin, the mite (adults) dislodgement on bottle gourd differed significantly with 10.8 km/hr wind as compared to the control (6.4 km/hr). Rest of the treatments, as in case of pumpkin, differed significantly.

With the increase in wind velocity, dislodgement of mites also increased significantly and both hosts followed the same trend. However, among all the treatments, dislodgment of adult mites was recorded to be more on bottle gourd as compared to pumpkin. This may have relevance to the morphological characters of the leaf. The leaves of pumpkin

TABLE 14. Effect of wind on the reduction of the adult mites (*T. neocaledonicus*)

| Treatment (wind velocity) | Pumpkin (Local) | | Bottle gourd (Kalyanpur long green, summer) | |
|---|---|---|---|---|
| | Mean population per leaf | Percentage reduction | Mean population per leaf | Percentage reduction |
| 10.8 km/hr (3 m/second) | 98.47 | 1.53 | 97.43 | 2.57 |
| 19.8 km/hr (5.5 m/second) | 97.03 | 2.97 | 95.57 | 4.43 |
| 25.2 km/hr (7.0 m/second) | 95.27 | 4.73 | 92.27 | 7.73 |
| 30.6 km/hr (8.5 m/second) | 93.27 | 6.73 | 89.47 | 10.53 |
| 34.2 km/hr (9.5 m/second) | 89.63 | 10.37 | 84.97 | 15.03 |
| 37.8 km/hr (10.5 m/second) | 85.53 | 14.47 | 78.07 | 21.93 |
| 6.4 km/hr (Control) | 99.43 | 0.57 | 99.30 | 0.70 |
| SEm ± | 0.50 | | 0.6416 | |
| CD at 5% | 1.3859 | | 1.7784 | |
| CD at 1% | 1.8214 | | 2.3372 | |

and so the mites cannot sustain the pull of the winds on such smooth surfaces.

being hard and hairy provide niches for the mites to guard themselves from the forceful dislodging winds, while on the smooth surfaces of bottle gourd leaves winds act more freely and so the mites cannot sustain the pull of the winds on such smooth surfaces.

Due to these morphological characters, the low speed wind might not be able to dislodge the mites appreciably. Perhaps this may be one of the factors responsible for non-significant differences observed between 6.4 and 10.8 km/hr in case of pumpkin leaves.

The present investigations revealed that winds play an important role in the dislodgement of natural population of mites and that the extent of dislodgement is governed by the intensity of wind and morphological characters of the leaves of the host plant. On the basis of behaviouristic studies it may be suggested that the eggs which remain attached to the plant surface will be prone to a greater extent and that the immatures which remain inside the web will be comparatively resistant to dislodgement as compared to the adults.

While making dislodgement presumptions due to wind the side of the leaf will also have to be taken into account as one of the key factors. Unlike in the present studies, mites inhabiting ventral (upper) surface would be more liable to the removal by wind. The spread of plants may be another contributing factor. Thus, the vines spread on the soil surface may be less exposed to winds and the mites inhabiting them may be liable to dislodgement to a lesser degree as compared to mites inhabiting the plants which stand erect.

## Biology

Effect of food and temperature and humidity on the biology of the mite species: The biology of *T. neocaledonicus* was studied on five different varieties of cucurbits, *viz.* bottle gourd (Kalyanpur long green, summer), sponge gourd (Luffa pusa chikni), cucumber (Japanese long green), pumpkin (Local) and bitter gourd (Local) and the techniques used have been described under the chapter on 'Material and Methods'. The effect of biology on these hosts was studied under six constant temperatures, *viz.* 20°, 25°, 30°, 35°, 37° and 40°C ± 2°C in combination with two relative humidities, *viz.* 80±5 per cent and 50±5 per cent. At 40°C combined with both humidities the individual stages did not survive. At this temperature regimen the egg laying was observed but the eggs did not hatch.

Oviposition: The oviposition period (Table 15) was extremely variable at different temperatures and different foods. The oviposition period was found to be the shortest in case of bitter gourd (1.33 to 5.58 days), which was markedly different from the rest of the hosts. This period was usually found to be the longest in case of pumpkin (3.22 to 12.84 days) followed by bottle gourd (3.36 to 12.57 days). At 30° and 37°C with 50 per cent relative humidity, however, oviposition period was extended, being the longest on bottle gourd, followed by pumpkin.

With the increase in temperature, the oviposition period decreased. At 20°C and 80 per cent relative humidity, the oviposition period was recorded to be slightly lower than that obtained at 50 per cent in combination with the same temperature. At 25°C results of oviposition period compared at these two different humidity regimens did not show any definite increasing or decreasing trend. However, at higher temperatures (30°, 35° and 37°C) the oviposition period got extended in combination with more relative humidity.

TABLE 15. Oviposition and fecundity of *T. neocaledonicus*

| Host | Average oviposition period (in days) | | Fecundity (av.No.of eggs/ female) | |
|---|---|---|---|---|
| | 80% RH | 50% RH | 80% RH | 50% RH |
| | | Temperature at 20°C | | |
| Bottle gourd | 11.95 | 11.98 | 24.91 | 30.81 |
| Sponge gourd | 11.08 | 11.36 | 24.32 | 24.76 |
| Cucumber | 10.00 | 10.78 | 15.33 | 15.81 |
| Pumpkin | 12.45 | 12.12 | 26.53 | 33.51 |
| Bitter gourd | 4.79 | 3.55 | 11.00 | 12.83 |
| | | Temperature at 25°C | | |
| Bottle gourd | 12.57 | 11.41 | 48.32 | 44.18 |
| Sponge gourd | 11.12 | 11.83 | 34.31 | 40.97 |
| Cucumber | 11.00 | 10.36 | 20.33 | 22.86 |
| Pumpkin | 12.84 | 9.40 | 50.31 | 37.35 |
| Bitter gourd | 4.96 | 5.58 | 12.97 | 16.42 |
| | | Temperature at 30°C | | |
| Bottle gourd | 11.03 | 10.13 | 52.72 | 45.53 |
| Sponge gourd | 10.19 | 9.75 | 41.88 | 32.72 |
| Cucumber | 8.91 | 6.92 | 21.71 | 22.45 |
| Pumpkin | 11.33 | 8.17 | 53.97 | 40.66 |
| Bitter gourd | 2.89 | 2.41 | 15.21 | 10.94 |
| | | Temperature at 35°C | | |
| Bottle gourd | 5.83 | 3.66 | 38.86 | 39.36 |
| Sponge gourd | 4.08 | 3.65 | 38.14 | 23.94 |
| Cucumber | 3.80 | 3.33 | 23.64 | 19.26 |
| Pumpkin | 5.94 | 3.95 | 43.63 | 33.67 |
| Bitter gourd | 1.94 | 1.33 | 10.36 | 9.94 |
| | | Temperature at 37°C | | |
| Bottle gourd | 3.53 | 3.36 | 33.06 | 26.79 |
| Sponge gourd | 4.08 | 3.16 | 28.73 | 25.66 |
| Cucumber | 3.80 | 3.41 | 22.85 | 17.31 |
| Pumpkin | 4.47 | 3.22 | 37.63 | 24.06 |
| Bitter gourd | 2.03 | 2.42 | 10.14 | 11.21 |

On an average, the egg measured 0.115 mm in diameter. The eggs were spherical, smooth, deposited singly near the leaf veins. The freshly laid eggs were pale-yellowish and turned brownish before hatching. Prior to hatching the area along the periphery became transparent and two red coloured dots were clearly visible.

The fecundity was found to be the lowest on bitter gourd (9.94 to 16.42 eggs per female) at all the temperatures and relative humidities tested. The maximum number of eggs was recorded on pumpkin, at all the temperature regimens (20°, 25°, 30°, 35° and 37°C) but when these very regimens of temperature were combined with 50 per cent relative humidity, the number of eggs laid reduced considerably except at 20°C. However, at the temperature regimens with the exception of 20°C in combination with 50 per cent relative humidity, the maximum fecundity was observed on bottle gourd. Similarly, 20°C in combination with 80 per cent relative humidity produced a parallel effect. In general, fecundity increased with the increase in temperature (upto 30°C). However, at 35°C and 37°C, a decreasing trend in fecundity was observed.

At all the temperatures, except at 20°C, the fecundity was found to be lower when relative humidity was low

(50 per cent) than at higher relative humidity (80 per cent). The maximum fecundity was observed on pumpkin (53.97 per female) at 30°C in combination with 80 per cent relative humidity (Table 15).

Egg stage: The temperature and the relative humidity showed a direct relationship with the incubation period. At low temperature (20°C) this period was usually longer than at higher temperatures. The minimum incubation period was recorded on bottle gourd (41.60 $\pm$0.51 hrs) and pumpkin (42.12 $\pm$ 0.51 hrs) at 37°C and 80 per cent relative humidity. However, at 50 per cent relative humidity the duration of incubation period started getting longer. The maximum period (141.08 $\pm$ 0.49 hrs) was found on cucumber followed by that on bitter gourd (135.40 $\pm$ 0.56 hrs) at 20°C and 80 per cent relative humidity (Table 16).

At all the temperatures in combination with the relative humidities, the incubation period was more on cucumber and bitter gourd except at 37°C and 50 per cent relative humidity, the duration of this period on cucumber was slightly less than that on bottle gourd.

TABLE 16. Developmental period of different stages of *T. neocaledonicus* at different temperatures and relative humidities

| Food plants | Duration in hours | | | | | Adult longevity in days | |
|---|---|---|---|---|---|---|---|
| | Incubation period | Larval period | Proto nymphal period | Deuto nymphal period | Life cycle | Male | Female |
| | | | Temperature 20°C and relative humidity 80% | | | | |
| Bottle gourd | 100.59±0.43 | 71.82±0.37 | 74.53±0.40 | 70.81±0.44 | 317.75±0.82 | 13.11±0.71 | 15.13±0.68 |
| Sponge gourd | 93.56±0.37 | 66.96±0.43 | 75.04±0.43 | 68.86±0.40 | 304.42±0.82 | 11.55±0.51 | 14.07±0.55 |
| Cucumber | 141.08±0.49 | 85.16±0.47 | 81.93±0.43 | 84.56±0.50 | 392.73±0.95 | 10.90±0.32 | 12.47±0.37 |
| Pumpkin | 105.70±0.46 | 80.48±0.41 | 80.81±0.43 | 84.32±0.52 | 351.31±0.91 | 14.32±0.65 | 16.55±0.68 |
| Bitter gourd | 135.40±0.56 | 127.76±0.46 | 124.79±0.49 | 112.40±0.50 | 500.35±1.01 | 8.30±0.39 | 9.53±0.37 |
| | | | Temperature 20°C and relative humidity 50% | | | | |
| Bottle gourd | 85.45±0.45 | 70.05±0.46 | 72.61±0.45 | 68.08±0.44 | 296.19±0.90 | 11.83±0.70 | 13.99±0.54 |
| Sponge gourd | 85.20±0.44 | 66.56±0.47 | 74.53±0.44 | 69.62±0.46 | 295.91±0.91 | 11.26±0.36 | 13.61±0.42 |
| Cucumber | 131.70±0.41 | 80.95±0.42 | 78.99±0.45 | 79.12±0.42 | 370.76±0.85 | 9.94±0.37 | 12.07±0.35 |
| Pumpkin | 95.58±0.44 | 77.90±0.43 | 77.42±0.46 | 78.47±0.51 | 329.37±0.92 | 12.39±0.64 | 13.99±0.55 |
| Bitter gourd | 128.69±0.38 | 122.99±0.49 | 124.42±0.42 | 107.96±0.43 | 484.06±0.86 | 9.94±0.37 | 12.07±0.35 |

Contd........

Table 16 continued

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | Temperature at 25°C and relative humidity 80% | | | | |
| Bottle gourd | 69.73±0.48 | 58.87±0.41 | 62.69±0.39 | 55.65±0.49 | 246.94±0.86 | 11.53±0.37 | 13.84±0.60 |
| Sponge gourd | 65.86±0.50 | 56.64±0.41 | 61.49±0.50 | 50.60±0.38 | 234.59±0.91 | 12.14±0.55 | 14.16±0.44 |
| Cucumber | 90.77±0.49 | 72.66±0.43 | 70.07±0.44 | 64.95±0.44 | 298.45±0.90 | 9.24±0.61 | 11.77±0.80 |
| Pumpkin | 83.38±0.45 | 65.75±0.43 | 68.26±0.36 | 53.42±0.36 | 270.81±0.81 | 11.08±0.45 | 12.99±0.42 |
| Bitter gourd | 96.92±0.45 | 75.44±0.45 | 72.43±0.52 | 72.40±0.69 | 317.19±1.07 | 6.77±0.42 | 8.05±0.47 |
| | | | Temperature at 25°C and relative humidity 50% | | | | |
| Bottle gourd | 61.41±0.51 | 60.92±0.49 | 64.02±0.49 | 57.50±0.43 | 243.85±0.96 | 9.53±0.74 | 12.38±0.55 |
| Sponge gourd | 60.64±0.47 | 61.14±0.46 | 63.50±0.41 | 57.61±0.44 | 242.89±0.89 | 10.51±0.44 | 13.00±0.51 |
| Cucumber | 79.25±0.45 | 73.41±0.44 | 71.20±0.42 | 69.57±0.41 | 293.43±0.86 | 9.11±0.51 | 11.35±0.37 |
| Pumpkin | 73.45±0.44 | 70.41±0.47 | 68.27±0.37 | 56.87±0.50 | 269.00±0.89 | 8.66±0.85 | 12.56±0.57 |
| Bitter gourd | 84.71±0.42 | 74.21±0.49 | 71.90±0.46 | - | - | 5.80±0.55 | 8.17±0.45 |

Contd......

Table 16 continued

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | Temperature at 30°C and relative humidity 80% | | | | |
| Bottle gourd | 66.75±0.48 | 46.49±0.46 | 45.24±0.52 | 43.31±0.42 | 201.79±0.94 | 11.04±0.61 | 11.95±0.47 |
| Sponge gourd | 64.71±0.51 | 44.80±0.42 | 43.00±0.39 | 40.20±0.44 | 192.71±0.89 | 10.44±0.51 | 11.57±0.60 |
| Cucumber | 71.30±0.46 | 51.38±0.46 | 52.49±0.48 | 53.14±0.53 | 228.31±0.97 | 7.85±0.55 | 9.54±0.42 |
| Pumpkin | 70.56±0.46 | 50.99±0.44 | 47.34±0.46 | 45.45±0.46 | 214.34±0.91 | 9.83±0.47 | 11.69±0.45 |
| Bitter gourd | 81.57±0.45 | 60.89±0.65 | - | - | - | 6.00±0.58 | 7.50±0.50 |
| | | | Temperature at 30°C and relative humidity 50% | | | | |
| Bottle gourd | 57.21±0.49 | 40.41±0.46 | 35.81±0.38 | 37.14±0.41 | 170.57±0.88 | 9.74±0.45 | 11.11±0.33 |
| Sponge gourd | 55.81±0.46 | 42.79±0.47 | 36.50±0.45 | 37.14±0.41 | 172.24±0.70 | 9.34±0.44 | 10.01±0.58 |
| Cucumber | 61.10±0.46 | 45.56±0.44 | 43.50±0.39 | 43.32±0.41 | 193.48±0.85 | 6.29±0.37 | 8.37±0.39 |
| Pumpkin | 58.61±0.47 | 45.52±0.44 | 40.24±0.42 | 41.12±0.41 | 185.49±0.88 | 7.97±0.44 | 10.38±0.33 |
| Bitter gourd | 68.93±0.44 | 56.75±0.43 | - | - | - | 5.35±0.83 | 6.20±0.48 |

Contd........

Table 16 continued

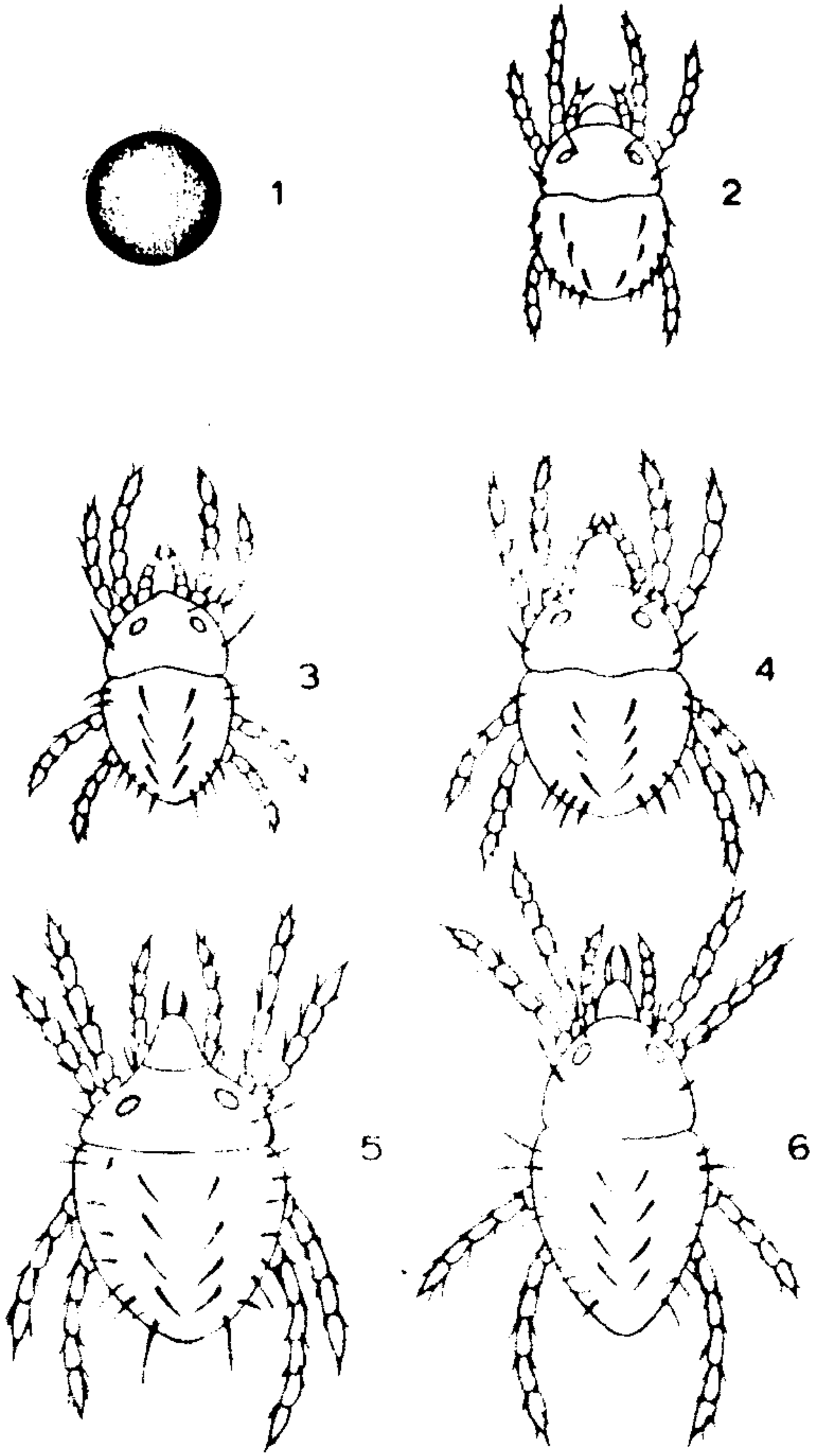
| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | *Temperature at 35°C and relative humidity 80%* | | | | |
| Bottle gourd | 46.86±0.44 | 33.52±0.45 | 32.80±0.45 | 33.60±0.47 | 146.78±0.91 | 4.77±0.42 | 6.08±0.42 |
| Sponge gourd | 49.54±0.44 | 33.13±0.43 | 32.57±0.46 | 33.99±0.51 | 149.23±0.92 | 4.92±0.45 | 5.57±0.45 |
| Cucumber | 55.21±0.47 | 41.78±0.46 | 38.45±0.45 | 39.68±0.48 | 175.12±0.93 | 3.44±0.38 | 4.14±0.35 |
| Pumpkin | 48.69±0.47 | 36.83±0.49 | 33.79±0.49 | 38.01±0.46 | 157.32±0.96 | 5.73±0.45 | 6.15±0.67 |
| Bitter gourd | 66.50±0.42 | - | - | - | - | 2.50±0.41 | 3.38±0.66 |
| | | | *Temperature at 35°C and relative humidity 50%* | | | | |
| Bottle gourd | 48.20±0.45 | 38.86±0.48 | 34.25±0.42 | 40.99±0.47 | 162.30±0.91 | 3.50±0.35 | 4.99±0.42 |
| Sponge gourd | 51.00±0.44 | 34.98±0.46 | 34.75±0.43 | 36.81±0.49 | 157.54±0.91 | 4.05±0.39 | 4.90±0.68 |
| Cucumber | 56.40±0.46 | 43.11±0.45 | 40.19±0.44 | 42.23±0.44 | 181.93±0.89 | 2.50±0.32 | 3.26±0.55 |
| Pumpkin | 53.98±0.51 | 38.53±0.50 | 37.43±0.44 | 37.37±0.44 | 167.31±0.94 | 3.88±0.37 | 5.29±0.55 |
| Bitter gourd | 70.28±0.56 | - | - | - | - | 2.50±0.50 | 3.00±0.58 |

Contd.....

Table 16 continued

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | Temperature at 37°C and relative humidity 80% | | | | |
| Bottle gourd | 41.60±0.51 | 32.08±0.48 | 35.66±0.65 | 26.03±0.59 | 135.37±1.12 | 3.97±0.39 | 4.99±0.42 |
| Sponge gourd | 42.35±0.50 | 32.36±0.51 | 34.08±0.50 | 34.03±0.53 | 142.82±1.02 | 3.53±0.37 | 5.41±0.39 |
| Cucumber | 47.65±0.61 | 33.70±0.57 | 33.36±0.53 | 23.71±0.84 | 138.42±1.30 | 3.25±0.50 | 4.90±0.48 |
| Pumpkin | 42.12±0.51 | 33.79±0.50 | 34.26±0.52 | 28.89±0.57 | 139.06±1.06 | 4.11±0.39 | 5.43±0.45 |
| Bitter gourd | 53.57±0.60 | - | - | - | - | 2.78±0.58 | 3.90±0.48 |
| | | | Temperature at 37°C and relative humidity 50% | | | | |
| Bottle gourd | 51.91±0.55 | 36.20±0.60 | 30.42±0.64 | 34.41±0.70 | 152.94±1.30 | 2.81±0.66 | 3.95±0.54 |
| Sponge gourd | 51.14±0.52 | 35.37±0.53 | 37.65±0.70 | 38.18±0.61 | 162.34±1.18 | 2.50±0.41 | 3.57±0.76 |
| Cucumber | 51.47±0.49 | 37.88±0.66 | 34.00±0.81 | 35.64±0.81 | 158.99±1.41 | 2.90±0.48 | 3.68±0.71 |
| Pumpkin | 50.70±0.50 | 37.29±0.51 | 38.42±0.54 | 36.50±0.74 | 162.91±1.16 | 2.77±0.42 | 3.26±0.55 |
| Bitter gourd | 54.86±0.65 | - | - | - | - | 2.00±0.50 | 3.71±0.38 |

FIG.6 DIAGRAMS OF DIFFERENT STAGES OF *Tetranychus neocaledonicus* André




1 EGG X 180 2. LARVA X 180 3. PROTONYMPH X 180
4 DEUTONYMPH X 180 5. ADULT FEMALE X 180 6. ADULT MALE X 180

Larval stage: Freshly hatched larvae on an average were 0.16 mm in length and 0.13 mm in breadth. They were almost spherical, had 3 pairs of legs and appeared light amber coloured. The larval period was minimum (32.08 ± 0.48 hrs) on bottle gourd at 37°C and 80 per cent relative humidity. It was maximum on bitter gourd (127.76 ± 0.46 hrs) at 20°C and 80 per cent relative humidity. At 20°C and 50 per cent relative humidity, this period was found decreasing. However, at 37°C and 50 per cent relative humidity, the period increased as compared to 80 per cent relative humidity. Moreover, the mortality percentage also increased.

Protonymphal stage: The protonymphs emerged after a brief quiescent larval stage. They had four pairs of legs and measured on an average 0.23 mm in length and 0.16 mm in breadth. The colour changed from deep green to dark brown with specks on the dorsum. The minimum period 30.42 ± 0.64 hrs) was recorded at 37°C and 50 per cent relative humidity on bottle gourd. This period was observed increasing with the increase in temperature. However, on bottle gourd this was not the case. The maximum period was found on bitter gourd at 20°C in combination with both relative humidities (Table 16).

Fig-6

Deutonymphal stage: The deutonymphs emerged from quiescent protonymphs. They measured on an average 0.28 mm in length and 0.19 mm in breadth. The body was pale yellow in colour with black spots on the dorsum. The minimum deutonymphal period was recorded at 37°C temperature and 80 per cent relative humidity on cucumber (23.71 $\pm$ 0.84 hrs), followed by that on bottle gourd (26.03 $\pm$ 0.59 hrs). The deutonymphs took maximum time to cross over to adult stage on bitter gourd at 20°C under both relative humidities.

Life-cycle: On bitter gourd the life-cycle was completed at 20°C in combination with both relative humidities, whereas at 25°C it could be achieved with 80 per cent relative humidity only. On other temperatures it could not be completed on either humidities. However, on other hosts the life-cycle of the mite species was completed upto 37°C temperature successfully (Table 16).

At 20°C temperature and 80 per cent relative humidity, the life-cycle of the mite took longer time for completion on all the hosts, while completion took lesser time on all the hosts at higher temperature regimens. However, at 35° and 37°C combined with 50 per cent relative humidity, the completion of life-cycle took longer time than their combination with 80 per cent relative humidity.

The minimum period at which life-cycle was completed was recorded on bottle gourd (135.37 ± 1.12 hrs) at 37°C in combination with 80 per cent relative humidity. The mites, however, took maximum time in completing their life-cycle on bitter gourd (500.35 ± 1.01 hrs) at 20°C temperature and 80 per cent relative humidity. These mites could not complete their life-cycle on bitter gourd when temperature exceeded 25°C as combined with 80 per cent relative humidity. On the other hosts the life-cycle completion took maximum time at 20°C and gradually this period was shortened with other higher temperature regimens.

Adult stage: [Fig-1] The female measured on an average 0.43 mm in length and 0.31 mm in breadth. The length and breadth of the males measured on an average 0.28 mm and 0.16 mm respectively. Adults were octopods. The female body was red with round abdomen while males were light red or yellowish with pointed abdomen.

Longevity: At all the temperatures and relative humidity combinations, adult longevity period was recorded to be longer in females as compared to males. The maximum life-span of males was found 14.32 ± 0.65 days at 20°C and 80 per cent relative humidity on pumpkin, followed by bottle gourd (13.11 ± 0.71 days). In case of females it was

16.55 ± 0.68 days at the corresponding temperature and relative humidity on pumpkin, followed by bottle gourd (15.13 ± 0.68 days). The minimum longevity of adults was recorded on bitter gourd(in males, 2.00 ± 0.50 days and in females, 3.71 ± 0.38 days) at 37°C and 50 per cent relative humidity. In females on cucumber the adult longivity recorded was minimum (3.26 ± 0.55 days) at this temperature and relative humidity (Table 16).

Web formation: As the temperature increased the intensity of web formation also increased. The maximum web formation was recorded at 37°C and 50 per cent relative humidity.

The temperature and humidity combinations seemed to have little bearing on the longevity of adult mites since their mortality rate on bitter gourd was even otherwise very high (Table 17). Between 20° and 25°C, the mortality rate did not change appreciably. On bitter gourd the life-cycle could not continue after protonymphal stage at 25°C and 50 per cent relative humidity. However, with 80 per cent relative humidity, a small percentage survived. With the increase in temperature the mortality rate in all the stages increased considerably and at 40°C the mites did not survive.

TABLE 17. Mortality percentage of different immature stages of *T. neocaledonicus*

| Relative humidity | Host | Eggs | Larva | Proto nymph | Deuto nymph |
|---|---|---|---|---|---|
| | | **Temperature at 20°C** | | | |
| 80% | Bottle gourd | 5.33 | 6.34 | 6.01 | 5.60 |
| | Sponge gourd | 7.33 | 7.19 | 6.97 | 3.33 |
| | Cucumber | 8.67 | 6.57 | 7.03 | 6.72 |
| | Pumpkin | 3.33 | 5.52 | 5.11 | 3.08 |
| | Bitter gourd | 17.33 | 10.48 | 10.80 | 7.07 |
| 50% | Bottle gourd | 6.67 | 9.28 | 7.87 | 5.12 |
| | Sponge gourd | 6.67 | 7.85 | 8.53 | 2.54 |
| | Cucumber | 6.67 | 5.71 | 6.81 | 4.07 |
| | Pumpkin | 6.66 | 7.14 | 6.92 | 5.78 |
| | Bitter gourd | 7.33 | 7.19 | 7.75 | 5.04 |
| | | **Temperature at 25°C** | | | |
| 80% | Bottle gourd | 7.33 | 7.91 | 6.25 | 9.17 |
| | Sponge gourd | 5.33 | 5.63 | 5.97 | 5.56 |
| | Cucumber | 7.33 | 6.47 | 6.92 | 6.61 |
| | Pumpkin | 5.33 | 5.63 | 7.46 | 7.26 |
| | Bitter gourd | 18.00 | 15.45 | 16.35 | 71.26 |
| 50% | Bottle gourd | 7.33 | 9.35 | 8.73 | 9.57 |
| | Sponge gourd | 7.33 | 7.91 | 7.03 | 9.24 |
| | Cucumber | 9.33 | 8.09 | 9.60 | 7.96 |
| | Pumpkin | 5.33 | 7.75 | 6.11 | 7.32 |
| | Bitter gourd | 16.67 | 40.80 | 15.79 | 100.0 |

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| | | | | | |
|---|---|---|---|---|---|
| 50% | Bottle gourd | 9.33 | 12.50 | 11.76 | 9.52 |

Table 17 continued

| | | | | | |
|---|---|---|---|---|---|
| | | Temperature at 30°C | | | |
| 80% | Bottle gourd | 9.33 | 8.09 | 9.60 | 6.19 |
| | Sponge gourd | 9.33 | 8.09 | 8.80 | 6.14 |
| | Cucumber | 8.67 | 10.22 | 9.76 | 9.01 |
| | Pumpkin | 6.67 | 8.57 | 10.16 | 7.83 |
| | Bitter gourd | 16.00 | 58.62 | 100.0 | - |
| 50% | Bottle gourd | 9.33 | 12.50 | 11.76 | 9.52 |
| | Sponge gourd | 9.33 | 10.03 | 13.22 | 8.57 |
| | Cucumber | 8.00 | 14.49 | 10.17 | 13.46 |
| | Pumpkin | 6.00 | 10.64 | 11.90 | 10.81 |
| | Bitter gourd | 14.67 | 22.66 | 100.0 | - |
| | | Temperature at 35°C | | | |
| 80% | Bottle gourd | 13.33 | 13.08 | 14.16 | 13.40 |
| | Sponge gourd | 12.67 | 12.21 | 13.04 | 13.00 |
| | Cucumber | 14.67 | 13.28 | 14.41 | 12.12 |
| | Pumpkin | 10.67 | 11.19 | 10.85 | 12.38 |
| | Bitter gourd | 20.00 | 100.0 | - | - |
| 50% | Bottle gourd | 15.33 | 11.02 | 15.93 | 14.74 |
| | Sponge gourd | 14.00 | 13.18 | 15.18 | 16.84 |
| | Cucumber | 15.33 | 16.53 | 15.09 | 14.44 |
| | Pumpkin | 13.33 | 13.85 | 12.50 | 15.31 |
| | Bitter gourd | 22.00 | 100.0 | - | - |
| | | Temperature 37°C | | | |
| 80% | Bottle gourd | 20.67 | 22.69 | 41.30 | 14.81 |
| | Sponge gourd | 21.33 | 20.34 | 15.96 | 15.19 |
| | Cucumber | 24.00 | 21.05 | 20.00 | 56.25 |
| | Pumpkin | 20.67 | 23.96 | 20.13 | 12.68 |
| | Bitter gourd | 28.00 | 100.0 | - | - |
| 50% | Bottle gourd | 29.33 | 54.72 | 20.83 | 15.79 |
| | Sponge gourd | 26.67 | 22.73 | 49.41 | 16.28 |
| | Cucumber | 25.33 | 50.00 | 57.14 | 8.33 |
| | Pumpkin | 24.67 | 25.66 | 22.62 | 43.08 |
| | Bitter gourd | 37.00 | 100.0 | - | - |

On the basis of high fecundity and minimum time taken to complete the life-cycle, pumpkin and bottle gourd were found to be the most suitable hosts. The life-cycle was completed in the shortest duration at 37°C. However, at this temperature the mortality rate recorted was quite high and the fecundity was low. It may, therefore, be considered as an unfavourable temperature for their population increase. At 30°C the fecundity was maximum, the mortality rate was also not so high and the life-cycle was slightly extended. It may, therefore, be considered as the most favoured temperature under the present set-up of the temperature and humidity conditions. Gupta et al. (1972) has also recorded 30°C to be the most favourable temperature for this particular mite species. High humidity (80 per cent) was recorded to be more favourable at higher temperatures (30°C and above), whereas at low temperatures (20° and 25°C) and at low humidity regimen (50 per cent) the reduction in the duration of life-cycle of the pest was recorded. Thus 50 per cent relative humidity in combination with low temperature regimens (20 and 25°C) and high humidity (80 per cent) in combination with high temperature regimens may be considered congenial to the population built-up of the mite species.

Nature and extent of damage

The mites were observed to puncture the epidermis of the leaves with their stylets and suck the cell-sap with their chelicerae. As a result of this, white spots develop on the leaves. With the increase in their population the number of chlorotic spots increase and collesce giving rise to blotches on the leaves. The attacked leaves turn pale yellow with chlorotic dried patches on them (Fig. 6). The leaves also lose their stiffness and severely affected ones drop down. This brings about fall in the health and vitality of the plants. Ultimately growth, flowering and fruiting is seriously affected resulting in poor or complete failure of the crop. The chlorosis consequent on the feeding by developing populations reduces the photosynthetic area. The mites preferably inhabit the under-surface of the leaves but during their peak period of infestation, a few migrate and abound the upper surface, and sometimes the terminal and floral parts are also infested. Generally the infestation is more on the lower and older leaves.

Initially the infestation builds round the thick veins of the leaf and with the increase in their number they spread throughout the leaf surface and start web formation which is more profuse during summer months when the

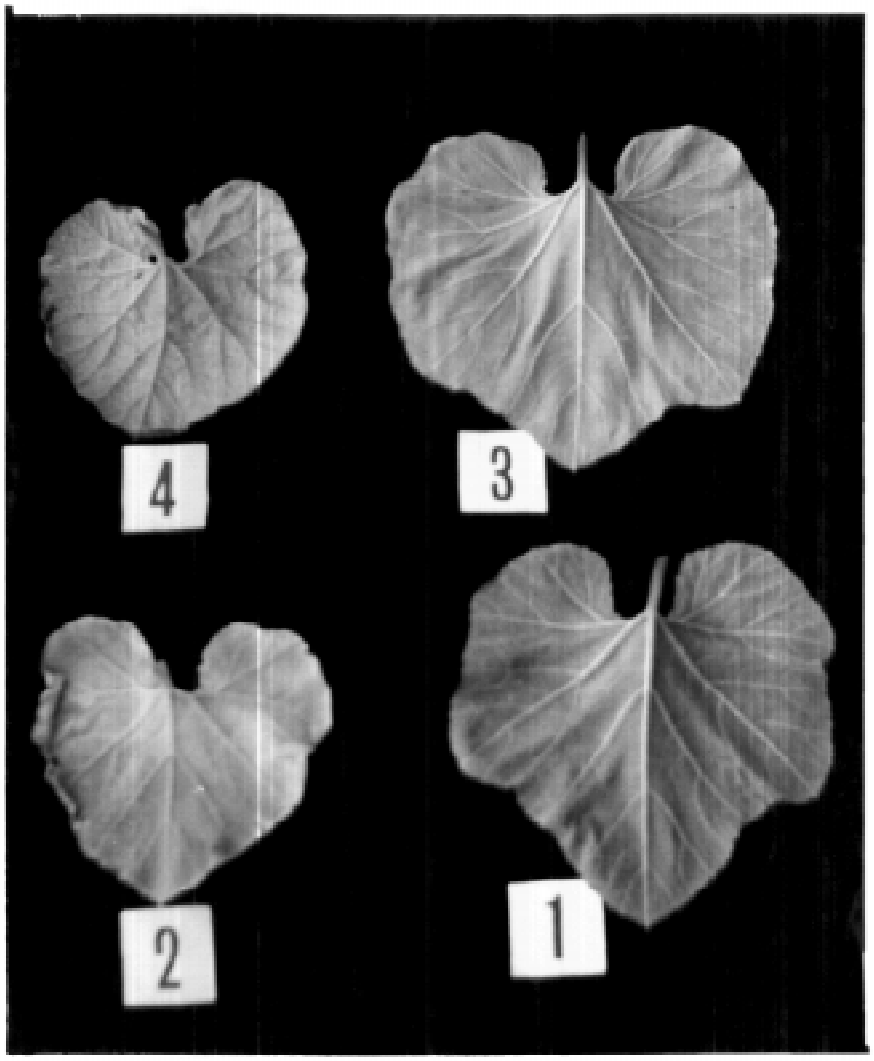


Figure 6 - Nature of damage on pumpkin (Local) and bottle gourd (Kalyanpur long green, summer)
Pumpkin 1, healthy leaf; 2, infested leaf
Bottle gourd 3, healthy leaf; 4, infested leaf

temperature is high and during October-November when their population is at its peak. The dust particles falling on the leaf surface get entangled in the web, particularly in the summer season, which affect the photosynthetic activity of the leaves hampering their normal growth and activity.

The intensity index proposed in the present findings (Table 18) was derived on the basis of release of counted number of mite population on two month-old potted plants of two cucurbits, viz. bottle gourd (Kalyanpur long green, summer) and pumpkin (Local), under laboratory conditions. The intensity of attack proportionately increased with the increase in the number of mites released. High damage index was obtained with the more number of mites in the short period of time (Table 19). When comparatively less numbers were released, the same extent of severity was obtained after a longer duration. As a result of releasing 100, 250, 500 and 1000 mites per plant the highest damage index was established after 7, 6, 5 and 4 weeks respectively, indicating thereby that damage index was inversely proportional to the population of mites released.

TABLE 18. Intensity index of mite damage on two cucurbits

| Damage index | | Definition | | Mite population* | |
|---|---|---|---|---|---|
| | | | | Bottle gourd** | Pumpkin (Local) |
| 0 | Healthy | No mite | Plant survives | 0.000 | 0.000 |
| 1 | Insignificant | Scattered mite population | Plant survives | 0.833 | 1.000 |
| 2 | Established (one or two white patches) | Mites at vain base | Plant survives | 2.778 | 3.000 |
| 3 | Medium (few-5 to 6-white patches) | Mites at various branch-veins and base also | Plant survives, but lower leaves turn pale-yellow | 7.778 | 9.611 |
| 4 | Severe (numerous white patches) | Mites found on under surface, distributed uniformly | Plant survives, but no flowering | 15.667 | 16.056 |
| 5 | Very severe (almost 80% of the leaf area white) | Mites found on both sides of leaf | Plant does not survive, dries within 2 months | 28.167 | 28.000 |

* Average per 2 $cm^2$ spots.
** Kalyanpur long green, summer

TABLE 19. Damage index manifested with the release of known number of mites over a period of eight weeks on the two hosts

| No. of mites released per plant | Host | Weeks | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | I | II | III | IV | V | VI | VII | VIII |
| 100 | Bottle gourd | 1 | 1 | 1 | 2 | 2 | 3 | 4 | 4 |
| | Pumpkin | 1 | 1 | 2 | 2 | 3 | 4 | 5 | 5 |
| 250 | Bottle gourd | 1 | 1 | 2 | 2 | 3 | 4 | 4 | 5 |
| | Pumpkin | 1 | 1 | 2 | 3 | 4 | 5 | 5 | 5 |
| 500 | Bottle gourd | 1 | 2 | 3 | 3 | 4 | 4 | 5 | 5 |
| | Pumpkin | 2 | 3 | 4 | 4 | 5 | 5 | 5 | 5 |
| 1000 | Bottle gourd | 1 | 2 | 3 | 4 | 4 | 5 | 5 | 5 |
| | Pumpkin | 2 | 4 | 4 | 5 | 5 | 5 | 5 | 5 |
| Control | Bottle gourd | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Pumpkin | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Effect of sites on the incidence

Most of the published data on the population dynamics of the mites are based on the experiments carried out on the research stations where conditions are pretty atypical of the situation in farmers' fields owing to mixed sowing dates, range of maturities and variable seasonal cultivars. To illustrate this point, observations during the present investigations were taken at three different locations: the Horticulture Farm where insecticides are used more frequently; the vegetation is dense and a wide range of plants, shrubs and trees of horticultural interest are there; the farmers' field, where insecticides are less frequently used. The college insectory which has altogether a different environmental set-up, a place very much secluded from the farmers' field or open atmoshpere and where insecticides are not used at all.

Two hosts, _viz_. pumpkin (Local) and bottle gourd (Kalyanpur long green, summer) were exposed for the test. Observations were taken when hosts were about 3 months old. The maximum incidence was recorded on these hosts in the Horticulture Farm followed by that of farmers' field. The lowest infestation level was observed in the insectary. This range of infestation did not vary with either the host or the season (Table 20).

The maximum population recorded at the Horticulture Farm may be due to high density and wide range of vegetation including perennial plants which allow the mites to thrive throughout the year. Due to the characteristic vegetation, frequent irrigation facilities, comparatively high humidity and intensive use of fertilizers and non-selective pesticides, the mite population multiplies

TABLE 20. Incidence* of *T. neocaledonicus* at three different locations on two susceptible hosts in Udaipur

| Location | Date | Pumpkin (Local) | | | | Bottle gourd** | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $R_1$ | $R_2$ | $R_3$ | Average | $R_1$ | $R_2$ | $R_3$ | Average |
| Horticul-ture Farm | 6- 6-77 | 301 | 220 | 275 | 265.3 | 327 | 300 | 289 | 305.3 |
| | 10-10-77 | 387 | 306 | 391 | 361.3 | 433 | 337 | 351 | 373.7 |
| College Insectory | 6- 6-77 | 6 | 10 | 21 | 12.3 | 3 | 11 | 5 | 6.3 |
| | 10-10-77 | 3 | 15 | 0 | 6.0 | 11 | 0 | 21 | 10.7 |
| Farmers' Field | 6- 6-77 | 107 | 80 | 73 | 86.7 | 85 | 112 | 37 | 78.0 |
| | 10-10-77 | 151 | 137 | 82 | 122.3 | 113 | 103 | 131 | 115.7 |

**Kalyanpur long green, summer  * Population/54 x 2 $cm^2$

rapidly and increases in damaging proportions. This site is comparatively less vulnerable to the winds and hence the reduction in mite population may have taken place to a lesser degree. The lowest population in the college insectary might have been due to the lack of vegetation and more open space, and also due to the reason that the insecticides were not used at the site. Being an open site winds might also have contributed to dislodging the population. The farmers' fields is a site which provides the environmental conditions between the Horticulture Farm and the college insectary, comparatively closer to the former. Thus it was not unusual to find the site moderately infested.

On the basis of present observations it may be suggested that the data to date collected from research centres or secluded places may be misleading and may bear little relevance to the situation and that for obtaining most realistic figures the experiments may be carried out on farmers' field which is our prime concern.

## Pesticidal trials

In order to find out the efficacy of certain pesticides against the mites attacking pumpkin and bottle gourd, two field trials were laid out in Randomized Block Design in the Horticulture Farm of Rajasthan College of Agriculture, Udaipur. In all, 14 pesticides (acaricides and insecticides) were tested against the vegetable mite, *T. neocaledonicus* attacking pumpkin and bottle gourd in and around Udaipur. It was also considered necessary to evaluate the effect of plain water spray over the mite population inhabiting the cucurbit leaves of these two plant species. Thus, 15 treatments were undertaken and control was run simultaneously for the comparison of results. Each treatment was replicated thrice. The reduction of the pest population was taken as a criterion for drawing the inferences given in the following write-up:

TABLE 21. Efficacy of various pesticides against *T. neocaledonicus* (crop pumpkin)

| S.No. | Treatments | After 24 hours | | After 48 hours | | After 72 hours | | After 5 days | |
|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 3 |
| 1 | Phorate Gr | 13.055* (169.933) | 0.184 | 6.004 (35.548) | 79.120 | 1.835 (2.867) | 98.316 | 0.707 (0.000) | 100.00 |
| 2 | Aldicarb Gr | 13.348 (177.669) | +0.999 | 5.925 (34.606) | 80.328 | 0.707 (0.000) | 100.00 | 0.707 (0.000) | 100.00 |
| 3 | Disulfoton Gr | 12.968 (167.669) | +1.0133 | 6.359 (39.937) | 75.940 | 0.707 (0.000) | 100.00 | 0.707 (0.000) | 100.00 |
| 4 | Carbofuran Gr | 12.928 (166.633) | 0.356 | 8.227 (67.184) | 59.825 | 2.318 (4.873) | 97.086 | 0.707 (0.000) | 100.00 |
| 5 | Dinobuton | 4.876 (23.275) | 84.469 | 1.678 (2.316) | 98.455 | 0.707 (0.000) | 100.00 | 0.707 (0.000) | 100.00 |
| 6 | Cyhexatin | 5.227 (26.822) | 80.601 | 1.814 (2.791) | 97.981 | 0.707 (0.000) | 100.00 | 0.707 (0.000) | 100.00 |
| 7 | Sulphur | 6.928 (47.497) | 64.199 | 5.514 (29.904) | 77.460 | 5.753 (32.597) | 75.430 | 6.576 (42.744) | 67.782 |

Note: 1, mean population; 2, per cent reduction
Figures in parentheses are retransformed values
* Transformed values + population increased

Contd......

Table 21 continued

| S.No. | Treatments | After 7 days | | After 10 days | | After 15 days | | After 21 days | |
|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 |
| 1 | Phorate Gr | 0.707 (0.000) | 100.00 | 0.707 (0.000) | 100.00 | 0.707 (0.000) | 100.00 | 1.655 (2.239) | 98.685 |
| 2 | Aldicarb Gr | 0.707 (0.000) | 100.00 | 0.707 (0.000) | 100.00 | 0.707 (0.000) | 100.00 | 2.037 (3.649) | 97.926 |
| 3 | Disulfoton Gr | 0.707 (0.000) | 100.00 | 0.707 (0.000) | 100.00 | 1.267 (1.105) | 99.334 | 2.401 (5.265) | 96.828 |
| 4 | Carbofuran Gr | 0.707 (0.000) | 100.00 | 1.386 (1.421) | 99.150 | 2.000 (3.500) | 97.907 | 2.734 (6.975) | 95.829 |
| 5 | Dinobuton | 0.998 (0.496) | 99.669 | 1.642 (2.196) | 98.535 | 2.904 (7.933) | 94.706 | 4.257 (17.622) | 88.241 |
| 6 | Cyhexatin | 1.904 (3.125) | 97.740 | 1.932 (3.233) | 97.662 | 3.015 (8.590) | 93.737 | 4.178 (16.956) | 87.737 |
| 7 | Sulphur | 7.356 (53.611) | 59.591 | 7.939 (62.528) | 52.870 | 8.235 (67.315) | 49.262 | 9.068 (81.729) | 38.397 |

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Table 21 continued

| S.No. | Treatments | After 24 hours | | After 48 hours | | After 72 hours | | After 5 days | |
|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 |
| 8 | Methamidophos | 5.449 (29.192) | 81.700 | 2.029 (3.617) | 97.733 | 0.707 (0.000) | 100.00 | 0.707 (0.000) | 100.00 |
| 9 | Dicofol | 5.210 (26.644) | 84.568 | 1.739 (2.524) | 98.538 | 0.707 (0.000) | 100.00 | 0.707 (0.000) | 100.00 |
| 10 | Phenthoate | 4.616 (20.800) | 86.596 | 1.559 (1.930) | 98.757 | 0.707 (0.000) | 100.00 | 0.707 (0.000) | 100.00 |
| 11 | Malathion | 4.909 (23.598) | 80.138 | 2.545 (5.977) | 94.969 | 1.171 (0.871) | 99.267 | 1.792 (2.711) | 97.718 |
| 12 | Endosulfan | 4.706 (21.646) | 80.487 | 2.722 (6.909) | 93.772 | 1.171 (0.871) | 99.215 | 1.386 (1.421) | 98.719 |
| 13 | Dimethoate | 4.377 (18.658) | 87.731 | 1.836 (2.871) | 98.112 | 0.707 (0.000) | 100.00 | 0.707 (0.000) | 100.00 |
| 14 | Phosphamidon | 5.113 (25.643) | 80.171 | 2.181 (4.257) | 96.708 | 0.707 (0.000) | 100.00 | 0.707 (0.000) | 100.00 |
| 15 | Water | 10.849 (117.201) | 28.961 | 10.753 (115.127) | 30.218 | 10.894 (118.179) | 28.369 | 10.940 (119.184) | 27.759 |
| 16 | Control | 13.083 (170.665) | +1.928 | 13.031 (169.307) | +1.117 | 13.055 (169.933) | +1.491 | 13.230 (174.533) | +4.239 |
| SEm ± | | 0.1828 | | 0.2528 | | 0.1578 | | 0.2588 | |
| CD at 5% | | 0.5279 | | 0.7300 | | 0.4557 | | 0.7474 | |
| CD at 1% | | 0.7109 | | 0.9832 | | 0.6137 | | 1.0065 | |

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Table 21 continued

| S.No. | Treatments | After 7 days | | After 10 days | | After 15 days | | After 21 days | |
|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 |
| 8 | Methamidophos | 1.386 (1.421) | 99.109 | 1.954 (3.318) | 97.920 | 3.129 (9.291) | 94.176 | 4.337 (18.310) | 88.522 |
| 9 | Dicofol | 2.264 (4.626) | 97.321 | 2.290 (4.744) | 97.252 | 3.230 (9.933) | 94.247 | 4.626 (20.900) | 87.895 |
| 10 | Phenthoate | 2.187 (4.283) | 97.241 | 2.666 (6.608) | 95.743 | 3.571 (12.252) | 92.107 | 5.123 (25.745) | 83.414 |
| 11 | Malathion | 2.676 (6.661) | 94.394 | 3.280 (10.258) | 91.366 | 4.175 (16.931) | 85.750 | 5.164 (26.167) | 77.976 |
| 12 | Endosulfan | 1.761 (2.601) | 97.655 | 2.377 (5.150) | 95.357 | 3.340 (10.656) | 90.394 | 4.400 (18.860) | 82.998 |
| 13 | Dimethoate | 0.707 (0.000) | 100.00 | 0.998 (0.496) | 99.674 | 2.112 (3.961) | 97.395 | 2.856 (7.657) | 94.965 |
| 14 | Phosphamidon | 0.707 (0.000) | 100.00 | 1.386 (1.421) | 98.901 | 2.375 (5.141) | 96.025 | 3.177 (9.593) | 92.582 |
| 15 | Water | 10.993 (120.346) | 27.055 | 11.127 (123.310) | 25.259 | 11.337 (128.028) | 22.399 | 11.708 (136.577) | 17.217 |
| 16 | Control | 13.289 (176.098) | +5.173 | 13.269 (175.566) | +4.856 | 13.555 (183.238) | +9.438 | 13.913 (193.072) | +15.311 |
| SEm ± | | 0.2352 | | 0.2354 | | 0.2256 | | 0.2494 | |
| CD at 5% | | 0.6792 | | 0.6798 | | 0.6515 | | 0.7202 | |
| CD at 1% | | 0.9147 | | 0.9155 | | 0.8774 | | 0.9699 | |

Pumpkin: From the pretreatment population counts of the mites, it was observed that they ranged from 111 to 176 per 54 x 2 $cm^2$ leaf area (Table 21).

The data collected after 24 hours interval of application of pesticides revealed that there was a considerable decline in the mite population with all the treatments undertaken except phorate, aldicarb, disulfoton and carbofuran. However, in control the population reduction was almost parallel to the above mentioned pesticides. Dimethoate and phenthoate gave very good percentage reduction in the pest population being above 86 per cent, while malathion, endosulfan, phosphamidon and cyhexatin gave reduction above 80 per cent. Methamidophos, dicofol and dinobuton gave the reduction in the mite population ranging from 82 to 85 per cent. The mean post-treatment population after 24 hours of pesticide application was lowest being 19 in case of dimethoate treatment and ranged from 21 to 29 among other treatments, namely dinobuton, cyhexatin, methamidophos, dicofol, phenthoate, malathion, endosulfan and phosphamidon. When the data were subjected to the analysis of variance, all these pesticides including dimethoate and phenthoate did not differ significantly among themselves, but proved significantly superior over sulphur (WDP) where the post-treatment population recorded was 48 and afforded only

64 per cent reduction. However, water spray proved significantly inferior to sulphur spray affording only 29 per cent reduction. The systemic insecticides, namely carbofuran, disulfoton, phorate and aldicarb, tested against the mite population were found significantly inferior to all the remaining pesticides. However, control did not differ significantly from the above mentioned systemic insecticides. The systemic insecticides generally take time before they reach to the site of infestation. As such, it is evident from these results that they were not translocated within 24 hours to give the effective kill of the mites.

The results obtained after 48 hours of pesticide application showed that there was considerable increase in the reduction of the mite population in all the treatments except that of water spray and control. The reduction enhanced to more than 90 per cent in all the foliar treatments except sulphur where it was 77 per cent. The systemic insecticides — phorate, aldicarb, disulfoton and carbofuran — also manifested considerable increase in population reduction from 60 to 80 per cent. It is thus, evident that the soil pesticides were not translocated from soil to the plant upto 24 hours, but it seems translocation took effect before 48 hours.

Among the systemic soil insecticides group, carbofuran was significantly inferior to phorate, aldicarb and disulfoton in its action on mite reduction. However, carbofuran proved significantly superior over control and water spray in reducing the mite population. Sulphur was as effective as aldicarb or phorate after 48 hours interval. Among the foliar treatments (mainly contact pesticides) two distinct groups with the marked significance over each other were statistically evident. The significantly superior group comprised phenthoate, dimethoate, dinobuton, cyhexatin and dicofol. Methamidophos, malathion, endosulfan and phosphamidon although significantly inferior to these pesticides were significantly superior over the remaining ones.

After 72 hours more apparent statistical distinctions were noticeable. Water spray was significantly inferior in reducing the mite population to sulphur spray but both were superior over control. All the three treatments differed significantly among themselves. Carbofuran was significantly superior over all the three above mentioned treatments. Phorate, although significantly superior over carbofuran, differed in its action from that of malathion and endosulfan which proved significantly superior over it. The remaining pesticides, namely aldicarb, disulfoton, dinobuton, cyhexatin, methamidophos, dicofol, phenthoate, dimethoate and phosphamidon, proved significantly superior over all the rest of the treatments giving a hundred per cent reduction of the mite population.

After a lapse of 5 days, sulphur spray reduced the mite population proving significantly effective over water spray which in turn proved significantly superior over control. Thus, the results with regard to the three treatments were essentially the same as obtained at three days interval. However, carbofuran and phorate which were found significantly inferior to malathion and endosulfon at 3 days interval, now proved superior over them. This may be perhaps due to their short-lived residual action indicating thereby that the population build-up had started on the plants treated with them. The remaining pesticides did not differ significantly among themselves but were superior over sulphur, malathion and endosulfan. It may, however, be interesting to record here that phorate and carbofuran take little more time in translocation as compared to other two systemic compounds, namely, aldicarb and disulfoton. This point is also strengthened by the data presented in Table 21, where it can be observed that the mean population of mites was 2.9 and 4.9 in phorate and carbofuran respectively at 3 days interval, whereas at 5 days interval there was a sharp reduction in their population having been completely wiped out (zero).

Perusal of the data presented in Table 21 indicates that the results obtained at 7 days interval did not differ much from those obtained at 5 days interval except that cyhexatin, dicofol and phenthoate lost their effectiveness to some extent at this interval and were comparable to malathion and endosulfan..

Phorate, aldicarb, disulfoton and dimethoate maintained to give almost a hundred per cent reduction of the mite population upto 10 days and it is also evident from the data presented in Table 21 that they were significantly superior over all the remaining insecticides.

All the six systemic insecticides, namely phorate, aldicarb, disulfoton, carbofuran, dimethoate and phosphamidon were significantly superior over the rest in reducing the mite population upto 21 days giving 93 to 100 per cent reduction in the mite population.

The effectiveness of these pesticides was no doubt consistent from the point of view of the reduction in the mite population as well as persistence over the period of 21 days. The data recorded both at 15 days and 21 days interval indicated similarity in their performance even though the mode of their application was different.

From these results, it may be concluded that aldicarb and disulfoton maintained their effectiveness in reducing the mite population from the third day of application to 21 days. Carbofuran and phorate although effective in reducing the mite population manifested their effectiveness only after 5 days of their application. Among the acaricides tested, dinobuton and phenthoate although quick in action provided protection only upto 5 days. However, sulphur was comparatively inferior to all the acaricides tested in this trial. All the miticides were sprayed as emulsifiable concentrates except sulphur which was sprayed in the form of suspension (WDP). The formulation of miticides may be one of the factors that could affect their toxicity to the mite species concerned. Among the insecticides-cum-acaricides the results obtained from dimethoate and phosphamidon treated plants it may be pointed out that they proved as effective as aldicarb and disulfoton in reducing the mite population as well as in their residual action.

Bottle gourd: The efficacy of 14 pesticides against the mite *T. neocaledonicus* on bottle gourd was also studied. The population counts were made before application and at the definite time intervals after application of pesticides. The data thus obtained have been presented in Table 22.

TABLE 22. Efficacy of various pesticides against *T. neocaledonicus* (crop bottle gourd)

| S.No. | Treatments | After 24 hours | | After 48 hours | | After 72 hours | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 1 | 2 | 1 | 2 |
| 1 | Phorate Gr | 11.494* (131.612) | 4.146 | 3.651 (12.830) | 90.656 | 0.707 (0.000) | 100.00 |
| 2 | Aldicarb Gr | 11.874 (140.492) | 1.636 | 2.727 (6.937) | 95.143 | 0.707 (0.000) | 100.00 |
| 3 | Disulfoton Gr | 9.806 (95.658) | +2.720 | 2.853 (7.640) | 91.796 | 0.707 (0.000) | 100.00 |
| 4 | Carbofuran Gr | 10.283 (105.240) | 3.889 | 3.709 (13.257) | 87.893 | 0.707 (0.000) | 100.00 |
| 5 | Dinobuton | 4.133 (16.582) | 87.846 | 1.171 (0.871) | 99.362 | 0.707 (0.000) | 100.00 |
| 6 | Cyhexatin | 4.758 (22.139) | 86.726 | 0.998 (0.496) | 99.703 | 0.707 (0.000) | 100.00 |
| 7 | Sulphur | 7.734 (59.315) | 63.458 | 5.727 (32.300) | 80.101 | 5.468 (29.399) | 81.888 |

Note: 1, Mean population; 2, Per cent reduction
Figures in parentheses are retransformed values
* Transformed values

Contd.....

Table 22 continued

| S.No. | Treatments | After 5 days | | After 7 days | | After 10 days | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 1 | 2 | 1 | 2 |
| 1 | Phorate Gr | 0.707 (0.000) | 100.00 | 0.707 (0.000) | 100.00 | 0.707 (0.000) | 100.00 |
| 2 | Aldicarb Gr | 0.707 (0.000) | 100.00 | 0.707 (0.000) | 100.00 | 0.707 (0.000) | 100.00 |
| 3 | Disulfoton Gr | 0.707 (0.000) | 100.00 | 0.707 (0.000) | 100.00 | 1.290 (1.164) | 98.750 |
| 4 | Carbofuran Gr | 0.707 (0.000) | 100.00 | 0.707 (0.000) | 100.00 | 1.954 (3.318) | 96.970 |
| 5 | Dinobuton | 0.707 (0.000) | 100.00 | 1.171 (0.871) | 99.362 | 2.676 (6.661) | 95.118 |
| 6 | Cyhexatin | 0.707 (0.000) | 100.00 | 0.998 (0.496) | 99.703 | 2.799 (7.334) | 95.603 |
| 7 | Sulphur | 7.526 (56.141) | 65.413 | 9.939 (98.284) | 39.450 | 10.324 (106.085) | 34.644 |

Contd......

Table 22 continued

| S.No. | Treatments | After 24 hours | | After 48 hours | | After 72 hours | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 1 | 2 | 1 | 2 |
| 8 | Methamidophos | 3.711 (13.272) | 89.685 | 0.707 (0.000) | 100.00 | 0.707 (0.000) | 100.00 |
| 9 | Dicofol | 3.794 (13.894) | 90.436 | 0.998 (0.496) | 99.659 | 0.707 (0.000) | 100.00 |
| 10 | Phenthoate | 4.124 (16.507) | 88.668 | 1.171 (0.871) | 99.402 | 0.707 (0.000) | 100.00 |
| 11 | Malathion | 3.509 (11.813) | 86.773 | 1.268 (1.108) | 98.759 | 0.707 (0.000) | 100.00 |
| 12 | Endosulphan | 3.431 (11.272) | 88.705 | 1.171 (0.871) | 99.127 | 0.707 (0.000) | 100.00 |
| 13 | Dimethoate | 2.856 (7.657) | 94.411 | 0.707 (0.000) | 100.00 | 0.707 (0.000) | 100.00 |
| 14 | Phosphamidon | 4.455 (19.347) | 86.665 | 1.678 (2.316) | 98.404 | 0.707 (0.000) | 100.00 |
| 15 | Water | 7.346 (53.464) | 37.986 | 7.493 (55.645) | 35.456 | 8.169 (66.233) | 23.175 |
| 16 | Control | 10.806 (116.270) | +3.003 | 11.018 (120.900) | +7.105 | 11.600 (134.06) | +18.763 |
| SEm ± | | 0.4276 | | 0.2798 | | 0.1806 | |
| CD at 5% | | 1.2348 | | 0.8080 | | 0.5215 | |
| CD at 1% | | 1.6630 | | 1.0882 | | 0.7024 | |

+ Population increased

Contd.....

Table 22 continued

| S.No. | Treatments | After 5 days | | After 7 days | | After 10 days | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 1 | 2 | 1 | 2 |
| 8 | Methamidophos | 0.707 (0.000) | 100.00 | 1.470 (1.661) | 98.709 | 4.046 (15.870) | 87.665 |
| 9 | **Dicofol** | 1.717 (2.448) | 98.315 | 1.932 (3.233) | 97.775 | 4.168 (16.872) | 88.387 |
| 10 | Phenthoate | 1.268 (1.108) | 99.239 | 2.097 (3.897) | 97.325 | 4.487 (19.633) | 86.522 |
| 11 | Malathion | 1.677 (2.312) | 97.411 | 2.971 (8.327) | 90.677 | 4.242 (17.495) | 80.412 |
| 12 | Endosulphan | 0.998 (0.496) | 99.503 | 1.678 (2.316) | 97.679 | 3.908 (14.772) | 85.198 |
| 13 | Dimethoate | 0.707 (0.000) | 100.00 | 0.707 (0.000) | 100.00 | 2.318 (4.873) | 96.443 |
| 14 | Phosphamidon | 0.707 (0.000) | 100.00 | 0.707 (0.000) | 100.00 | 3.716 (13.309) | 90.827 |
| 15 | Water | 8.927 (79.191) | +8.145 | 10.177 (103.071) | +19.554 | 11.065 (121.934) | +41.433 |
| 16 | Control | 11.819 (139.189) | +23.307 | 11.972 (142.829) | +26.532 | 12.266 (149.955) | +32.845 |
| SEm± | | 0.1780 | | 0.2086 | | 0.2800 | |
| CD at 5% | | 0.5140 | | 0.6024 | | 0.8086 | |
| CD at 1% | | 0.6923 | | 0.8114 | | 1.0889 | |

+ Population increased

After 24 hours of application, there was a considerable decrease in the mite population due to the pesticides applied as foliar sprays than the systemic insecticides applied as soil treatment. More than 90 per cent reduction in mite population was recorded in case of dicofol and dimethoate treated plants. The treatment of dinobuton, cyhexatin, methamidophos, phenthoate, malathion, endosulfan and phosphamidon gave the reduction of mites ranging from 80 to 90 per cent. However, in the sulphur treatment reduction of 63 per cent was recorded. Plain water treatment gave about 38 per cent reduction in the pest population. There was negligible reduction in the population in phorate, aldicarb and carbofuran treated plants. In disulfoton and control treatments population of the mites increased slightly indicating thereby that disulfoton had not even started its toxic action. The statistical analysis of the data indicated that the treatments, viz. dimethoate, endosulfan, malathion, methamidophos and dicofol were significantly superior over other treatments but did not differ significantly among themselves. Next in order of effectiveness were phenthoate, dinobuton, phosphamidon and cyhexatin, which proved significantly superior over phorate, aldicarb, carbofuran, disulfoton, sulphur and water spray.

It is evident from Table 22 that after 48 hours of application in all the treatments except carbofuran, sulphur and water, the reduction in the mite population varied between 90-100 per cent. There was increase in reduction of mites in case of sulphur to 80 per cent as compared to 63 per cent obtained at 24 hours interval. However, in water treatment the population started building-up. Thus, water treatment lost its efficacy at this stage. The analysis of variance of the data revealed that treatments, viz. dimethoate, methamidophos, cyhexatin, dicofol, dinobuton, phenthoate, endosulfan and malathion proved significantly superior over the other treatments but did not differ significantly among themselves.

The results obtained at 72 hours interval manifested interesting differences. All the treatments except sulphur and water, exhibited 100 per cent reduction in the mite population. Thus, all the pesticides except sulphur proved quite effective in lowering down the mite population. There was no significant difference among them. In treatment with sulphur there was a slight increase in population reduction.

After 5 days of the treatment, the population of the mite started building up in case of sulphur, dicofol and malathion treatments. In rest of the treatments, there was almost 100 per cent reduction in the population. The analysis of variance revealed that treatments, viz. methamidophos, cyhexatin, disulfoton, phorate, carbofuran, endosulfan and phenthoate were non-significant among themselves but significantly superior over the other treatments.

The results obtained at 7 days interval also revealed that the population started building up in dinobuton, cyhexatin, methamidophos and endosulfan treatments. The statistical analysis showed that the treatments, viz. dimethoate, phosphamidon, aldicarb, disulfoton, phorate and carbofuran, were significantly superior over methamidophos, dicofol and endosulfan. Malathion was significantly inferior to all these above mentioned treatments but superior over sulphur and plain water treatments. Cyhexatin and dinobuton were similar in toxicity to the above mentioned systemic insecticide group but significantly superior over malathion.

It is evident from Table 22 that after 10 days of treatment the population started building up 1-9 per cent in case of the treatments, viz. disulfoton, carbofuran, dimethoate and phosphamidon. The analysis of variance showed that treatments, viz. aldicarb, phorate and disulfoton, were non-significant among themselves but superior over all the other treatments.

The population counts could not be recorded at 15 and 21 days interval due to the rains which reduced the mite population considerably.

From the point of view of effectiveness of 14 pesticides tested in a field trial against T. neocaledonicus infesting pumpkin and bottle gourd in Udaipur, it is evident that dimethoate, endosulfan, malathion (insecticides), dicofol and methamidophos (acaricides) gave significantly superior reduction of their population over the remaining compounds. Phosphamidon (insecticide), phenthoate, dinobuton and cyhexatin (acaricides) were found equally effective among the significant group but only on mites infesting pumpkin, after 24 hours of application.

Dimethoate and phosphamidon maintained their significant efficacy in reducing the mite population on both the hosts upto 7 days. However, their efficacy was in no way detered on pumpkin against this host and extended upto 10 days. Malathion and endosulfan, although as effective as dimethoate and phosphamidon, lost their efficacy after 72 hours on pumpkin as well as on bottle gourd.

A number of workers in Punjab have found dimethoate comparatively more efficacious against different species of mites. Singh and Saini (1971) sprayed 0.03 per cent dimethoate against _T. telarius_ on castor and there was 97-99 per cent mortality. Gupta _et al._ (1972 ) tested 14 compounds against _T. cucurbitae_ infesting brinjal and found dimethoate 0.025 per cent the best in controlling mite infestation. Dhooria and Sagar (1975) found 1.35-2.25 kg ai/ha dimethoate granules, as a soil treatment, most effective against _T. cinnabarinus_ infesting squash melon. Sandhu and Dhooria (1975) reported dimethoate granules, applied as a soil treatment, gave complete kill of _Eutetranychus_ sp. on _Katchnar_ (_Bauhenia variegata_) for 2-4 weeks.

In Gujarat, Bharodia and Talati (1976_b_) evaluated several pesticides against _T. neocaledonicus_ in the laboratory and found that 0.03 per cent dimethoate gave 100 per cent kill of mites in 72 hours. However, dimethoate 0.05 per cent spray on okra and brinjal in Bangalore gave only 48.4 and 65.5 per cent reduction in the population of _T. neocaledonicus_ (Krishniah and Tandon, 1975).

Mailloux and Morrison (1962) tested several compounds and among them dimethoate giving appreciable kill of _T. telarius_ infesting French bean in U.S.A. Similarly, Thomas (1963) reported good control of three species of mites, _viz._ _T. altanticus_, _T. pacificus_ and _T. telarius_ was possible in some locations in U.S.A. with 1.3-3.5 kg ai/ha dimethoate applied as a soil treatment.

From Egypt, Osman (1974) reported excellent control of *T. cucurbitacearum* infesting *Phaseolus* sp. with dimethoate foliar spray; later on, Osman and Rasmy (1976) got good reduction of *T. cinnabarinus* and *T. utricae* infesting groundnut leaves with 0.1 per cent spray of dimethoate.

In Russia, Deryabin and Shaposhnikov (1975) found dimethoate @ 2 kg ai/ha giving 88.8 and 66.4 per cent control of Tetranychids after 30 and 50 days respectively. Sukharuchenko *et al*. (1977) recommended the use of dimethoate against cotton mites once in a season. They further cautioned against the frequent use of dimethoate, which could provoke the outbreak of cotton pests since it has been found toxic to natural enemies.

The findings of above mentioned authors proved that dimethoate besides being a potent aphid killer is an effecient acaricide. During the course of the present investigation dimethoate 0.03 per cent used as a foliar spray remained effective only upto 10 days. Its effectiveness was quite comparable to that of the systemic insecticides, *viz*. aldicarb, phorate and disulfoton which, however, persisted for a longer period (15-21 days). Perhaps soil treatment of dimethoate in the form of granules could have enhanced residual toxicity of dimethoate in the present studies.

Sandhu and Dhooria (1975) got complete kill of *Eutetranychus* sp. upto 4 weeks on *katchnar* (*Bauhenia variegata*) with dimethoate granules applied as a soil treatment. Foliar spray of 0.025 per cent dimethoate on brinjal in Hissar against *T. cucurbitae* has been reported to give 97 per cent reduction upto 15 days. Singh *et al.* (1975) reported reduction of this mite on the higher side. It may, however, be due to the nature of the crop and the differing rate of translocation through the plant species.

Phosphamidon which was found similar in its effectiveness to dimethoate in the present studies has also been reported to be outstandingly effective amongst several compounds tested against *T. telarius* in laboratory screening trial conducted in Israel by Ascher and Cwilich (1960). Similarly, El-badry and Khalil (1972) got complete control of *T. cinnabarinus* when phosphamidon @ 500 ml ai/acre was sprayed over cotton crop in Egypt. Bharodia and Talati (1976*b*) got 100 per cent kill of *T. neocaledonicus* with 0.03 per cent spray of phosphamidon on cotton. Similarly, Srivastava and Mathur (1962) have reported phosphamidon giving superior knock down of *T. telarius* on castor. Singh *et al.* (1975) sprayed 0.025 per cent phosphamidon on brinjal against *T. cucurbitae* and found it to be one of the best out of 19 chemicals tested. Atwal *et al.*

(1969) got 90-100 per cent kill of adults of _T. cucurbitae_ with 0.025 per cent phosphamidon spray on brinjal.

In the present studies, malathion or endosulfan as already reported lost their effectiveness much before other insecticides included in this test. Singh and Saini (1971) got 96-99 per cent control of _T. telarius_ on castor and found it as effective as dicofol or dimethoate but only for 48 hours. However, Atwal _et al_. (1969), Gupta _et al_.(1972) and Iacob _et al_. (1974) found malathion to be least effective among several other compounds in controlling _T. cucurbitae_ and _T. urticae_ on brinjal and cucumber respectively. Gupta _et al_. (1972 ) also reported 0.05 and 0.075 per cent endosulfan least effective against _T. cucurbitae_ on brinjal.

Among acaricides, sulphur was least effective in controlling the pest at all the intervals tested in the present studies. It was also significantly inferior to all other pesticides and as effective as plain water spray in reducing the mite infestation on both pumpkin and bottle gourd.

Srivastava and Mathur (1962) also found it least effective among five compounds tested against _T. telarius_ on castor. Dinobuton, cyhexatin and methamidophos were significantly superior and as effective as dimethoate and phosphamidon over a period of 7 days, while other two compounds of the same group, viz. dicofol and phenthoate, lost their effectiveness and fell apart from the significant group after 5 days of application. Ascher and Cwilick (1960), Singh and Saini (1971), Osman (1974) and Krishniah and Tondon (1975) found dicofol outstanding in its performance among several other compounds against T. telarius and T. cucurbitacearum. Among other acaricides, Krishniah and Tandon (1975), Gaaboub et al. (1977) and Sukharuchenko et al. (1977) found dicofol highly toxic to T. telarius and cotton mites respectively. They further reported that it spared predators. Gupta et al. (1972 ) have reported it to be effective ovicide giving 100 per cent kill of the eggs of T. cucurbitae at 0.025 and 0.075 per cent concentrations. Worthing (1968) got excellent control of T. telarius on Chrysanthemum with dinobuton out of 37 compounds tested as protectants. Ignatova (1975) found 0.2 per cent dinobuton spray to kill 98-100 per cent grape vine mites (T. utricae) and to retain its toxicity from 30-50 days. Similarly, Gaaboub et al. (1977) and Sukharuchenko et al. (1977) found dinobuton highly toxic to cotton and other mites. Cone and Burdajewicz (1972), Lindquist and Spadafora (1972), Krishniah and Tandon (1975) and Walters (1976) found cyhexatin most effective in controlling _T. utricae_ and _T. reocaledonicus_ attacking rose, apple, hops, okra and brinjal in different locations around various countries.

The systemic granular pesticides, _viz_. aldicarb, disulfoton, phorate and carbofuran, began their activity perhaps after 48 hours of their application. They were significantly inferior to many pesticides before 72 hours but after this period and upto 10 days they maintained their significant superiority over the remaining compounds.

On pumpkin, aldicarb, phorate and disulfoton, proved significantly superior over the remaining compounds tested against the pest upto 15 days. Carbofuran, dimethoate and phosphamidon although significantly inferior to the above mentioned compounds gave comparatively better reduction over the remaining eight compounds. Phorate and aldicarb were most effective even upto 21 days after application, but disulfoton, carbofuran, dimethoate and phosphamidon, though significantly inferior to phorate and aldicarb, were superior to the remaining ones.

Out of the 14 pesticides tested aldicarb and disulfoton afforded maximum population reduction and persistence when applied as granules @ 1.5 kg ai/ha to the soil. However, their action was delayed as compared to dimethoate and phosphamidon. This difference may perhaps be due to the fact that aldicarb and disulfoton granules applied to the soil took time in translocation and to reach to the site of mite infestation. From these results it can also be derived that either the soil application of these pesticides should be planned well in time or else a contact acaricide like dicofol or dinobuton should be sprayed simultaneously if the quick knockdown along with long persistance be the aim. Wilcox and Howland (1960) lend support to our findings who demonstrated that phorate or disulfoton @ 1 kg ai/ha gives adequate protection to lima beans against T. telarius for 2-3 months. Wene et al. (1972) also reported excellent performance of aldicarb and phorate against T. cinnabarinus and T. turkestane infesting lucerne in Arizona. They further reported that out of three systemic soil insecticides carbofuran even @ 3.36 kg ai/ha failed to control the mites. Results of the present finding also proved that carbofuran was significantly inferior to aldicarb, and disulfoton in the duration of its residual toxicity which diminished 12 days earlier to these compounds.

Bindra et al. (1970) found aldicarb, phorate and disulfoton when applied to the soil @ 1.25 kg ai/ha against T. telarius on lima beans in Ludhiana giving adequate protection upto 20 days and 100 per cent kill upto 7 days.

Considering the climatic factors involved in the degradation of pesticides it is quite likely that pesticides commonly employed by Wilcox and Howland (1960) and Bindra et al.(1970) as well as in the present studies do not go together for the fact that in America or Russia (under temperate climate) pesticides degrade slowly as compared to quick dissipation in the subtropical or tropical climatic conditions. Deryabin and Shaposhnikov (1975) got adequate control of Tetranychids upto 50 days in Russia with dimethoate granules but under Indian conditions the dissipation recorded lasted for adequate protection upto 4 weeks (Sandhu and Dhooria, 1975).

Pablo and Pangga (1971) have also reported disulfoton having given good control against T. utricae on green gram (Phaseolus aureus) in Manila (Phillipines) when applied as granules in the soil. A side dressing of aldicarb granules @ 1 kg toxicant/ha against T. cinnabarinus infesting okra (EaswaraMoortay et al., 1976) and application of aldicarb granules in the trenches around the hop crowns @ 7.2 g toxicant/hill have given good control of T. utricae in Washington State (Cone and Maitlen, 1976). The previous findings have thus proved beyond doubt that phorate, aldicarb and disulfoton rate among some of the best pesticides for Tetranychids. However, species of mites involved in the present studies differs from the species subjected to pesticidal efficacy test by the previous authors. It seems thus that there is little effect of species on the efficacy of pesticides so far as Tetranychids are concerned.

No parasite of this mite species was recorded and the population of predators was found to be very low, hence the effect of pesticides on predator-parasite complex could not be worked out.

Residual toxicity of pesticides

In order to study the persistence of different pesticides tested in the field trial on pumpkin and bottle gourd, a pot trial was undertaken in the departmental insectary of the College. The concentration of pesticidal sprays and the amount of the pesticide to be mixed with the soil was essentially the same as used in the field trial.

The residual toxicity of the pesticides was determined by working out the PT values from the mortality data of mites collected from the treated plants up to a period of 21 days. It was found that phorate, aldicarb, disulfoton, carbofuran, cyhexatin, methamidophos, dicofol, endosulfan, dimethoate and phosphamidon were effective in killing the mites upto 21 days, while dinobuton and phenthoate persisted for only 15 days. Similarly, sulphur and

TABLE 23. Residual toxicity of different pesticides

| S.No. | Treatments | Corrected percentage mortality after | | | | | | | P | T | PT | ORE* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 48 hours | 72 hours | 5 days | 7 days | 10 days | 15 days | 21 days | | | | |
| 1 | Phorate Gr | 57.15 | 100.00 | 100.00 | 100.00 | 100.00 | 94.54 | 71.95 | 21 | 89.09 | 1870.89 | 1 |
| 2 | Aldicarb Gr | 64.27 | 100.00 | 100.00 | 100.00 | 100.00 | 87.29 | 66.68 | 21 | 88.32 | 1854.72 | 2 |
| 3 | Disulfoton Gr | 62.51 | 100.00 | 100.00 | 100.00 | 95.00 | 85.43 | 66.68 | 21 | 87.09 | 1828.89 | 3 |
| 4 | Carbofuran Gr | 53.56 | 100.00 | 100.00 | 100.00 | 91.65 | 81.83 | 56.16 | 21 | 83.31 | 1749.51 | 5 |
| 5 | Dinobuton | 100.00 | 100.00 | 96.34 | 86.43 | 71.65 | 29.08 | 0.00 | 15 | 80.58 | 1208.70 | 11 |
| 6 | Cyhexatin | 100.00 | 100.00 | 98.20 | 88.15 | 75.00 | 36.33 | 10.53 | 21 | 72.60 | 1524.60 | 7 |
| 7 | Sulphur | 71.45 | 62.94 | 50.90 | 35.59 | 28.35 | 0.00 | 0.00 | 10 | 49.85 | 498.50 | 14 |
| 8 | Methamidophos | 100.00 | 100.00 | 94.54 | 81.34 | 63.35 | 25.42 | 5.53 | 21 | 66.88 | 1404.48 | 8 |
| 9 | Dicofol | 100.00 | 100.00 | 92.74 | 76.26 | 50.00 | 12.71 | 1.74 | 21 | 61.92 | 1300.32 | 10 |
| 10 | Phenthoate | 100.00 | 100.00 | 92.74 | 66.09 | 50.00 | 9.06 | 0.00 | 15 | 69.65 | 1044.75 | 12 |
| 11 | Malathion | 100.00 | 100.00 | 85.43 | 57.65 | 35.00 | 0.00 | 0.00 | 10 | 75.62 | 756.20 | 13 |
| 12 | Endosulfan | 100.00 | 100.00 | 96.34 | 67.82 | 53.35 | 12.71 | 5.26 | 21 | 62.21 | 1306.41 | 9 |
| 13 | Dimethoate | 100.00 | 100.00 | 100.00 | 100.00 | 93.35 | 67.27 | 47.37 | 21 | 86.86 | 1824.06 | 4 |
| 14 | Phosphamidon | 100.00 | 100.00 | 100.00 | 96.59 | 86.65 | 58.16 | 33.32 | 21 | 82.10 | 1724.10 | 6 |

* ORE - Order of relative efficacy based on PT values

malathion gave effective kill upto 10 days only. The relative residual toxicity of the pesticides which persisted for 21 days was found in the following order: Phorate > aldicarb > disulfoton > dimethoate > carbofuran > phosphamidon > cyhexatin > methamidophos > endosulfan > dicofol.

The relative residual toxicity of dinobuton was greater than phenthoate which lasted for 15 days only. Similarly, residual toxicity index (PT values) was higher being 756.2 for malathion and 498.5 for sulphur which was relatively inferior in its residual effectiveness to malathion, lasting only for 10 days.

All the systemic pesticides, whether applied as foliar spray or in the form of granules to the soil, persisted for longer duration (21 days) and their PT values were also higher than the remaining ones tested in this regard being above 1700 (Table 23).

The persistence of some of the acaricides, viz. cyhexatin, methmidophos and dicofol, was comparable to the above mentioned group of systemics but their range of PT values was of a lower order ranging from 1300 to 1525.

# SUMMARY

Laboratory and field studies were carried out from June, 1976 to June, 1978 to study the ecology and control of cucurbit mite, Tetranychus neocaledonicus Andre (Acarina : Tetranychidae) in the department of Agricultural Zoology and Entomology and on the Horticulture Farm of Rajasthan College of Agriculture and the surrounding areas of Udaipur.

## A. Host range

A field survey revealed that there were 41 plant species belonging to 18 families which harboured all the stages of the mite species. Usually the mites were observed confining to the dorsal (lower) surface of the leaves of these plants.

## B. Seasonal incidence and varietal susceptibility

The seasonal incidence of the mite species was studied on 13 cucurbit varieties grown in two different seasons. The data were recorded from March to December, 1977. On March sown crops incidence started in April

and reached its peak in June. In July sown crops the peak was observed during October-November. High temperature and moderately high humidity were found favourable for the population built-up. The rainfall reduced the mite population to varying low levels on different varieties. From the beginning of December the population density went down as the temperature level fell and by the end of December, plants could not survive due to frost and so the mite population could not survive.

The correlation between increase in population of individual stages as well as of total number of mites with average maximum temperature and relative humidity revealed a positive correlationship on all the crops and in most of the cases it was significant. The correlation between decrease in the population of mites with amount of rainfall and minimum temperature revealed positive correlation in all but one (pumpkin) host crops. In several cases this relationship was found to be significant.

Among 13 different varieties of cucurbits (bottle gourd: Kalyanpur long green, summer; Pusa selection prolific long; Pusa selection prolific round; Pusa manjari; Long white prolific and Local; cucumber: Japanese long green and Local; sponge gourd: Luffa pusa chikni; ridge gourd:

Jhinga tori and Local; pumpkin: Local; and bitter gourd: Local) tested for their varietal susceptibility, the seasonal incidence studies at weekly intervals revealed that pumpkin (Local) and bottle gourd (Kalyanpur long green, summer) sustained maximum mean mite population, being respectively 251 and 261/18 x 2 $cm^2$ leaf area and thus were considered to be the most susceptible ones. Bitter gourd (Local) proved to be resistant as it harboured minimum mean mite population (36/18 x 2 $cm^2$).

The external characters of the leaf were not found to have any bearing on the susceptibility or resistance to the mite species. A significant positive correlation was found between the nitrogen content present in the leaves and the population of the mites. However, potash and phosphorus contents of the leaves did not bear any significant correlation with mites population.

C. Natural enemies

Though no parasite was recorded, 8 predators belonging to two families, viz. Coccinellidae and Phytoseiidae, were found predating on the pest species. However, their population remained low throughout the crop season and did not excercise an effective role in checking the pest population.

D. Effect of rain and wind on the reduction of mite population

Different amounts of rainfall (11.2, 19.0, 20.6 and 36.0 mm) included in the present investigation reduced the mite population considerably. More number of adults were dislodged in comparison to immatures while eggs were found to be most resistant to dislodging. A varied response of the mite population to different varieties was observed with differing amount of rainfall. Pumpkin (Local) having broad, large, hard and hairy leaf surface was found to be most resistant to all the differing amounts of rain under study. Bottle gourd (the leaves of which are smooth and non-hairy) was recorded to be comparatively susceptible. Barring a few exceptions the reduction was least with 11.2 mm rainfall and the maximum with 36.0 mm rainfall.

The effect of wind velocities (10.8, 19.8, 25.2, 30.6, 34.2 and 37.8 km/hr) on the reduction of mite population on bottle gourd (Kalyanpur long green, summer and pumpkin, Local) revealed that the wind contributes its mite in the dislodgement of mites. With the increase in wind velocity, dislodgement of mites also increased significantly and both hosts followed the same trend. Dislodgement of adult mites was, however, recorded to be more on bottle gourd as compared to pumpkin. This was perhaps due to morphological characters of the leaf.

E. Biology

For studying the biology of the mite, a rearing cage was developed. Overall performance of the cage was quite good and gave adequate protection from the mite escape with least injury to the leaf and assured ventilation.

The effect of 20°, 25°, 30°, 35°, 37° and 40°C (± 2°C) constant temperatures and two constant humidity levels of 50 and 80 (± 5 per cent) on the biology of this mite was studied on five susceptible hosts, *viz.* bottle gourd (Kalyanpur long green, summer), cucumber (Japanese long green), sponge gourd (Luffa pusa chikni), pumpkin (Local) and bitter gourd (Local). At 20°C temperature and 80 per cent relative humidity, the life cycle of the mite was greatly extended on all the hosts. Higher temperatures above 20°C except 40°C stimulated their growth and development. High temperature (40°C) combined with either of the humidity levels brought about the mortality of individual stages. Most suitable temperature and relative humidity combination for their growth, development and reproduction was 30°C and 80 per cent relative humidity.

The maximum web formation was recorded at 37°C and 50 per cent relative humidity.

F. Nature and extent of damage

The vitality of plants was seriously affected by the chlorotic spots developing on the leaves as a result of their sucking the cell-sap. The mites preferably inhabited the under surface of leaves but sometimes terminal and floral parts were also found infested. In consideration of the infestation levels a five-point damage index scale has been proposed. The damage index was found to be inversely proportional to the number of mites released on the plants.

G. Effect of site on the incidence

The incidence of the mite species was carried out at three different locations, viz. Horticulture Farm, Farmers' field and College insectary. The maximum incidence was recorded on the Horticulture Farm followed by that of Farmers' field. The lowest infestation level was observed in the insectary. Thick and dense vegetation lead to their severe infestation.

H. Effect of pesticides and residual toxicity

Out of the 14 pesticides, viz. phorate, aldicarb, disulfoton, carbofuran (all in granular form applied @ 1.5 kg ai/ha); cyhexatin, methamidophos, phenthoate, malathion and endosulfan (each at 0.05 per cent concentration); phosphamidon, dicofol, dinobuton and dimethoate (each at 0.03 per cent); and sulphur (0.5 per cent concentration) tested against *T. neocaledonicus* in field (on pumpkin and bottle gourd) and in laboratory (on bottle gourd), phorate, aldicarb and disulfoton afforded maximum reduction in the mite population and were the most persistent. However, their action was delayed as compared to dimethoate and phosphamidon.

Among insecticides used as sprays, dimethoate proved to be the best, followed by phosphamidon. Methamidophos and cyhexatin were found to be most effective followed by dinobuton among the acaricides. The relative residual toxicity of the pesticides which persisted for 21 days was found to be in the order: phorate > aldicarb > disulfoton > dimethoate > carbofuran > phosphamidon > cyhexatin > methamidophos > endosulfan > dicofol.

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APPENDIX I

Random weekly population of the mite, <u>Tetranychus neocalidonicus</u> on 13 different cucurbit varieties **from** April to December, 1977 (54 x 2 $cm^2$)

Bottle gourd (<u>Lagenaria siceraria</u> L.)
Var. Kalyanpur long green (summer)

| Month and Date | | Egg | Immature | Adult | Total |
|---|---|---|---|---|---|
| March sown crop (4-3-1977) | | | | | |
| April | 4 | - | - | - | 0 |
| | 11 | - | - | 6 | 6 |
| | 18 | 18 | 46 | 22 | 86 |
| | 25 | 42 | 56 | 58 | 156 |
| May | 2 | 46 | 74 | 116 | 236 |
| | 9 | 62 | 100 | 150 | 312 |
| | 16 | 44 | 80 | 118 | 242 |
| | 23 | 126 | 164 | 160 | 450 |
| | *30 | 57 | 76 | 80 | 213 |
| June | 6 | 72 | 132 | 204 | 408 |
| | **13 | 142 | 195 | 212 | 549 |
| | 20 | 184 | 266 | 236 | 686 |
| | *27 | 235 | 12 | 20 | 267 |
| July | * 4 | 252 | 24 | 18 | 294 |
| | 11 | 188 | 172 | 110 | 470 |
| | 18 | 159 | 202 | 120 | 481 |
| | 25 | 150 | 209 | 178 | 537 |
| August | ** 1 | 67 | 78 | 73 | 218 |
| | ** 8 | 77 | 100 | 42 | 219 |
| | 15 | 98 | 119 | 80 | 297 |
| July sown crop (20-7-1977) | | | | | |
| | 22 | 133 | 189 | 152 | 474 |
| | *29 | 158 | 104 | 54 | 316 |
| September | * 5 | 101 | 51 | 17 | 169 |
| | 12 | 88 | 133 | 45 | 266 |
| | 19 | 127 | 166 | 132 | 425 |
| | 26 | 203 | 248 | 184 | 635 |
| October | 3 | 210 | 297 | 276 | 783 |
| | 10 | 137 | 304 | 239 | 680 |
| | 17 | 127 | 286 | 296 | 709 |
| | 24 | 175 | 273 | 252 | 700 |
| | 31 | 138 | 258 | 204 | 600 |
| November | 7 | 188 | 265 | 271 | 724 |
| | 14 | 178 | 260 | 245 | 683 |
| | 21 | 183 | 233 | 139 | 555 |
| | 28 | 197 | 202 | 147 | 546 |
| December | 5 | 150 | 219 | 128 | 497 |
| | 12 | 151 | 207 | 146 | 504 |
| | 19 | 123 | 136 | 81 | 340 |
| | 26 | 72 | 36 | 36 | 144 |
| | 28 | - | - | - | 0 |



contd.......

Bottle gourd (*Lagenaria siceraria* L.)
Var. Pusa selection prolific long

| Month and date | | Egg | Immature | Adult | Total |
|---|---|---|---|---|---|
| March sown crop (4-3-77) | | | | | |
| April | 4 | -- | -- | -- | 0 |
| | 11 | -- | -- | -- | 0 |
| | 18 | -- | -- | 4 | 4 |
| | 25 | 6 | 6 | 2 | 14 |
| May | 2 | 12 | 28 | 14 | 54 |
| | 9 | 37 | 47 | 74 | 158 |
| | 16 | 41 | 69 | 102 | 212 |
| | 23 | 58 | 73 | 99 | 230 |
| | *30 | 69 | 20 | 14 | 103 |
| June | 6 | 71 | 82 | 122 | 275 |
| | **13 | 65 | 91 | 127 | 283 |
| | 20 | 55 | 126 | 122 | 303 |
| | *27 | 66 | 16 | 12 | 94 |
| July | * 4 | 26 | 24 | 4 | 54 |
| | 11 | 26 | 32 | 18 | 76 |
| | 18 | 4 | 4 | 6 | 14 |
| | 25 | 49 | 47 | 65 | 161 |
| August | ** 1 | 32 | 61 | 13 | 106 |
| | ** 8 | 35 | 44 | 26 | 105 |
| | 15 | 80 | 93 | 55 | 228 |
| July sown crop (20-7-77) | | | | | |
| | 22 | 114 | 118 | 136 | 368 |
| | *29 | 173 | 45 | 21 | 239 |
| September | * 5 | 89 | 21 | 8 | 118 |
| | 12 | 70 | 70 | 93 | 233 |
| | 19 | 90 | 93 | 108 | 291 |
| | 26 | 131 | 158 | 149 | 438 |
| October | 3 | 112 | 148 | 140 | 400 |
| | 10 | 141 | 176 | 170 | 487 |
| | 17 | 114 | 145 | 195 | 454 |
| | 24 | 146 | 181 | 176 | 503 |
| | 31 | 132 | 158 | 150 | 440 |
| November | 7 | 122 | 122 | 138 | 382 |
| | 14 | 141 | 146 | 169 | 456 |
| | 21 | 145 | 185 | 110 | 440 |
| | 28 | 142 | 176 | 100 | 418 |
| December | 5 | 124 | 141 | 79 | 344 |
| | 12 | 145 | 138 | 71 | 354 |
| | 19 | 106 | 83 | 41 | 230 |
| | 26 | 111 | 84 | 116 | 311 |
| | 28 | - | - | - | 0 |



contd.........

Bottle gourd (*Lagenaria siceraria* L.)
Var. Pusa selection prolific round

| Month and date | | Egg | Immature | Adult | Total |
|---|---|---|---|---|---|
| | March sown crop (4-3-77) | | | | |
| April | 4 | - | - | - | 0 |
| | 11 | - | - | - | 0 |
| | 18 | - | - | - | 0 |
| | 25 | - | 4 | 6 | 10 |
| May | 2 | 29 | 41 | 60 | 130 |
| | 9 | 31 | 52 | 76 | 159 |
| | 16 | 14 | 32 | 46 | 92 |
| | 23 | 38 | 49 | 65 | 152 |
| | *30 | 19 | 4 | 2 | 25 |
| June | 6 | 39 | 32 | 92 | 163 |
| | **13 | 75 | 87 | 128 | 290 |
| | 20 | 57 | 66 | 97 | 220 |
| | *27 | 107 | 11 | 6 | 124 |
| July | * 4 | 56 | 69 | 40 | 165 |
| | 11 | 87 | 102 | 60 | 249 |
| | 18 | 82 | 87 | 48 | 217 |
| | 25 | 84 | 82 | 56 | 222 |
| August | **1 | 65 | 71 | 19 | 155 |
| | **8 | 80 | 7 | 4 | 91 |
| | 15 | 70 | 73 | 41 | 184 |
| | July sown crop (20-7-77) | | | | |
| | 22 | 115 | 113 | 76 | 304 |
| | *29 | 143 | 46 | 31 | 220 |
| September | * 5 | 155 | 20 | 9 | 184 |
| | 12 | 99 | 104 | 57 | 260 |
| | 19 | 95 | 111 | 65 | 271 |
| | 26 | 119 | 136 | 76 | 331 |
| October | 3 | 87 | 115 | 109 | 311 |
| | 10 | 110 | 137 | 133 | 380 |
| | 17 | 102 | 102 | 114 | 318 |
| | 24 | 107 | 107 | 121 | 335 |
| | 31 | 99 | 122 | 119 | 340 |
| November | 7 | 79 | 79 | 88 | 246 |
| | 14 | 76 | 78 | 90 | 244 |
| | 21 | 85 | 73 | 68 | 226 |
| | 28 | 82 | 96 | 56 | 234 |
| December | 5 | 87 | 102 | 60 | 249 |
| | 12 | 92 | 87 | 45 | 224 |
| | 19 | 76 | 60 | 30 | 166 |
| | 26 | 95 | 29 | 14 | 138 |
| | 28 | - | - | - | 0 |



Contd........

Bottle gourd (<u>Lagenaria siceraria</u> L.)
Var. Pusa mangari

| Month and date | | Egg | Immature | Adult | Total |
|---|---|---|---|---|---|
| | March sown crop (4-3-77) | | | | |
| April | 4 | - | - | - | 0 |
| | 11 | - | - | - | 0 |
| | 18 | - | - | - | 0 |
| | 25 | - | - | 2 | 2 |
| May | 2 | 1 | 2 | 2 | 5 |
| | 9 | 2 | 2 | 2 | 6 |
| | 16 | 13 | 26 | 10 | 49 |
| | 23 | 35 | 58 | 83 | 176 |
| | *30 | 10 | 16 | 4 | 30 |
| June | 6 | 33 | 56 | 86 | 175 |
| | **13 | 44 | 74 | 55 | 173 |
| | 20 | 57 | 65 | 95 | 217 |
| | *27 | 86 | 23 | 10 | 119 |
| July | * 4 | 47 | 6 | 3 | 56 |
| | 11 | 43 | 45 | 25 | 113 |
| | 18 | 37 | 38 | 50 | 125 |
| | 25 | 37 | 44 | 41 | 122 |
| August | **1 | 45 | 46 | 12 | 103 |
| | **8 | 6 | 14 | 2 | 22 |
| | 15 | 39 | 48 | 28 | 115 |
| | July sown crop (20-7-77) | | | | |
| | 22 | 71 | 73 | 85 | 229 |
| | *29 | 78 | 22 | 10 | 110 |
| September | * 5 | 118 | 33 | 15 | 166 |
| | 12 | 73 | 93 | 56 | 222 |
| | 19 | 133 | 156 | 90 | 379 |
| | 26 | 119 | 119 | 159 | 397 |
| October | 3 | 121 | 161 | 152 | 434 |
| | 10 | 116 | 144 | 140 | 400 |
| | 17 | 127 | 127 | 143 | 397 |
| | 24 | 137 | 165 | 156 | 458 |
| | 31 | 112 | 115 | 133 | 360 |
| November | 7 | 123 | 123 | 164 | 410 |
| | 14 | 136 | 136 | 152 | 424 |
| | 21 | 155 | 182 | 107 | 444 |
| | 28 | 131 | 128 | 87 | 346 |
| December | 5 | 88 | 92 | 51 | 231 |
| | 12 | 111 | 105 | 54 | 270 |
| | 19 | 130 | 101 | 51 | 282 |
| | 26 | - | - | - | 0 |
| | 28 | - | - | - | 0 |



Contd.........

Bottle gourd (*Lagenaria siceraria* L.)
Var. Long white prolific

| Month and date | | Egg | Immature | Adult | Total |
|---|---|---|---|---|---|
| March sown crop (4-3-77) | | | | | |
| April | 4 | - | - | - | 0 |
| | 11 | - | - | - | 0 |
| | 18 | - | - | - | 0 |
| | 25 | - | - | 2 | 2 |
| May | 2 | - | - | - | 0 |
| | 9 | - | 6 | 2 | 8 |
| | 16 | 8 | 10 | 6 | 24 |
| | 23 | 33 | 47 | 68 | 148 |
| | *30 | 42 | 12 | - | 54 |
| June | 6 | 37 | 53 | 76 | 166 |
| | **13 | 50 | 83 | 117 | 250 |
| | 20 | 66 | 58 | 129 | 253 |
| | *27 | 126 | 19 | 7 | 152 |
| July | * 4 | 93 | 25 | 12 | 130 |
| | 11 | 119 | 80 | 79 | 278 |
| | 18 | 61 | 80 | 76 | 217 |
| | 25 | 99 | 64 | 33 | 196 |
| August | **1 | 48 | 54 | 17 | 119 |
| | **8 | 53 | 42 | 37 | 132 |
| | 15 | 99 | 93 | 75 | 267 |
| July sown crop (20-7-77) | | | | | |
| | 22 | 116 | 143 | 83 | 342 |
| | *29 | 169 | 32 | 11 | 212 |
| September | * 5 | 148 | 19 | 9 | 176 |
| | 12 | 92 | 98 | 53 | 243 |
| | 19 | 113 | 110 | 74 | 297 |
| | 26 | 121 | 121 | 136 | 378 |
| October | 3 | 225 | 165 | 156 | 446 |
| | 10 | 118 | 160 | 148 | 426 |
| | 17 | 119 | 148 | 144 | 411 |
| | 24 | 128 | 159 | 154 | 441 |
| | 31 | 143 | 143 | 161 | 447 |
| November | 7 | 106 | 110 | 126 | 342 |
| | 14 | 77 | 76 | 101 | 254 |
| | 21 | 124 | 145 | 85 | 354 |
| | 28 | 119 | 136 | 76 | 331 |
| December | 5 | 99 | 105 | 58 | 262 |
| | 12 | 118 | 115 | 77 | 310 |
| | 19 | 67 | 63 | 33 | 163 |
| | 26 | 110 | 86 | 43 | 239 |
| | 28 | - | - | - | 0 |



Contd........

Bottle gourd (<u>Lagenaria siceraria</u> L.)
Var. Local (Udaipur)

| Month and date | | Egg | Immature | Adult | Total |
|---|---|---|---|---|---|
| March sown crop (4-3-77) | | | | | |
| April | 4 | - | - | - | 0 |
| | 11 | - | - | - | 0 |
| | 18 | - | - | - | 0 |
| | 25 | - | - | - | 0 |
| May | 2 | - | - | - | 0 |
| | 9 | 14 | 22 | 18 | 54 |
| | 16 | 19 | 13 | 38 | 70 |
| | 23 | - | 2 | 2 | 4 |
| | *30 | - | - | - | 0 |
| June | 6 | - | 6 | 4 | 10 |
| | **13 | 23 | 30 | 39 | 92 |
| | 20 | 26 | 35 | 50 | 111 |
| | *27 | 79 | 10 | 5 | 94 |
| July | * 4 | 74 | 13 | 6 | 93 |
| | 11 | 64 | 83 | 44 | 191 |
| | 18 | 69 | 72 | 83 | 224 |
| | 25 | 73 | 73 | 82 | 228 |
| August | ** 1 | 61 | 59 | 47 | 167 |
| | ** 8 | 42 | 48 | 28 | 118 |
| | 15 | 80 | 99 | 56 | 235 |
| July sown crop (20-7-77) | | | | | |
| | 22 | 73 | 72 | 97 | 242 |
| | *29 | 55 | 4 | 6 | 65 |
| September | * 5 | 83 | 6 | 6 | 95 |
| | 12 | 76 | 97 | 57 | 230 |
| | 19 | 109 | 138 | 82 | 329 |
| | 26 | 97 | 99 | 115 | 311 |
| October | 3 | 87 | 106 | 104 | 297 |
| | 10 | 106 | 139 | 132 | 377 |
| | 17 | 101 | 121 | 114 | 336 |
| | 24 | 74 | 98 | 93 | 265 |
| | 31 | 79 | 99 | 96 | 274 |
| November | 7 | 96 | 122 | 73 | 291 |
| | 14 | 74 | 76 | 88 | 238 |
| | 21 | 68 | 84 | 48 | 200 |
| | 28 | 67 | 79 | 46 | 192 |
| December | 5 | 81 | 95 | 56 | 232 |
| | 12 | 44 | 51 | 29 | 124 |
| | 19 | 50 | 47 | 25 | 122 |
| | 26 | - | - | - | 0 |
| | 28 | - | - | - | 0 |



Contd.........

Cucumber (<u>Cucumis sativus</u> L.)

Var. Cucumber Japnese long green

| Month and date | | Egg | Immature | Adult | Total |
|---|---|---|---|---|---|
| | | March sown crop (4-3-77) | | | |
| April | 4 | – | – | – | 0 |
| | 11 | – | – | – | 0 |
| | 18 | – | – | – | 0 |
| | 25 | – | 2 | 2 | 4 |
| May | 2 | 0 | 6 | 2 | 8 |
| | 9 | 2 | 10 | 2 | 14 |
| | 16 | 0 | 0 | 0 | 0 |
| | 23 | 10 | 16 | 10 | 36 |
| | *30 | 0 | 0 | 0 | 0 |
| June | 6 | 15 | 25 | 37 | 77 |
| | **13 | 36 | 52 | 75 | 163 |
| | 20 | 46 | 64 | 91 | 201 |
| | *27 | 76 | 22 | 11 | 109 |
| July | * 4 | 73 | 40 | 17 | 130 |
| | 11 | 59 | 75 | 45 | 179 |
| | 18 | 67 | 67 | 90 | 224 |
| | 25 | 51 | 59 | 87 | 197 |
| August | ** 1 | 37 | 67 | 38 | 142 |
| | ** 8 | 21 | 27 | 16 | 64 |
| | 15 | 26 | 30 | 18 | 74 |
| | | July sown crop (20-7-77) | | | |
| | 22 | 79 | 97 | 56 | 232 |
| | *29 | 111 | 45 | 17 | 173 |
| September | * 5 | 115 | 21 | 7 | 143 |
| | 12 | 57 | 67 | 39 | 163 |
| | 19 | 79 | 97 | 56 | 232 |
| | 26 | 93 | 123 | 116 | 332 |
| October | 3 | 103 | 136 | 127 | 366 |
| | 10 | 140 | 168 | 159 | 467 |
| | 17 | 151 | 187 | 182 | 520 |
| | 24 | 112 | 139 | 135 | 386 |
| | 31 | 139 | 139 | 156 | 434 |
| November | 7 | 110 | 136 | 132 | 378 |
| | 14 | 86 | 114 | 108 | 308 |
| | 21 | 141 | 180 | 107 | 421 |
| | 28 | 106 | 124 | 72 | 302 |
| December | 5 | 106 | 111 | 61 | 278 |
| | 12 | 109 | 106 | 72 | 287 |
| | 19 | 131 | 99 | 44 | 274 |
| | 26 | 86 | 68 | 34 | 188 |
| | 28 | 0 | 0 | 0 | 0 |



Contd........

Cucumber (*Cucumis sativus* L.)
Var. Cucumber local (Udaipur)

| Month and Date | | Egg | Immature | Adult | Total |
|---|---|---|---|---|---|
| | | March sown crop (4-3-77) | | | |
| April | 4 | - | - | - | 0 |
| | 11 | - | - | - | 0 |
| | 18 | - | - | 2 | 2 |
| | 25 | - | 4 | 2 | 6 |
| May | 2 | - | 2 | 6 | 8 |
| | 9 | 6 | 6 | 4 | 16 |
| | 16 | 7 | 12 | 17 | 36 |
| | 23 | 5 | 8 | 12 | 25 |
| | *30 | 4 | 4 | 2 | 10 |
| June | 6 | 4 | 6 | 9 | 19 |
| | **13 | 18 | 24 | 31 | 73 |
| | 20 | 29 | 33 | 51 | 113 |
| | *27 | 26 | 35 | 33 | 94 |
| July | * 4 | 71 | 16 | 22 | 109 |
| | 11 | 44 | 54 | 33 | 131 |
| | 18 | 58 | 71 | 41 | 170 |
| | 25 | 35 | 36 | 40 | 111 |
| August | ** 1 | 22 | 30 | 8 | 60 |
| | ** 8 | 5 | 2 | 4 | 11 |
| | 15 | 20 | 23 | 13 | 56 |
| | | July sown crop (20-7-77) | | | |
| | 22 | 66 | 81 | 46 | 193 |
| | *29 | 79 | 18 | 19 | 116 |
| September | * 5 | 65 | 10 | 4 | 79 |
| | 12 | 35 | 44 | 26 | 105 |
| | 19 | 75 | 85 | 48 | 208 |
| | 26 | 51 | 50 | 68 | 169 |
| October | 3 | 82 | 53 | 102 | 237 |
| | 10 | 80 | 79 | 96 | 255 |
| | 17 | 96 | 118 | 115 | 329 |
| | 24 | 104 | 119 | 116 | 339 |
| | 31 | 116 | 116 | 155 | 387 |
| November | 7 | 126 | 127 | 151 | 404 |
| | 14 | 135 | 134 | 180 | 449 |
| | 21 | 122 | 155 | 93 | 370 |
| | 28 | 85 | 100 | 58 | 243 |
| December | 5 | 102 | 107 | 59 | 268 |
| | 12 | 102 | 97 | 50 | 249 |
| | 19 | 62 | 49 | 25 | 136 |
| | 26 | 63 | 46 | 21 | 130 |
| | 28 | - | - | - | 0 |



Contd........

Sponge gourd (Luffa cylindrica Roem)
Var. Luffa pusa chikni

| Month and date | | Egg | Immature | Adult | Total |
|---|---|---|---|---|---|
| | | March sown crop (4-3-77) | | | |
| April | 4 | - | - | - | 0 |
| | 11 | - | - | - | 0 |
| | 18 | - | - | 6 | 6 |
| | 25 | - | 6 | 10 | 16 |
| May | 2 | - | 6 | 4 | 10 |
| | 9 | 10 | 8 | 24 | 42 |
| | 16 | 29 | 41 | 60 | 130 |
| | 23 | 43 | 55 | 74 | 172 |
| | *30 | 45 | 14 | 5 | 64 |
| June | 6 | 51 | 59 | 87 | 197 |
| | **13 | 55 | 77 | 108 | 240 |
| | 20 | 51 | 74 | 105 | 230 |
| | *27 | 75 | 20 | 9 | 104 |
| July | * 4 | 78 | 18 | 24 | 120 |
| | 11 | 116 | 77 | 39 | 232 |
| | 18 | 116 | 115 | 77 | 308 |
| | 25 | 29 | 57 | 65 | 151 |
| August | **1 | 13 | 72 | 21 | 106 |
| | **8 | 20 | 30 | 12 | 62 |
| | 15 | 26 | 32 | 18 | 76 |
| | | July sown crop (20-7-77) | | | |
| | 22 | 50 | 29 | 60 | 139 |
| | *29 | 69 | 16 | 21 | 106 |
| September | * 5 | 49 | 13 | 11 | 73 |
| | 12 | 25 | 29 | 19 | 73 |
| | 19 | 47 | 47 | 52 | 146 |
| | 26 | 97 | 100 | 115 | 312 |
| October | 3 | 78 | 90 | 132 | 300 |
| | 10 | 92 | 122 | 115 | 329 |
| | 17 | 104 | 125 | 118 | 347 |
| | 24 | 109 | 109 | 122 | 340 |
| | 31 | 157 | 162 | 187 | 506 |
| November | 7 | 138 | 142 | 164 | 444 |
| | 14 | 138 | 165 | 156 | 459 |
| | 21 | 156 | 165 | 90 | 411 |
| | 28 | 158 | 153 | 103 | 414 |
| December | 5 | 166 | 190 | 75 | 431 |
| | 12 | 173 | 164 | 84 | 421 |
| | 19 | 154 | 121 | 53 | 328 |
| | 26 | 123 | 64 | 39 | 226 |
| | 28 | - | - | - | 0 |

Contd........

Ridge gourd (*Luffa acutangula* Roxb.)
Var. Local (Udaipur)

| Month and date | | Egg | Immature | Adult | Total |
|---|---|---|---|---|---|
| March sown crop (4-3-77) | | | | | |
| April | 4 | - | - | - | 0 |
| | 11 | - | - | - | 0 |
| | 18 | - | - | - | 0 |
| | 25 | - | - | - | 0 |
| May | 2 | - | - | - | 0 |
| | 9 | - | 4 | 2 | 6 |
| | 16 | - | 2 | 4 | 6 |
| | 23 | - | 10 | 4 | 14 |
| | *30 | - | - | - | 0 |
| June | 6 | 6 | 14 | 4 | 24 |
| | **13 | 12 | 20 | 29 | 61 |
| | 20 | 25 | 36 | 52 | 113 |
| | *27 | 80 | 7 | 3 | 90 |
| July | * 4 | 71 | 17 | 17 | 105 |
| | 11 | 47 | 60 | 36 | 143 |
| | 18 | 48 | 60 | 34 | 142 |
| | 25 | 47 | 47 | 53 | 147 |
| August | ** 1 | 37 | 38 | 13 | 88 |
| | ** 8 | 19 | 22 | 13 | 54 |
| | 15 | 6 | 6 | 4 | 16 |
| July sown crop (20-7-77) | | | | | |
| | 22 | 4 | 8 | 2 | 14 |
| | *29 | 6 | 4 | - | 10 |
| September | * 5 | 0 | 6 | 2 | 8 |
| | 12 | 12 | 11 | 2 | 25 |
| | 19 | 26 | 29 | 16 | 71 |
| | 26 | 16 | 15 | 18 | 49 |
| October | 3 | 32 | 42 | 40 | 114 |
| | 10 | 53 | 65 | 64 | 182 |
| | 17 | 83 | 83 | 94 | 260 |
| | 24 | 87 | 86 | 115 | 288 |
| | 31 | 88 | 154 | 101 | 343 |
| November | 7 | 81 | 97 | 92 | 270 |
| | 14 | 85 | 105 | 102 | 292 |
| | 21 | 114 | 109 | 152 | 375 |
| | 28 | 97 | 96 | 109 | 302 |
| December | 5 | 133 | 109 | 61 | 303 |
| | 12 | 105 | 82 | 41 | 228 |
| | 19 | 54 | 52 | 25 | 131 |
| | 26 | 44 | 36 | 20 | 100 |
| | 28 | - | - | - | 0 |



Contd.........

Ridge gourd (<u>Luffa</u> <u>acutangula</u> Roxb.)
Var. Jhinga tori

| Month and date | | Egg | Immature | Adult | Total |
|---|---|---|---|---|---|
| | | March sown crop (4-3-77) | | | |
| April | 4 | - | - | - | 0 |
| | 11 | - | - | - | 0 |
| | 18 | - | 4 | 2 | 6 |
| | 25 | 0 | 0 | 2 | 2 |
| May | 2 | - | 6 | - | 6 |
| | 9 | 2 | 4 | 4 | 10 |
| | 16 | 6 | 8 | 6 | 20 |
| | 23 | 2 | 10 | 4 | 16 |
| | *30 | - | - | - | 0 |
| June | 6 | 4 | 4 | 2 | 10 |
| | **13 | 37 | 54 | 77 | 168 |
| | 20 | 68 | 88 | 118 | 274 |
| | *27 | 78 | 15 | 5 | 98 |
| July | * 4 | 61 | 33 | 14 | 108 |
| | 11 | 73 | 77 | 42 | 192 |
| | 18 | 69 | 67 | 46 | 182 |
| | 25 | 49 | 58 | 55 | 162 |
| August | ** 1 | 59 | 49 | 28 | 136 |
| | ** 8 | 28 | 27 | 19 | 74 |
| | 15 | 29 | 36 | 21 | 86 |
| | | July sown crop (20-7-77) | | | |
| | 22 | 38 | 48 | 47 | 133 |
| | *29 | 47 | 17 | 12 | 76 |
| September | * 5 | 14 | 2 | 2 | 18 |
| | 12 | 4 | 6 | - | 10 |
| | 19 | 28 | 30 | 34 | 92 |
| | 26 | 36 | 35 | 40 | 111 |
| October | 3 | 64 | 84 | 80 | 228 |
| | 10 | 69 | 85 | 83 | 237 |
| | 17 | 71 | 93 | 83 | 252 |
| | 24 | 100 | 121 | 114 | 335 |
| | 31 | 100 | 125 | 120 | 345 |
| November | 7 | 107 | 111 | 59 | 277 |
| | 14 | 108 | 109 | 145 | 362 |
| | 21 | 112 | 74 | 84 | 270 |
| | 28 | 128 | 134 | 74 | 336 |
| December | 5 | 136 | 133 | 89 | 358 |
| | 12 | 124 | 118 | 61 | 303 |
| | 19 | 127 | 104 | 58 | 289 |
| | 26 | 91 | 65 | 29 | 185 |
| | 28 | - | - | - | 0 |

Contd........

Pumpkin (Cucurbita moschata Duch.)
Var. Local (Udaipur)

| Month and date | | Egg | Immature | Adult | Total |
|---|---|---|---|---|---|
| March sown crop (4-3-77) | | | | | |
| April | 4 | - | - | - | 0 |
| | 11 | - | - | - | 0 |
| | 18 | - | 4 | 3 | 7 |
| | 25 | 7 | 10 | 9 | 26 |
| May | 2 | 22 | 28 | 25 | 75 |
| | 9 | 36 | 40 | 39 | 115 |
| | 16 | 26 | 43 | 78 | 147 |
| | 23 | 33 | 63 | 96 | 192 |
| | *30 | 74 | 13 | 19 | 106 |
| June | 6 | 36 | 62 | 100 | 198 |
| | **13 | 88 | 120 | 107 | 315 |
| | 20 | 87 | 100 | 102 | 289 |
| | *27 | 215 | 33 | 25 | 273 |
| July | * 4 | 130 | 61 | 26 | 217 |
| | 11 | 98 | 122 | 77 | 297 |
| | 18 | 119 | 179 | 99 | 397 |
| | 25 | 118 | 128 | 91 | 337 |
| August | ** 1 | 99 | 83 | 38 | 220 |
| | ** 8 | 54 | 31 | 50 | 135 |
| | 15 | 102 | 68 | 55 | 225 |
| July sown crop (20-7-77) | | | | | |
| | 22 | 100 | 118 | 140 | 358 |
| | *29 | 224 | 45 | 51 | 320 |
| September | * 5 | 125 | 24 | 36 | 185 |
| | 12 | 104 | 69 | 139 | 312 |
| | 19 | 162 | 197 | 147 | 506 |
| | 26 | 183 | 242 | 229 | 654 |
| October | 3 | 183 | 242 | 278 | 703 |
| | 10 | 195 | 271 | 270 | 736 |
| | 17 | 200 | 282 | 260 | 742 |
| | 24 | 197 | 278 | 256 | 731 |
| | 31 | 152 | 330 | 273 | 755 |
| November | 7 | 211 | 145 | 239 | 595 |
| | 14 | 228 | 213 | 293 | 734 |
| | 21 | 173 | 233 | 135 | 541 |
| | 28 | 203 | 219 | 121 | 543 |
| December | 5 | 246 | 201 | 112 | 559 |
| | 12 | 211 | 200 | 103 | 514 |
| | 19 | 134 | 137 | 64 | 335 |
| | 26 | 125 | 95 | 52 | 272 |
| | 28 | - | - | - | 0 |



Contd.........

Bittor gourd (<u>Momordica</u> <u>charantea</u> L.)
Var. Local (Udaipur)

| Month and date | | Egg | Immature | Adult | Total |
|---|---|---|---|---|---|
| March sown crop (4-3-77) | | | | | |
| April | 4 | - | - | - | 0 |
| | 11 | - | - | - | 0 |
| | 18 | - | - | - | 0 |
| | 25 | - | - | - | 0 |
| May | 2 | - | - | - | 0 |
| | 9 | - | - | 2 | 2 |
| | 16 | - | - | 4 | 4 |
| | 23 | - | - | 2 | 2 |
| | *30 | - | - | - | 0 |
| June | 6 | - | - | - | 0 |
| | **13 | - | - | - | 0 |
| | 20 | - | - | 6 | 6 |
| | *27 | - | - | - | 0 |
| July | * 4 | 2 | - | 2 | 4 |
| | 11 | 2 | - | 2 | 4 |
| | 18 | 3 | 2 | 4 | 9 |
| | 25 | 5 | - | 1 | 6 |
| August | ** 1 | 4 | 1 | - | 5 |
| | ** 8 | 2 | 4 | 2 | 8 |
| | 15 | 2 | - | - | 2 |
| July sown crop (20-7-77) | | | | | |
| | 22 | 3 | - | - | 3 |
| | *29 | 4 | - | 1 | 5 |
| September | * 5 | - | - | - | 0 |
| | 12 | 2 | - | 1 | 3 |
| | 19 | 12 | 6 | 2 | 20 |
| | 26 | 26 | 14 | 2 | 42 |
| October | 3 | 36 | 24 | 28 | 88 |
| | 10 | 64 | 9 | 14 | 87 |
| | 17 | 78 | 14 | 18 | 110 |
| | 24 | 50 | 30 | 17 | 97 |
| | 31 | 56 | 34 | 20 | 110 |
| November | 7 | 36 | 28 | 16 | 80 |
| | 14 | - | - | - | 0 |
| | 21 | 4 | 1 | - | 5 |
| | 28 | - | 2 | - | 2 |
| December | 5 | 4 | 3 | - | 7 |
| | 12 | - | - | - | 0 |
| | 19 | - | - | - | 0 |
| | 26 | - | - | - | 0 |
| | 28 | - | - | - | 0 |

* Rain occurred ** Data recorded before rain

APPENDIX II

Analysis of variance of different stages of *T. neocaledonicus* on various cucurbits (varietal susceptibility)

| Source of variation | df | SS | MSS | F value |
|---|---|---|---|---|
| | | **Eggs** | | |
| Rep. SS | 2 | 258.82 | 129.41 | 1.74 |
| Tr. SS | 12 | 9215.90 | 767.99 | 10.31** |
| Error | 24 | 1787.18 | 74.47 | - |
| Total | 38 | 11261.90 | | |
| | | **Immatures** | | |
| Rep. SS | 2 | 89.28 | 44.64 | 0.66 |
| Tr. SS | 12 | 22131.03 | 1844.25 | 27.29** |
| Error | 24 | 1622.05 | 67.59 | |
| Total | 38 | 23842.36 | | |
| | | **Adults** | | |
| Rep. SS | 2 | 4.66 | 2.33 | 0.04 |
| Tr. SS | 12 | 18698.30 | 1558.19 | 26.79** |
| Error | 24 | 1396.01 | 58.17 | |
| Total | 38 | 20098.97 | | |
| | | **Total population** | | |
| Rep. SS | 2 | 61.74 | 30.87 | 0.21 |
| Tr. SS | 12 | 117225.07 | 9768.76 | 66.59** |
| Error | 24 | 3520.93 | 146.71 | |
| Total | 38 | 120807.74 | | |

** Significant at 1 per cent level

## APPENDIX III a

Effect of wind velocity on the dislodgement of mite population on pumpkin (Cucurbita moschata) var. Local (Udaipur)

| Treatment (wind velocity) | Leaf number | | | | | | | | | | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
| 3 m/sec | 97 | 100 | 100 | 100 | 98 | 97 | 99 | 100 | 95 | 98 | 98.4 |
| (10.8 km/hr) | 98 | 98 | 98 | 100 | 100 | 98 | 96 | 99 | 100 | 100 | 98.8 |
| | 100 | 100 | 97 | 99 | 100 | 97 | 96 | 100 | 93 | 100 | 98.2 |
| 5.5 m/sec | 96 | 100 | 100 | 98 | 98 | 95 | 95 | 98 | 95 | 95 | 97.0 |
| (19.8 km/hr) | 98 | 95 | 97 | 99 | 98 | 96 | 97 | 99 | 100 | 97 | 97.6 |
| | 99 | 98 | 97 | 96 | 100 | 90 | 96 | 100 | 92 | 97 | 96.5 |
| 7.0 m/sec | 96 | 98 | 99 | 98 | 92 | 95 | 95 | 93 | 95 | 94 | 95.5 |
| (25.2 km/hr) | 98 | 95 | 93. | 95 | 98 | 93 | 97 | 98 | 98 | 95 | 96.0 |
| | 93 | 97 | 97 | 96 | 95 | 90 | 94 | 99 | 92 | 90 | 94.3 |
| 8.5 m/sec | 93 | 98 | 98 | 95 | 87 | 90 | 95 | 93 | 95 | 93 | 93.7 |
| (30.6 km/hr) | 96 | 95 | 90 | 95 | 95 | 93 | 95 | 98 | 93 | 90 | 94.0 |
| | 93 | 95 | ·93 | 95 | 95 | 90 | 92 | 93 | 90 | 85 | 92.1 |
| 9.5 m/sec | 88 | 90 | 95 | 95 | 87 | 99 | 95 | 90 | 95 | 90 | 91.4 |
| (34.2 km/hr) | 87 | 90 | 85 | 90 | 92 | 88 | 92 | 92 | 93 | 89 | 89.8 |
| | 90 | 90 | 90 | 90 | 87 | 85 | 92 | 85 | 83 | 85 | 87.7 |
| 10.5 m/sec | 83 | 88 | 95 | 85 | 85 | 88 | 90 | 80 | 87 | 83 | 86.4 |
| (37.8 km/hr) | 82 | 85 | 82 | 87 | 90 | 85 | 92 | 90 | 85 | 82 | 86.0 |
| | 85 | 83 | 90 | 87 | 85 | 85 | 87 | 80 | 80 | 80 | 84.2 |
| Control* | 100 | 100 | 100 | 100 | 99 | 99 | 100 | 100 | 97 | 99 | 99.4 |
| (6.4 km/hr) | 100 | 100 | 99 | 100 | 100 | 98 | 100 | 100 | 100 | 100 | 99.7 |
| | 100 | 100 | 99 | 99 | 100 | 100 | 99 | 100 | 95 | 100 | 99.2 |

* Atmosphere wind velocity

APPENDIX IV a

Effect of wind velocity on the dislodgement of mite population on bottle gourd (*Lagenaria siceraria*) var. Kalyanpur long green

| Treatment (wind velocity) | Leaf number | | | | | | | | | | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
| 3.0 m/sec | 100 | 99 | 100 | 100 | 96 | 99 | 100 | 100 | 98 | 95 | 98.7 |
| (10.8 km/hr) | 98 | 100 | 100 | 90 | 100 | 97 | 98 | 100 | 100 | 92 | 97.5 |
| | 90 | 91 | 95 | 100 | 98 | 100 | 97 | 98 | 100 | 92 | 96.1 |
| 5.5 m/sec | 100 | 97 | 98 | 95 | 95 | 99 | 100 | 95 | 97 | 95 | 97.1 |
| (19.8 km/hr) | 98 | 95 | 98 | 90 | 100 | 92 | 98 | 97 | 96 | 90 | 95.4 |
| | 90 | 90 | 92 | 95 | 98 | 97 | 95 | 98 | 100 | 87 | 94.2 |
| 7.0 m/sec | 95 | 95 | 90 | 90 | 92 | 99 | 95 | 93 | 97 | 94 | 94.0 |
| (25.1 km/hr) | 93 | 95 | 92 | 85 | 98 | 90 | 98 | 95 | 90 | 87 | 92.3 |
| | 88 | 83 | 92 | 90 | 96 | 95 | 89 | 95 | 95 | 82 | 90.5 |
| 8.5 m/sec | 90 | 90 | 90 | 90 | 87 | 89 | 92 | 90 | 97 | 94 | 90.9 |
| (30.6 km/hr) | 90 | 92 | 90 | 85 | 95 | 85 | 90 | 90 | 90 | 87 | 89.4 |
| | 85 | 80 | 90 | 90 | 96 | 93 | 85 | 85 | 95 | 82 | 88.1 |
| 9.5 m/sec | 85 | 87 | 87 | 83 | 87 | 85 | 92 | 87 | 90 | 90 | 87.3 |
| (34.2 km/hr) | 85 | 87 | 85 | 82 | 85 | 85 | 87 | 85 | 89 | 80 | 85.0 |
| | 85 | 77 | 83 | 83 | 85 | 87 | 80 | 81 | 87 | 78 | 82.6 |
| 10.5 m/sec | 80 | 83 | 80 | 76 | 75 | 80 | 90 | 80 | 79 | 77 | 80.0 |
| (37.8 km/hr) | 81 | 80 | 80 | 82 | 81 | 78 | 80 | 75 | 80 | 70 | 78.7 |
| | 71 | 70 | 80 | 71 | 73 | 86 | 80 | 75 | 80 | 69 | 75.5 |
| Control* | 100 | 99 | 100 | 100 | 98 | 99 | 100 | 98 | 100 | 98 | 99.2 |
| (6.4 km/hr) | 100 | 100 | 100 | 98 | 100 | 99 | 100 | 100 | 97 | 99 | 99.3 |
| | 100 | 98 | 100 | 100 | 100 | 100 | 99 | 100 | 98 | 99 | 99.4 |

* Atmosphere wind velocity

APPENDIX V

Analysis of variance of efficacy of different pesticides against *T. neocaledonicus* at different intervals on bottle gourd (Kalyanpur long green, summer)

| Source of variation | df | SS | MS | F |
|---|---|---|---|---|
| **After 24 hours of application** | | | | |
| Replication SS | 2 | 0.9046 | 0.4523 | 0.8246 |
| Treatment SS | 15 | 495.1426 | 33.0095 | 60.1814** |
| Error | 30 | 16.4548 | 0.5485 | |
| Total | 47 | 512.5020 | | |
| **After 48 hours of application** | | | | |
| Replication SS | 2 | 0.3650 | 0.1825 | 0.7766 |
| Treatment SS | 15 | 378.5847 | 25.2390 | 107.4000** |
| Error | 30 | 7.0487 | 0.2350 | |
| Total | 47 | 385.9984 | | |
| **After 72 hours of application** | | | | |
| Replication SS | 2 | 0.0149 | 0.0075 | 0.0766 |
| Treatment SS | 15 | 490.8087 | 32.7206 | 334.2247** |
| Error | 30 | 2.9355 | 0.0979 | |
| Total | 47 | 493.7591 | | |

Contd........

After 5 days of application

| | | | | |
|---|---|---|---|---|
| Replication SS | 2 | 0.2569 | 0.1285 | 1.3512 |
| Treatment SS | 15 | 565.6467 | 37.7098 | 396.5279** |
| Error | 30 | 2.8543 | 0.0951 | |
| Total | 47 | 568.7579 | | |

After 7 days of application

| | | | | |
|---|---|---|---|---|
| Replication SS | 2 | 0.0801 | 0.0401 | 0.3070 |
| Treatment SS | 15 | 675.2379 | 45.0159 | 344.6853** |
| Error | 30 | 3.9194 | 0.1306 | |
| Total | 47 | 679.2374 | | |

After 10 days of application

| | | | | |
|---|---|---|---|---|
| Replication SS | 2 | 1.1496 | 0.5748 | 2.4428 |
| Treatment SS | 15 | 585.3171 | 39.0211 | 165.8355** |
| Error | 30 | 7.0581 | 0.2353 | |
| Total | 47 | 593.5248 | | |

** Significant at 1 per cent level

APPENDIX VI

Analysis of variance of efficacy of different pesticides against *T. neocaledonicus* at different intervals on pumpkin (Local)

| Source of variation | df | SS | MS | F value |
|---|---|---|---|---|
| **After 24 hours of application** | | | | |
| Replication SS | 2 | 0.4307 | 0.2154 | 2.1518 |
| Treatment SS | 15 | 669.8491 | 44.6566 | 446.1199** |
| Error | 30 | 3.0016 | 0.1001 | |
| Total | 47 | 673.2814 | | |
| **After 48 hours of application** | | | | |
| Replication SS | 2 | 0.9352 | 0.4676 | 2.4392 |
| Treatment SS | 15 | 574.0176 | 38.2678 | 199.6234** |
| Error | 30 | 5.7523 | 0.1917 | |
| Total | 47 | 580.7051 | | |
| **After 72 hours of application** | | | | |
| Replication SS | 2 | 0.1508 | 0.0754 | 1.0080 |
| Treatment SS | 15 | 674.9766 | 44.9984 | 601.5829** |
| Error | 30 | 2.2445 | 0.0748 | |
| Total | 47 | 677.3719 | | |
| **After 5 days of application** | | | | |
| Replication SS | 2 | 0.1136 | 0.0568 | 0.2824 |
| Treatment SS | 15 | 719.7597 | 47.9840 | 238.6077** |
| Error | 30 | 6.0341 | 0.2011 | |
| Total | 47 | 725.9074 | | |

Contd.....

After 7 days of application

| | | | | | |
|---|---|---|---|---|---|
| Replication | SS | 2 | 0.1704 | 0.0852 | 0.5136 |
| Treatment | SS | 15 | 692.5989 | 46.1733 | 278.3201* |
| Error | | 30 | 4.9759 | 0.1659 | |
| Total | | 47 | 697.7452 | | |

After 10 days of application

| | | | | | |
|---|---|---|---|---|---|
| Replication | SS | 2 | 0.1691 | 0.0846 | 0.5090 |
| Treatment | SS | 15 | 670.5644 | 44.7043 | 268.9787** |
| Error | | 30 | 4.9869 | 0.1662 | |
| Total | | 47 | 675.7204 | | |

After 15 days of application

| | | | | | |
|---|---|---|---|---|---|
| Replication | SS | 2 | 0.5040 | 0.2520 | 1.6492 |
| Treatment | SS | 15 | 619.2867 | 41.2858 | 270.1950** |
| Error | | 30 | 4.5826 | 0.1528 | |
| Total | | 47 | 624.3733 | | |

After 21 days of application

| | | | | | |
|---|---|---|---|---|---|
| Replication | SS | 2 | 0.3418 | 0.1709 | 0.9164 |
| Treatment | SS | 15 | 548.3541 | 36.5569 | 196.0155** |
| Error | | 30 | 5.5942 | 0.1865 | |
| Total | | 47 | 554.2901 | | |

* Significant at 5 per cent level
** Significant at 1 per cent level

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