SUSCEPTIBILITY OF MANGO (*Mangifera indica* Linnaeus) VARIETIES TO INFESTATION BY IDIOCERINE SPECIES (IDIOCERINAE: JASSIDAE: HOMOPTERA) OF HOPPERS

BY

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THESIS

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DECLARATION

I hereby declare that this thesis entitled "Susceptibility of Mango (*Mangifera indica* Linnaeus) varieties to infestation by Idiocerine species (Idiocerinae; Jassidae: Homoptera) of hoppers" is a bonafide record of work done by me during the course of research work and the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title, of any other University or Society.

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CERTIFICATE

Certified that this thesis entitled "Susceptibility of Mango (*Mangifera indica* Linnaeus) varieties to infestation by Idiocerine species (Idiocerinae: Jassidae: Homoptera) of hoppers" is a record of research work done independently by Shri. B. Narasimha Murthy under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to him.

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We, the undersigned members of the Advisory Committee of Shri. B. Narasimha Murthy, a candidate for the degree of Master of Science in Agriculture with major in Agricultural Entomology, agree that the thesis entitled "Susceptibility of Mango (Mangifera indica Linnaeus) varieties to infestation by Idiocerine species (Idiocerinae: Jassidae:Homoptera) of hoppers" may be submitted by Shri. B. Narasimha Murthy in partial fulfilment of the requirements for the degree.

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CONTENTS

LIST OF TABLES

7a. Seasonal influence on population of adults of I. niveosparsus during November 1980-April 1981

7b. Varietal influence on population fluctuations of adults of I. niveosparsus during November 1980-April 1981

8. Fluctuations of populations of I. clypealis on different mango varieties at fortnightly intervals (sweep counts)

9a. Seasonal influence on population fluctuations of adults of I. clypealis during November 1980-April 1981

9b. Varietal influence on population fluctuations of adults of I. clypealis during blossoming period

10. F_1 progeny production (mean values) of I. niveosparsus on vegetative shoots of different mango varieties under confinement

11. F_1 progeny production (mean values) of I. niveosparsus on inflorescence of different mango varieties under confinement

12. Nitrogen content in shoots and floral branches of different mango varieties

13. Sugar content (%) in shoots and floral branches of different mango varieties

14. Tannin content in shoots and floral branches of different mango varieties

15. Simple and partial correlation coefficients involving the bio-chemical constituents of the floral branches of different varieties and progeny production of I. niveosparsus under confinement

16. Extent of damage to hermaphrodite flowers due to feeding/ovipositional activity of I. clypealis

17. Extent of damage to male flowers due to feeding/ovipositional activity of I. clypealis

LIST OF FIGURES

INTRODUCTION

LIST OF PLATES

INTRODUCTION

INTRODUCTION

Mango (Mangifera indica Linnaeus) is one of the most important fruit crops grown in India. India accounts for nearly 80 per cent of the total World production of mangoes. The total area under mango in India is about 7,50,000 ha and the important areas of production are Uttar Pradesh, Andhra Pradesh, Bihar, Kerala and West Bengal in that order. Substantial quantities of mango fruits of excellent dessert qualities are exported from the Country and the foreign exchange earnings from exports during 1975-76 was of the order of nineteen million Rupees. There is a growing demand of dessert types of fruits for export and of suitable varieties for the preparation of mango juice, squashes and jams.

The damage by insect pests has always been a serious problem to the mango growers. Among the factors contributing to yield losses in mango, the inflorescence blight and premature fruit-drop caused by the Idiocerine hoppers are of considerable importance. The extent of damage on this account has been estimated to be about 60% in serious

infestations. As a short-term strategy for increasing the production of mango fruits, effective management of hopper populations is of considerable importance. Effective control of the mango hoppers can be brought about by scheduled application of suitable contact insecticides during the blossom season. Thorough spraying of the target tissues in large trees with conventional application equipments is often found to be extremely difficult. The application of insecticides in mango orchards will adversely affect insect pollinators and natural enemies besides causing environmental pollution hazards.

The cultivation of mango varieties which are either resistant or tolerant to the mango hoppers would be the most ideal method of reducing the fruit losses. Mango being amenable to vegetative propagation by grafting, it would be possible to ensure durability of resistance/tolerance in promising varieties.

Practically no information is available on the relative susceptibility of mango varieties to infestation by the mango hoppers in India. The

present studies were, therefore, taken up to screen some of the mango varieties with reference to their relative susceptibility to the hoppers and to ascertain the influence of nitrogen, soluble sugars and tannin on the extent of susceptibility of the varieties.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Among the pests infesting mango inflorescence, the Idiocerine hoppers are of considerable importance. The hoppers cause severe inflorescence blight and are often responsible for substantial reduction in fruit yields and total crop failures are not uncommon. The partial bearing of fruits in Uttar Pradesh is attributed to hopper infestations (Pruthi, 1969). In view of the high pest population levels, the Government of Utter Pradesh declared fourteen districts, namely, Meerut, Saharanpur, Muzaffarnagar, Bulandshaher, Moradabad, Bijnor, Rampur, Sitapur, Lucknow, Prathapgarh, Lakshmipur, Kheri, Varanasi, Onnao and Farrukhabad as "effected areas" with respect to mango hopper infestation during the period from January to March (U.P. Government Gazettee Extraordinary notification No. A-1824/XII(2)-2174/71 issued in November 1972).

Distant (1908) catalogued and described Idiocerus niveospersus Lethierry, I. atkinsoni Lethierry and I. clypealis Lethierry from India as serious pests of mango. Baker (1915) erected a new genus Idioscopus and transferred Idiocerus clypealis

to this genus. Maldonado-Capriles (1964) transferred I. atkinsoni and I. niveosparsus also to the genus Idioscopus. Anufriev (1970) shifted Idioscopus atkinsoni to new genus Amritodus. A new species A. brevistylus was reported as pests of mango in Karnataka state (Viraktamath, 1976). The species of Idiocerine hoppers occurring in India are thus, Idioscopus clypealis, I. niveosparsus, Amritodus atkinsoni and A. brevistylus. The hoppers occur in all the mango growing areas of India. In Punjab State, I. clypealis and A. atkinsoni are the common species (Rahman, 1939), while in South India I. niveosparsus was reported to be the dominant species responsible for blossom blight (Rao, 1930). A. atkinsoni which is relatively larger and of darker colouration is the most common species in Northern India. I. clypealis is common in Maharashtra and Gujarat and this species as well as I. niveosparsus are widespread in Peninsular India (Pruthi, 1969). Rao and Ramakrishnan (1979), reported that the hopper populations occurring in New Delhi and Andhra Pradesh were I. clypealis and those found in Mangalore, Pusa (Bihar) and Burma as I. nigroclypeatus. After studying the type specimens from these regions Viraktamath (Personal

Communication, 1980) stated that I. clypealis and I. nigroclypeatus are synonyms.

The mango hoppers have been recorded to occur on citrus spp. and Calophyllus inophythum, but these plants do not serve as alternate hosts (Uppal and Wagle, 1944). Nayar et al. (1976) reported the occurrence of the hoppers on Sapota. In Philippines I. clypealis has a wider host range including mango, while I. niveosparsus is recorded only on Mango (Serrano and Palo, 1933). Beeson (1941) reported that the Idiocerine hoppers associated with the mango trees of the forest ecosystem survived on alternate tree crops such as Bauhinia purpurea, Ficus retusa, Gmelina arborea, Lantana aculeata and Morus indica under adverse conditions.

The hoppers make slits on the inflorescence, unopened flowers, young leaves and deposits the eggs singly within these slits. The mechanical injury to the tissues due to oviposition wound causes inflorescence blight. Large numbers of adults and nymphs feed on mango inflorescence causing flower drop. The hoppers secrete honey dew copiously and species of sooty mould fungi develop on the honey dew medium, thereby retarding the photosynthetic processes (Rao, 1930; Rahman, 1939). The yield loss due to

mango hopper infestation was estimated as 25 to 60 percentage (Cheema et al., 1954; Gangolly, et al., 1957). Rao (1930) estimated that the damage inflicted by the pest to mango inflorescence is of the order of 80-100%.

Patel et al. (1975) studied the longevity, sex-ratio and seasonal incidence of A. atkinsoni in the Gujarat State. When adults were provided with natural food, the longevity was the highest being three to four days, while under laboratory conditions, they did not thrive for more than a day. Except in February, June and November, the male populations were found to be very sparse. Adult populations increased as the mango trees came to flowering and the peak populations occurred in June.

Rahman (1939) found that the Jassids in Winter, take refuge under leaves and within cracks in the bark and that they moved over to the lower side of the thicker branches and under leaves during the Summer season. A large number of hoppers are killed by exposure to excessive heat, rain, frost and by natural enemies.

The life-cycles of the species occurring in India have been studied in detail. In Bombay,

I. niveosparsus was observed as principal species and were abundant in January and early February. The eggs of I. niveosparsus are laid in the mid ribs of young leaves, usually on the lower surfaces or in the axes of the flower-heads and these hatch in five to six days. The adults appear 10-11 days later. They breed at any time of the year, if there is suitable food available for the nymphs in the form of flower-heads or tender vegetative shoots. The hoppers are very susceptible to high temperatures, but live for a long time in a cool places. Shady orchards are, therefore, more susceptible than open ones. There is considerable variation in the populations of the hoppers during the season and in successive years (Wagle, 1928). I. niveosparsus and A. atkinsoni had three generations per year during January-March and June-October while I. clypealis had only one generation during the period January-March (Wagle, 1934).

Rahman (1939) studied the biology of hoppers in Punjab. I. clypealis and A. atkinsoni may both lay as many as 200 eggs in separate slits made in the inflorescence and tissues of unopened flowers or young leaves. The nymphs hatch in 8-10 days and mature 17-19 days later.

The mango hoppers I. clypealis and I. (ghunrocerus) (niveosparsus) are destructive in the Phillippines during the flowering period and large numbers of the active stages feed and destroy the inflorescence. Trees which are not in the flowering stage do not normally support nymphal populations. There was no progeny production from adults caged on actively growing seedlings. The adults appeared to undergo long periods of reproductive inactivity (Glass et al., 1966).

In the Phillippines, eggs of I. niveosparsus are laid in the flower-stalks and flower-buds during the blossoming season and in the midribs of tender leaves in the off-season. The mean incubation period is four days, nymphal stage being 7.5 days. In the case of I. clypealis, eggs are laid exclusively in the flower-buds, the incubation period and the nymphal stages being 4.5 days and 9.5 days respectively (Serrano and Palo, 1933).

In Mysore State, five to six generations of the hoppers are completed in succession during the blossoming season (Subramanian Iyer, 1922).

The mango hoppers support a large number of natural enemies and population levels of the

associated natural enemies in trees of different varieties might perhaps be one of the factors regulating infestation levels. The natural enemies of hoppers in the Phillippines include the fungus Isaria spp. (Stilbellaceae:Deuteromycetes) parasitic on the adults of I. clypealis and the predators such as Coccinellids, ants and spiders (Serrano and Palo, 1933). Husain and Pruthi (1924) recorded Pipunculus annulifemur Brun. (Pipunculidae:Diptera), Pyrilloxenos compactus pierce (Stylopidae:Strepsiptera) Epipyrops fulginosa Tam. (Epipyropidae:Lepidoptera) and the entomogenous fungi Isaria stellata and Hirsutella versicolor (Stilbellaceae:Deuteromycetes) as parasitic on adults of the different species of hoppers.

Practically no information is available on the relative susceptibility of mango varieties to infestation by Idiocerine hoppers. Most of the mango varieties under cultivation in the Phillippines are apparently attacked by I. niveosparsus and I. clypealis with equal severity (Serrano and Palo 1933).

However, information on the relative susceptibility of some of the mango varieties to other pests such as the fruitfly Anastrepha fraterculus Wied, shoot gall psylla Apsylla cistella Buckton and the bud mite Aceria mangiferae Sayed are available. Runer (1922) found that the mango variety "manga blanca" cultivated in Havana was immune to infestation by the fruitfly Anastrepha fraterculus. According to Prasad (1957), the grafted varieties of mango are more prone to infestation by the mango shoot gall psylla Apsylla cistella than those which are raised from seeds. The results obtained by Singh (1954) and Sen (1951) were also quite similar. Among the mango varieties Zardalu, Maldan, Krishnabhog and Bombai were found to be more susceptible to infestation by A. cistella, the percentage damage values being 68%, 51%, 50% and 40% respectively. The Alphonso and Himasagar varieties were less damaged by the pest, the percentage damage values being 10% and 8%, respectively.

The resistance of mango varieties to the bud mite Aceria mangiferae was not consistent in different locations. The extent of malformation

of mango inflorescence and the population of A. mangiferae were found to be correlated (Bindra and Bakhetia 1969). Srivastava (1972) reported that in the mango orchard of the IARI, the variety Bhadawaran appeared to be comparatively less susceptible to the bud mite.

MATERIALS AND METHODS

MATERIALS AND METHODS

The field experiment for evaluating twelve of the mango varieties available in the orchard attached to the Instructional Farm and Research Station, Mannuthy were screened for their relative susceptibility to infestation by Idiosoopus niveosparsus and I. clypealis during June 1980 to April 1981.

Twenty three year old trees of the different varieties were screened for the experiment. These varieties were grafted progenies and all were regular bearers and conformed to the original type descriptions (Anon., 1967). The varieties were Alphonso, Bennet Alphonso, Bangalora, Banganapalli, Allumpur Baneshan, Mundappa, Kalapady, Neelum, Prior, Chandrakaran, Goa and Chandanam.

The population fluctuations of hoppers on different mango varieties during the pre and post-flowering stages being regulated by the extent of susceptibility of the varieties to infestation by the hoppers, ten sweep samples were collected from the tree canopy segments at monthly intervals during the period from June to September 1980.

The seasonal fluctuations of Idiocerine hoppers on different varieties at fortnightly intervals

In order to ascertain the seasonal population fluctuations of the hoppers on different varieties during the pre-flowering, flowering and post-flowering stages, periodical fortnightly counts of adults and nymphs of the hoppers were made on the shoots and the floral branches. For this, the canopy was divided into four near equal segments and the vegetative shoots and panicles were selected each at three per segment. Counts in each tree were thus made from 12 shoots and 12 panicles, there being four replications. The nymphs and adults occurring on vegetative shoots and floral branches were collected in large perforated polythene bags (150 gauge) of size 30 x 20 cm by rapidly enclosing the selected shoots/floral branches. The main axes were rapidly tapped to dislodge the insects from the shoots/floral branches and the insects were transferred to specimen tubes. The insects thus collected were killed using benzene fumes from soaked cotton rolls. The identities of the hoppers were

established based on the morphological attributes.

In addition to direct counting of insect populations occurring on randomly selected shoots/ panicles, the overall hopper population trends in different varieties were monitored by counting the population of the adults by sweeping around the entire plant canopy ten times with a standard insect net. The insects thus collected included those which occurred both on the shoots and floral branches. The hoppers thus collected were killed and the species composition of the catches was determined under a Steriomicroscope.

Maintaining stock cultures of Idiocerine hoppers

Cultures of I. clypealis and I. niveosparsus were maintained on the variety Bennet Alphonso which were found to be suitable for the purpose. To start with, the floral branches which emerged out quite early in the season were used for insect rearing and later on as more inflorescences were available these were also used for rearing the insects. Five pairs of freshly emerged adults

Plate 1 Field cages for confinement of adults of *Idioscopus niveosparsus* Leth. on floral branches of mango for F_1 progeny production

of the two species were separately confined in each field cage, enclosing the floral branches. In case the population exceeded the optimum levels, the cultures were sub-divided at periodic intervals.

Cylindrical cages of (Plate 1) 30 cm length and 20 cm diameter were used for the confinement of the hoppers. The cages were made of wire frame work covered over with polythene net-cloth which ensured adequate aeration. The terminals of the wire frame-work towards one side were provided with small hook like bends at the apices to facilitate proper fixing of the cages around the shoot/ floral branches.

The F_1 progeny production of hoppers on vegetative shoots and inflorescence of different varieties

Sweep counts as well as direct counts on shoots/floral branches revealed that the dominant species at the commencement of flowering season was I. niveosparsus and, therefore, these studies were conducted using this. For ascertaining the

progeny production of I. niveosparsus, four each of the freshly emerged and healthy shoots/floral branches were selected in each tree and five pairs of the freshly emerged adults drawn from stock cultures were released under confinement in each of the floral branch/shoot for a total of 20 days. Each variety was replicated four times and there were four cages in each tree.

Extent of damage

When I. niveosparsus were confined in polycages, substantial flower shedding was recorded in most of the cases. Another field experiment was conducted to ascertain the extent of flower shedding consequent on feeding/oviposition by the Idiocerine hoppers. I. clypealis was used for this experiment since this was the dominant species available in field cultures at that time.

Secondary branches, of freshly emerging terminal inflorescences of Alphonso, Bennet Alphonso, Bangalora, Banganapally, Allumpur Baneshan, Kalapady, Mundappa, Neelum, Prior, Chandrakaran, Goa and Chandanam were selected

randomly and the unopened buds and the withered flowers were all removed with a fine forceps. In all, there were two replications for the experiment. Five pairs of freshly emerged I. clypealis were released in perforated polythene cages which were tied over with a twine (Plate 2). A control was kept by enclosing the selected panicles caged but without test insects. On the sixth day, the shed male and hermaphrodite flowers were removed from the cages and these were separately counted.

Estimation of nitrogen, soluble sugars and tannin

In order to ascertain whether the susceptibility of mango varieties to Idiocerine hopper infestation was influenced by biochemical constituents, the vegetative shoots and panicles were analysed for total nitrogen, soluble sugars and tannin during January 1981. For chemical assay, random samples of fresh vegetative shoots and floral branches were removed at periodic intervals from different varieties and these were then pooled variety-wise. The samples were dried in an electric oven at 65°C for 24 hours. The dried

Plate 2 Polythene cages for confinement of *I. clypealis* Leth. on the floral branches of mango for studying the extent of damage to the flowers

samples were then ground using a laboratory mill fitted with a 0.5 mm mesh sieve. The total nitrogen was estimated as per the method by Jackson (1958). The soluble sugars and tannin content of vegetative shoots and inflorescence were estimated by using a Spectrophotometer.

For the estimation of soluble sugars such as sucrose, glucose, fructose, 0.2 g of sample was transferred into a conical flask of 500 ml capacity and after adding 200 ml of distilled water, the flask was capped and shaken over the shaking machine for 1 hr. Subsequently the material was passed through a 12.5 cm Whatman no. 1 filter paper. The first few drops of the filtrate were rejected and the rest of it was used for the determination of soluble sugars. The procedure suggested by Deriaz (1961) was adopted for estimating the soluble sugars which was expressed as percentage of glucose.

For the estimation of tannin, one gm of plant sample was boiled 30 minutes with 50 ml of water and this was then allowed to cool. Thereafter, the material was transferred to 100 ml volumetric flask and was then diluted to mark. After thorough

shaking, the material was filtered. The above aliquot was used for estimation of tannin. The prooedure suggested by the Association of Official Analytical Chemists (1970) was followed in estimating the tannin oontent.

Statistical analysis

For comparing the progeny production of I. niveosparsus on different varieties, the Analysis of Variance technique as described by Snedecor and Cochran (1967) was adopted. Data relating to field population fluctuations of I. niveosparsus and I. clypealis on different varieties at fortnightly intervals were analysed by the χ^2 test (Snedecor and Cochran (1967). The influence of the biochemical constituents (nitrogen, soluble sugars, tannin) of inflorescence of Alphonso, Bennet Alphonso, Bangalora, Banganapalli, Allumpur Baneshan, Kalapady, Mundappa, Neelum, Prior, Chandrakaran, Goa and Chandanam on the progeny production of I. niveosparsus was ascertained by working out simple and partial correlation

coefficients (Snedecor and Cochran, 1967).

For comparing the flower drop due to feeding of I. clypealis on different varieties, the Analysis of Variance technique suggested by Snedecor and Cochran (1967) was made use of.

RESULTS

RESULTS

The seasonal population fluctuations of Idiocerine hoppers on different mango varieties at fortnightly intervals

The population fluctuations of the Idiocerine hoppers on the twelve mango varieties included in the study during the period June 1980 to April 1981 were monitored by direct counting of the adults and nymphs of I. niveosparsus and I. clypealis occurring on the shoots and by taking sweep samples.

Occurrence of Idiocerine hoppers on different mango varieties during pre-flowering period (June to September 1980)

The twelve selected mango varieties were sampled during pre-flowering period from June to September 1980 as already explained under Materials and Methods and the results are furnished in Table 1. The data were not amenable to statistical analysis. None of the varieties supported higher populations in the month of June 1980. During the month of July 1980 only the varieties Allumpur Baneshan and Prior supported negligible population. The

Table 1 Occurrence of Idiocerine hoppers on mango varieties during pre-flowering period (June to September 1980)

Sl.No.	Varieties	June	July	August	September	Total
1.	Alphonso	0	0	0	0	0
2.	Bennet Alphonso	0	0	0	1	1
3.	Bangalora	0	0	0	0	0
4.	Banganapalli	0	0	0	0	0
5.	Allumpur Baneshan	0	1	1	0	2
6.	Kalapady	0	0	0	0	0
7.	Mundappa	0	0	1	1	2
8.	Neelum	0	0	0	1	1
9.	Prior	0	1	1	2	4
10.	Chandrakaran	0	0	1	1	2
11.	Goa	0	0	1	2	3
12.	Chandanam	0	0	1	3	4
	Total	0	2	6	11	19

* Total from four replications

populations showed slow progressive increase from July onwards. It is remarkable that in the varieties Alphonso, Bangalora, Banganapalli and Kalapady populations did not occur throughout the pre-flowering stage from June to September 1980.

Population fluctuations of adult hoppers on vegetative shoots of different mango varieties at fortnightly intervals (direct counting)

The population fluctuations of adult hoppers belonging to both Idiocerus niveospersus and I. clypealis were monitored by counting the insects occurring on randomly selected shoots. Data on this is presented in Table 2. These are graphically depicted in Fig 1a, 1b. The variety Chandanem supported the maximum number of hoppers on vegetative shoots (31), while in the variety Kalapady, the adults were only twelve. In order to test whether the adult Idiocerine populations occurring on different mango varieties during November 1980 - April 1981 were significantly different, χ^2 test was employed and results of testing are

Table 2 Population fluctuations of adult Idiocerine hoppers (I. niveosparsus and I. clypealis, on vegetative shoots of different mango varieties at fortnightly intervals during November 1980 - April 1981

Sl no	Varieties	November '80	December '80		January '81		February '81		March '81		April '81	Total
		2nd fort-night	1st fort-night	2nd fort-night	1st fort-night	2nd fort-night	1st fort-night	2nd fort-night	1st fort-night	2nd fort-night	1st fort-night	
1.	Alphonso	0	0	0	1	3	1	4	0	6	6	21
2.	Bennet Alphonso	1	0	2	3	4	0	4	0	1	1	16
3.	Bangalora	2	2	2	2	3	1	2	2	0	0	16
4.	Banganapalli	1	0	1	3	3	1	3	0	1	2	15
5.	Allumpur Baneshan	1	0	0	3	4	0	4	1	2	3	18
6.	Kalepady	0	1	0	2	3	2	4	0	0	0	12
7.	Mundappa	2	0	0	5	5	0	1	0	3	4	20
8.	Neelum	4	2	0	2	1	0	1	1	6	6	23
9.	Prior	6	3	2	1	2	0	3	4	0	1	22
10.	Chandrakaran	1	3	5	2	2	1	0	0	2	5	21
11.	Goa	4	3	3	0	1	3	2	3	0	0	19
12.	Chandanam	2	4	3	4	5	6	3	2	2	0	31
	Total	24	18	18	28	36	15	31	13	23	28	234

* Total from four replications

furnished in Table 3a. It will be seen that the χ^2 value is non-significant.

It is thus indicated that the populations of I. niveosparsus and I. clypealis were not significantly different in the twelve mango varieties.

The fortnightly population totals showed considerable fluctuations, the peak being registered in the second fortnight of January 1981 and the least was in the first fortnight of March 1981. Whether the populations recorded at fortnightly intervals were significantly different, χ^2 test was employed and the results of testing are indicated in Table 3b. This χ^2 test indicated that the populations were not significantly different in the different fortnights.

Population fluctuations of nymphs of I. niveosparsus and I. clypealis on vegetative shoots of different mango varieties at fortnightly intervals (Direct counting)

The nymphal populations of I. niveosparsus and I. clypealis occurring on randomly selected vegetative shoots of different varieties were directly counted at

Table 3a χ^2 test for the population fluctuations of the adult Idiocerine hoppers occurring on vegetative shoots of different mango varieties at fortnightly intervals

Sl no	Varieties	Total number of adult Idiocerine hoppers occurring on shoots	χ^2 value for the variations of the observed populations and the expected levels based on the mean values
1.	Alphonso	21	
2.	Bennet Alphonso	16	
3.	Bangalora	16	
4.	Banganapalli	15	
5.	Allumpur Baneshan	18	
6.	Kalapady	12	12.25 NS
7.	Mundappa	20	
8.	Neelum	23	
9.	Prior	22	
10.	Chandrakaran	21	
11.	Goa	19	
12.	Chandanam	31	

NS = Non-significant at 5 per cent level

Table 3b χ^2 test for the population fluctuations of the adult Idiocerine hoppers occurring on vegetative shoots of mango at fortnightly intervals

Periods of sampling		Total number of adult Idiocerine hoppers occurring on shoots	χ^2 value for the variations of the observed populations and the expected levels based on the mean values
November '80	2nd fortnight	24	
December '80	1st fortnight	18	
	2nd fortnight	18	
January '81	1st fortnight	28	
	2nd fortnight	36	
February '81	1st fortnight	15	11.80 NS
	2nd fortnight	31	
March '81	1st fortnight	13	
	2nd fortnight	23	
April '81	1st fortnight	28	

NS = Non-significant at 5 per cent level

fortnightly intervals and the results are furnished in Table 4a. The varieties Kalapady, Mundappa, Neelum, Chandrakaran and Bennet Alphonso did not support any nymphal populations throughout the season while on Bangalora, Banganapalli and Allumpur Baneshan nymphs occurred only in one particular fortnight during the season. The nymphal populations were only negligible on the varieties Alphonso, Goa and Chandanam. The nymphal populations did not show any distinct peaks.

Population fluctuations of mango hopper nymphs (I. niveosparsus and I. olynealis) on floral branches of different mango varieties at fortnightly intervals

Population trends in varieties

Data on the population fluctuations of mango hopper nymphs (I. niveosparsus and I. olynealis) on floral branches of different varieties are furnished in Table 4b and the data are presented in Fig 2a, 2b. Nymphal populations were not found in the first fortnight of November. In the first fortnight of December, Allumpur Baneshan showed a nymphal population of 42 while Kalapady and Mundappa

Table 4a Population fluctuations of I. niveosparsus and I. clypealis nymphs on vegetative shoots of different mango varieties

Sl no	Varieties	November'80	December '80		January '81		February '81		March '81		April '81		Total
		2nd fort-night	1st fort-night	2nd fort-night	1st fort-night	2nd fort-night	1st fort-night	2nd fort-night	1st fort-night	2nd fort-night	1st fort-night		
1.	Alphonso	0	0	6	0	0	0	0	0	0	0		6
2.	Bennet Alphonso	0	0	0	0	0	0	0	0	0	0		0
3.	Bangalora	0	0	0	1	0	0	0	0	0	0		1
4.	Banganapalli	0	1	0	0	0	0	0	0	0	0		1
5.	Allumpur Baneshan	0	0	0	0	1	0	0	0	0	0		1
6.	Kalapady	0	0	0	0	0	0	0	0	0	0		0
7.	Mundappa	0	0	0	0	0	0	0	0	0	0		0
8.	Neelum	0	0	0	0	0	0	0	0	0	0		0
9.	Prior	0	0	2	0	0	0	0	0	0	0		2
10.	Chandrakaran	0	0	0	0	0	0	0	0	0	0		0
11.	Goa	0	0	3	0	0	0	0	0	0	0		3
12.	Chandanam	0	0	0	3	1	0	0	0	0	0		4
	Total	0	1	11	4	2	0	0	0	0	0		18

* Total from four replications

Table 4b Population fluctuations of Idiocerine hopper nymphs (I. niveosparsus and I. clypealis) on inflorescence of different mango varieties at fortnightly intervals during November 1980 - April 1981

Sl no	Varieties	November 1980 2nd fortnight	December '80 1st fort-night	December '80 2nd fort-night	January '81 1st fort-night	January '81 2nd fort-night	February '81 1st fort-night	February '81 2nd fort-night	March '81 1st fort-night	March '81 2nd fort-night	April '81 1st fort-night	Total
1.	Alphonso	0	0	0	4	13	11	17	3	0	0	48
2.	Bennet Alphonso	0	0	35	17	37	84	17	1	0	0	191
3.	Bangalora	0	0	1	28	23	23	11	2	0	0	88
4.	Banganapalli	0	0	17	39	25	6	8	1	0	0	96
5.	Allumpur Baneshan	0	42	24	50	61	15	3	0	0	0	195
6.	Kalapady	0	2	8	22	31	9	3	0	0	0	75
7.	Mundappa	0	2	7	68	84	153	29	5	0	0	348
8.	Neelum	0	0	0	0	17	16	21	11	0	0	65
9.	Prior	0	0	5	46	66	11	46	18	0	0	192
10.	Chandrakaran	0	0	7	58	73	123	24	0	0	0	285
11.	Goa	0	0	19	41	58	366	272	10	0	0	766
12.	Chandanam	0	0	0	3	5	73	223	38	0	0	342
	Total	0	46	123	376	493	890	674	89	0	0	2691

* Total from four replications

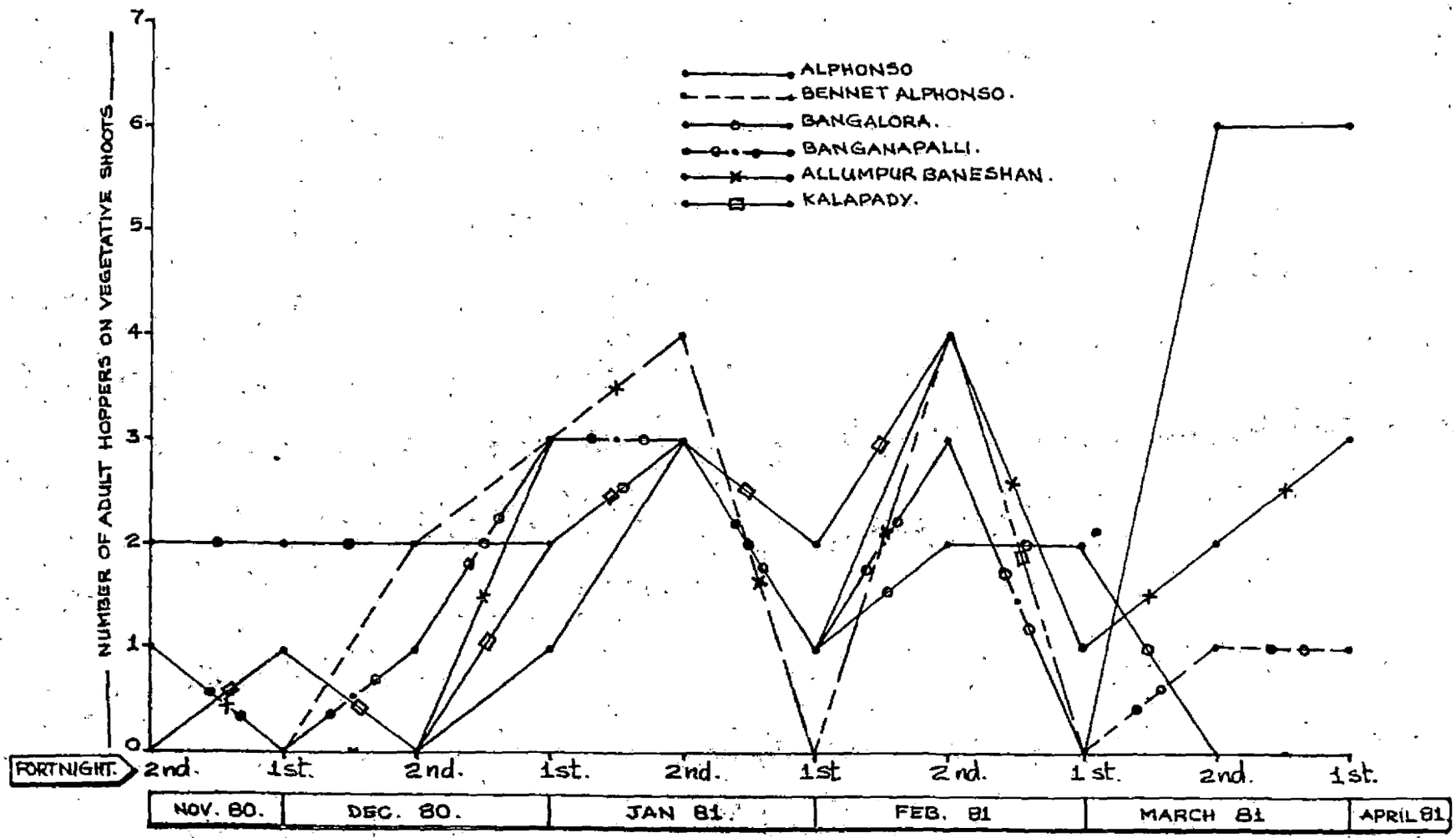


FIG. 1a.- POPULATION FLUCTUATIONS OF *I. niveosparsus* AND *I. clypealis* ADULTS ON THE VEGETATIVE SHOOTS OF DIFFERENT MANGO VARIETIES.

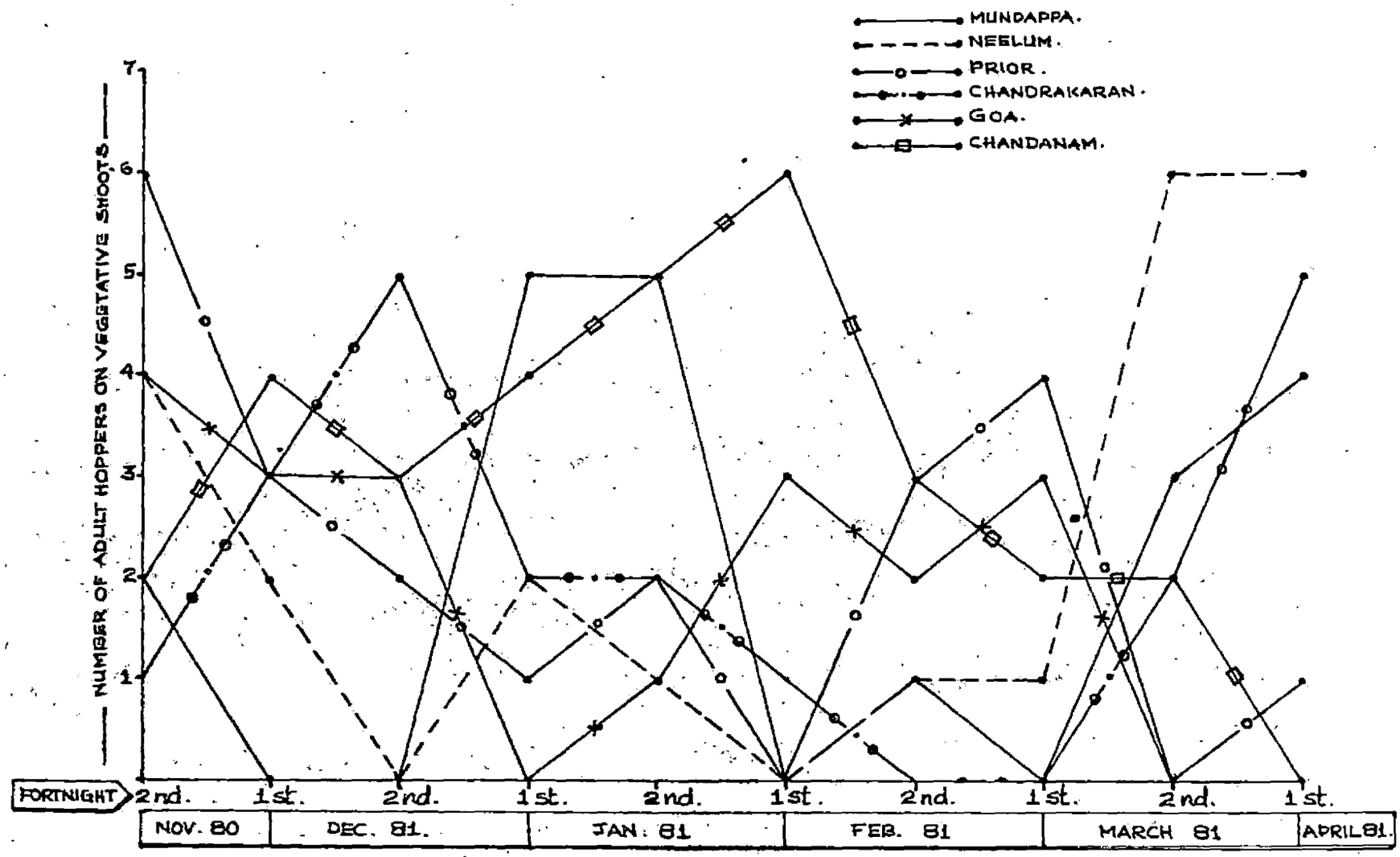


FIG. 1b.- POPULATION FLUCTUATIONS OF *I. niveospatsus* AND *I. clypealis* ADULTS ON THE VEGETATIVE SHOOTS OF DIFFERENT MANGO VARIETIES.

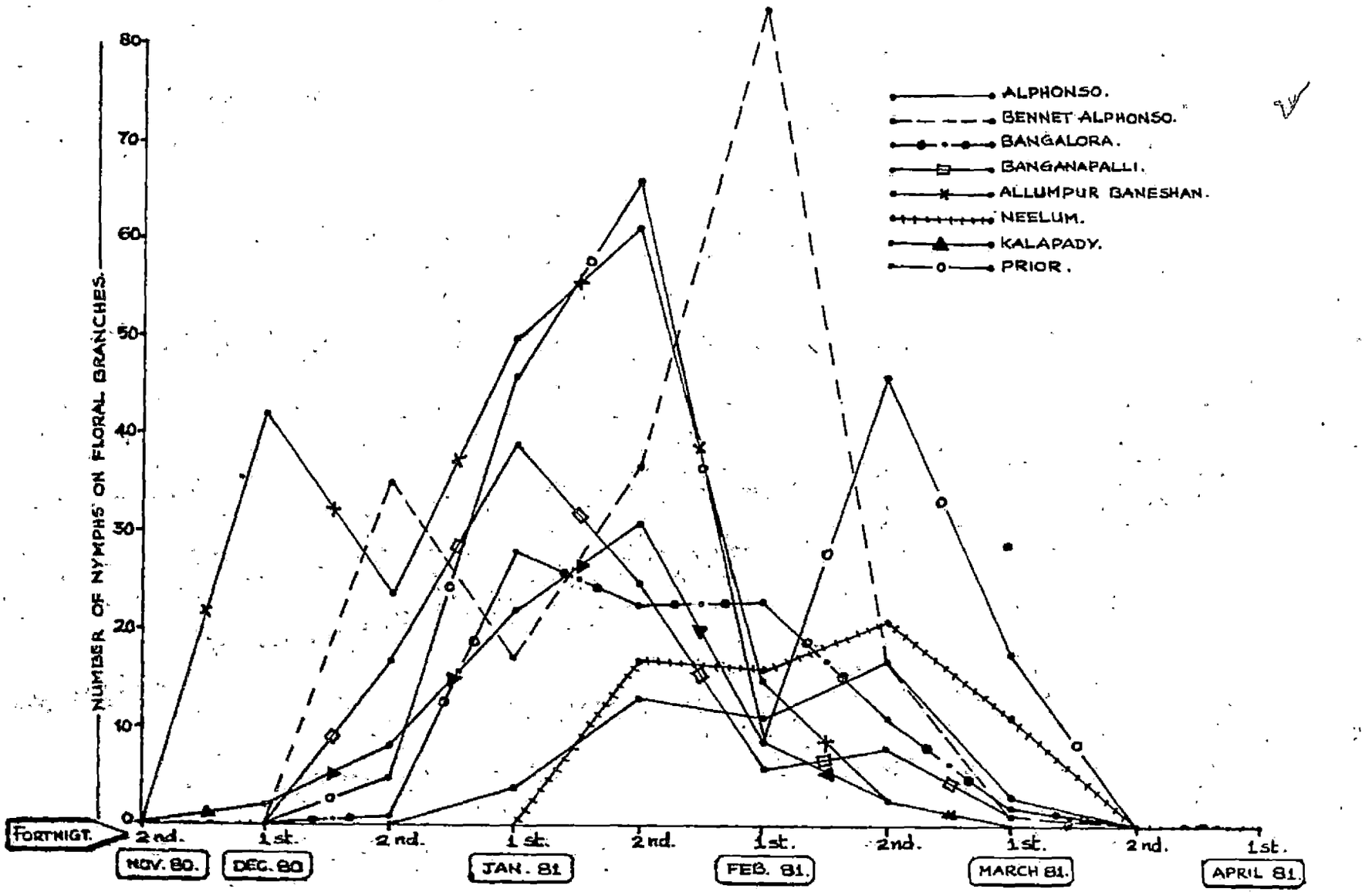


FIG. 2a.- POPULATION FLUCTUATIONS OF *I. niveospatsus* AND *I. clypealis* NYMPHS ON THE FLORAL BRANCHES OF DIFFERENT MANGO VARIETIES.

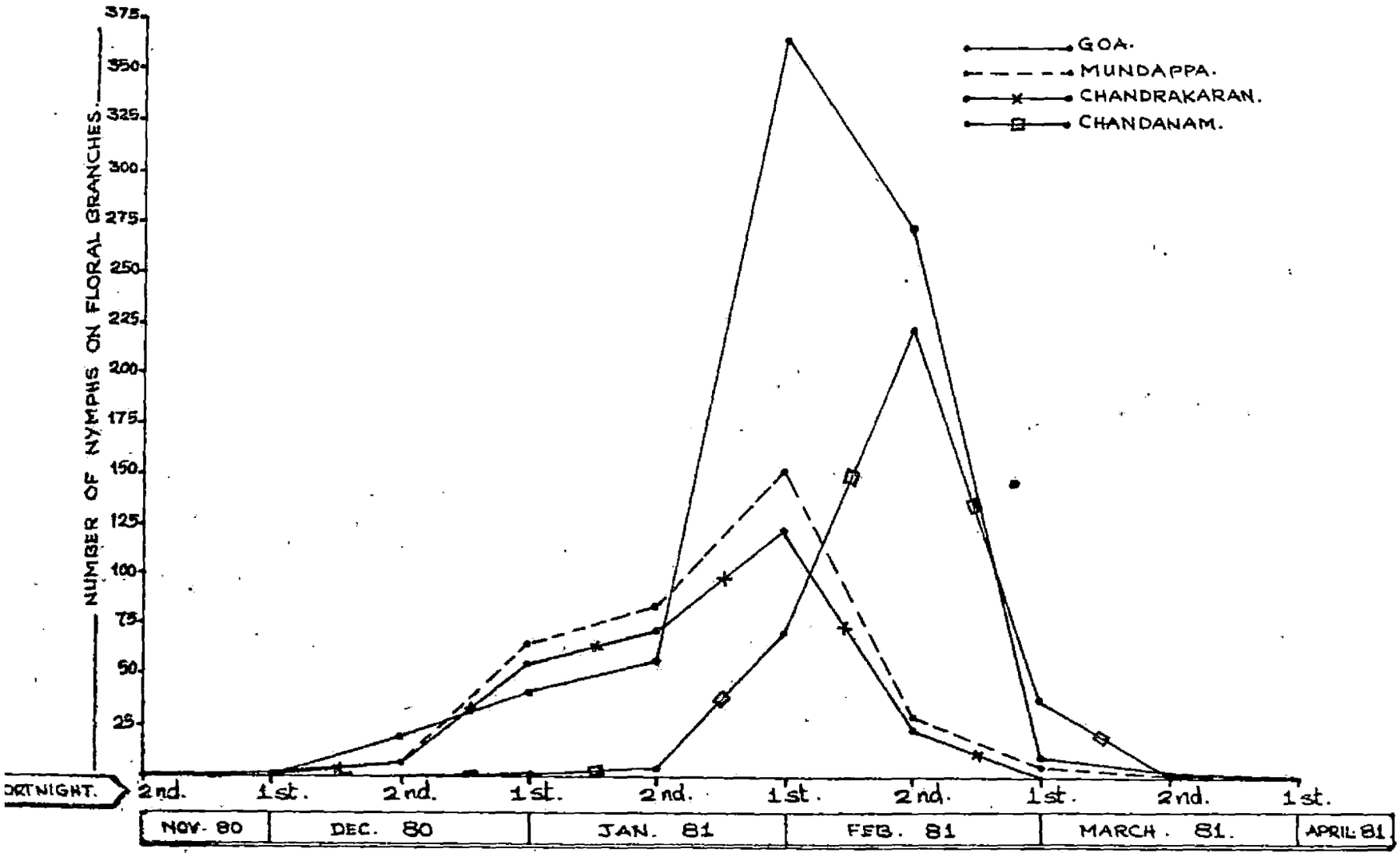


FIG. 2.b.- POPULATION FLUCTUATIONS OF *I. niveosparsus* AND *I. clypealis* NYMPHS ON FLORAL-BRANCHES OF DIFFERENT MANGO VARIETIES.

showed only two each. In the other varieties none was found. From the second fortnight of December 1980 onwards population started building up on Bennet Alphonso, Bangenapalli, Prior, Chandrakaran and Goa. However, on the variety Chandanam, nymphal populations started development from the first fortnight of January 1981 only. The variety Goa supported the maximum number hopper nymphs on inflorescence (757), while in the variety Alphonso the nymphal populations were very low, being 48 only. Whether the nymphal populations of hopper occurring on different varieties during the blossom season were different, the χ^2 test was employed and the results of testing are indicated in Table 5a. It is noted that the χ^2 value for this is highly significant, thereby indicating that the varieties supported significantly different populations of hopper nymphs during the period in question.

Seasonal population trends

The fortnightly totals showed considerable fluctuations, the peak being registered in the first fortnight of February. In the second fortnight of November, second fortnight of March and in the first

Table 5a χ^2 test for the population fluctuations of Idiocerine hopper nymphs (I. niveospersus and I. clypealis) on inflorescences of different mango varieties at fortnightly intervals

Sl no	Varieties	Total number of Idiocerine hopper nymphs (I. niveospersus and I. clypealis) occurring on inflorescence	χ^2 value for the variations of the observed populations and the expected levels based on mean values
1.	Alphonso	48*	
2.	Bennet Alphonso	156	
3.	Bangalora	87	
4.	Banganapalli	79	
5.	Ailumpur Baneshan	129	
6.	Kalapady	65	2082.44**
7.	Mundappa	339	
8.	Neelum	65	
9.	Prior	187	
10.	Chandrakaran	278	
11.	Goa	747	
12.	Chandanam	342	

* Based on data from 1st fortnight of January to 1st fortnight of March

**Significant at 1 per cent level

fortnight of April the hopper nymphs were not found on the floral branches. Whether the populations recorded at different fortnightly intervals were significantly different, χ^2 test was employed and the results of testing are indicated in Table 5b. It is revealed that the populations were significantly different at fortnightly intervals during the season.

Population fluctuations of adult hoppers on different varieties at fortnightly intervals (Sweep counts)

Population of I. niveosparsus

The fluctuations in the adult populations of I. niveosparsus were monitored by sweep counting at every fortnightly intervals during the period November 1980 to April 1981 and the data are presented in Table 6. These are graphically depicted in Fig 3a, 3b. Periodic sweep counts showed that the populations ranged from 27 in the first fortnight of March 1981 to 50 in the second fortnight of November 1980. Fortnightly totals

Table 5b χ^2 test for the population fluctuations of the Idiocerine hopper nymphs (I. niveosparsus and I. clypealis) occurring on inflorescence of mango at fortnightly intervals

Periods of sampling	Total number of Idiocerine hopper nymphs (I. niveosparsus and I. clypealis) occurring on inflorescence	χ^2 value for the variations of the observed populations and the expected levels based on mean values
January 1981		
1st fortnight	376*	
2nd fortnight	493	
February 1981		
1st fortnight	890	726.85**
2nd fortnight	674	
March 1981		
1st fortnight	392	

* Based on data from 1st fortnight of January to 1st fortnight of March

** Significant at 1 per cent level

Table 6 Fluctuations of populations of I. niveosparsus on different mango varieties at fortnightly intervals (sweep counts)

Sl no	Varieties	November '80	December '80		January '81		February '81		March '81		April '81	Total
		2nd fort-night	1st fort-night	2nd fort-night	1st fort-night	2nd fort-night	1st fort-night	2nd fort-night	1st fort-night	2nd fort-night	1st fort-night	
1.	Alphonso	3	6	2	4	1	2	0	3	2	2	25
2.	Bennet Alphonso	5	4	5	0	4	2	1	4	1	1	27
3.	Bangalora	1	2	1	2	4	2	3	2	3	3	23
4.	Banganapalli	3	7	6	0	2	3	1	3	2	2	29
5.	Allumpur Baneshan	5	2	4	4	5	3	5	1	3	0	32
6.	Kalapady	1	3	4	3	2	3	5	2	5	2	30
7.	Mundappa	6	7	3	2	2	3	1	2	1	4	31
8.	Neelum	4	4	2	3	1	4	0	2	4	5	29
9.	Prior	6	3	4	2	4	0	7	2	4	3	35
10.	Chandrakaran	10	1	3	4	3	2	3	0	1	1	28
11.	Goa	6	2	5	2	2	3	7	1	0	2	30
12.	Chandanam	0	0	0	7	4	5	2	4	5	4	31
	Total	50	41	39	33	34	32	35	27	30	29	350

*Total from four replications

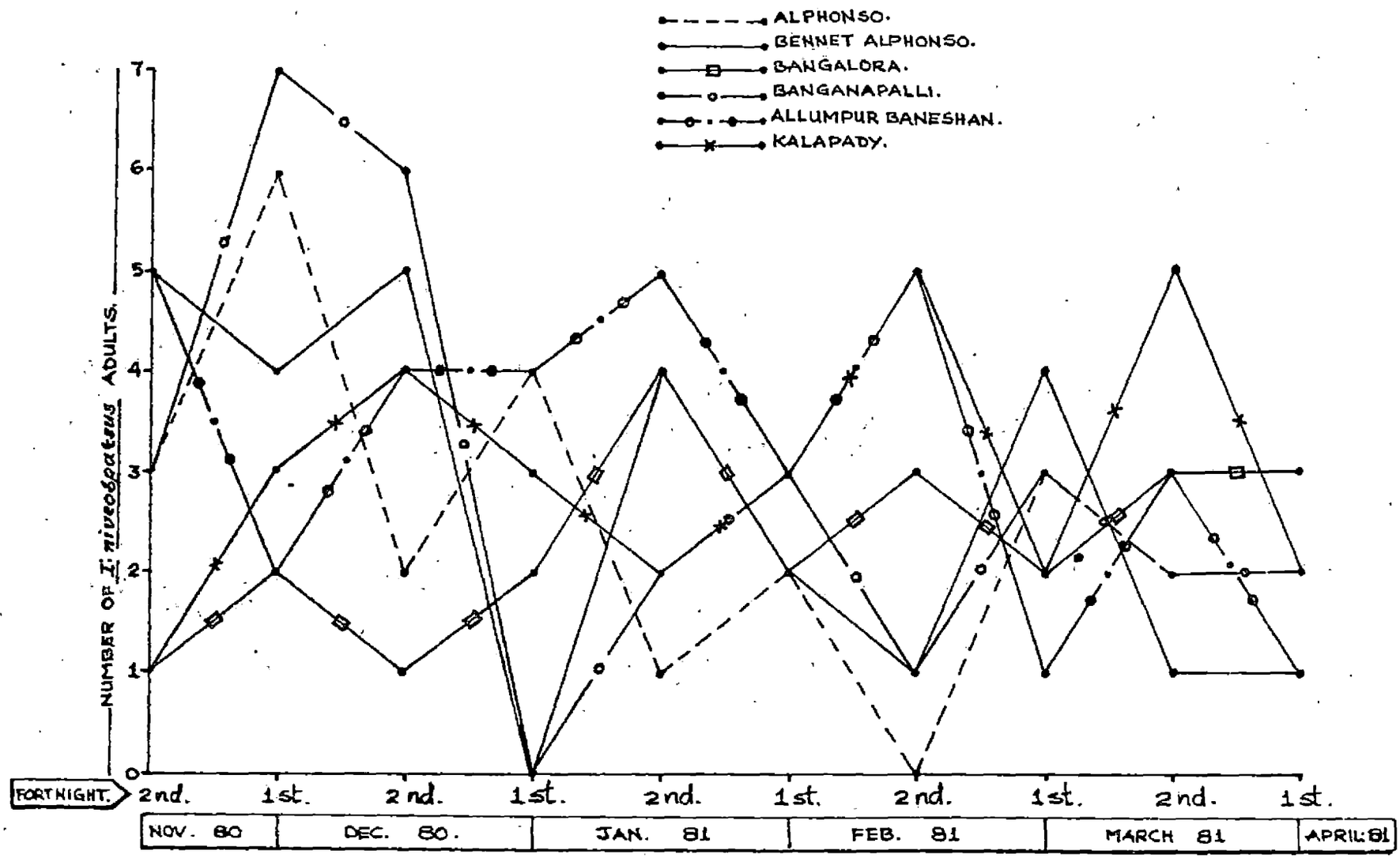


FIG. 3a.- POPULATION FLUCTUATIONS OF *I. niveosparsus* ADULTS ON DIFFERENT MANGO-VARIETIES.

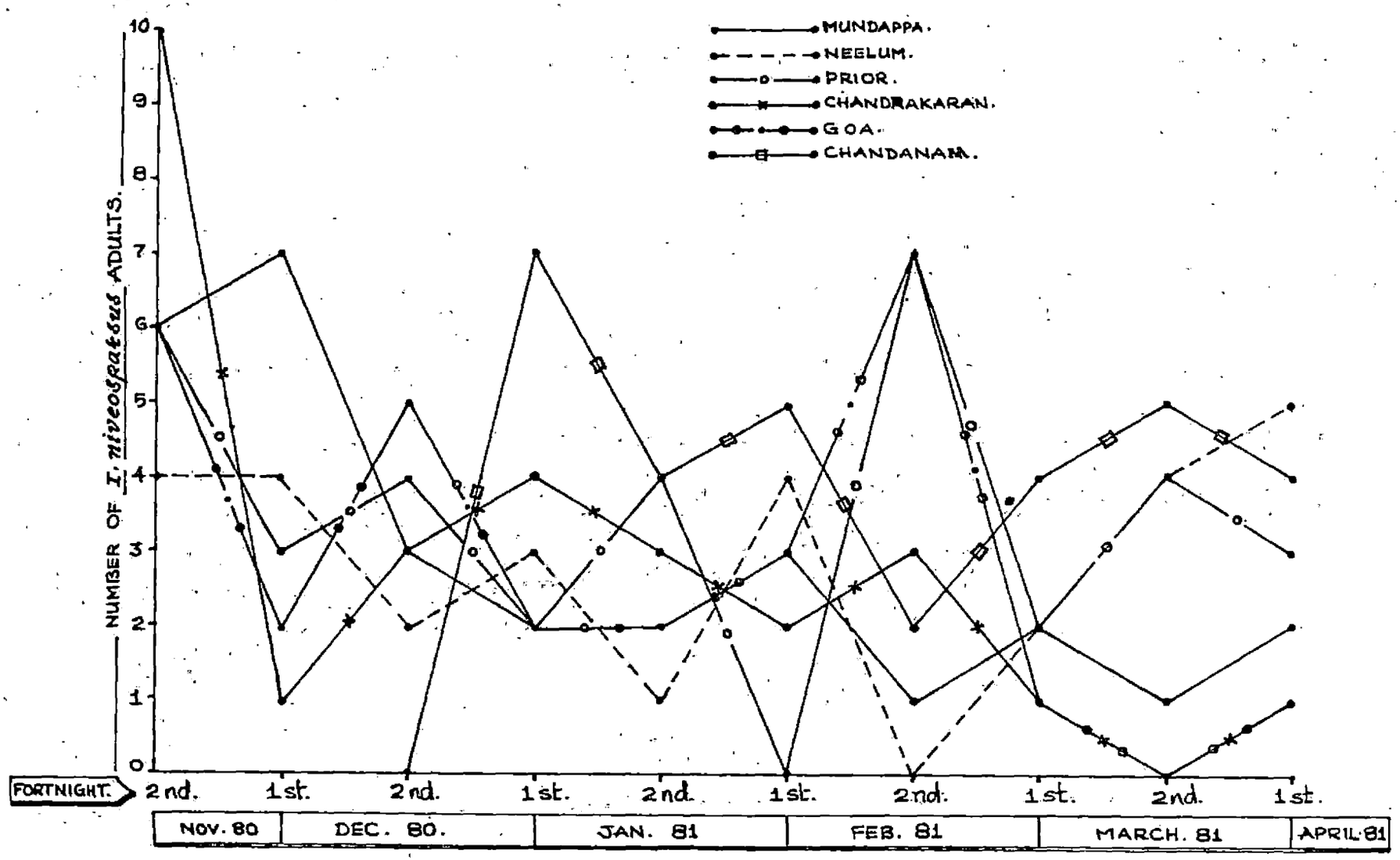


FIG. 3.b.- POPULATION FLUCTUATIONS OF *I. niveospatsus* ADULTS ON DIFFERENT MANGO-VARIETIES.

did not show significant fluctuations during the period of survey. Whether the populations at different fortnightly intervals were significantly different was tested by conducting χ^2 test. The results of this analysis are presented in Table 7a.

The total adult populations of I. niveosparsus on different varieties ranged from 23 in Bangalora to 35 in Prior (Table 6). The χ^2 test (Table 7b) indicated that the varietal influence on population was not significant.

Populations of I. clypealis

The adult populations recorded on different varieties at fortnightly intervals by sweep counting are indicated in Table 8 and the data are presented in Fig 4a, 4b. The results of χ^2 test are given in Table 9a. Significant variations in the fortnightly populations of I. clypealis was detected, the range being from 16 in the second fortnight of December to 236 in first fortnight of April.

Table 7a Seasonal influence on population fluctuations of adults of I. niveosparsus during November 1980 - April 1981

Period of sampling	Total number of adult I. niveosparsus occurring on tree canopy (sweep counts)	χ^2 value for the variations of the observed populations and the expected levels based on the mean values
November 1980		
2nd fortnight	50	
December 1980		
1st fortnight	41	
2nd fortnight	39	
January 1981		
1st fortnight	33	
2nd fortnight	34	
February 1981		12.00 NS
1st fortnight	32	
2nd fortnight	35	
March 1981		
1st fortnight	27	
2nd fortnight	30	
April 1981		
1st fortnight	29	

NS = Non-significant at 5 per cent level

Table 7b Varietal influence on population fluctuations of adults of I. niveosparsus during November 1980 - April 1981

Sl no	Varieties	Total number of adult I. niveosparsus occurring on tree canopy (sweep counts)	χ^2 value for the variations of the observed populations and the expected levels based on the mean values
1.	Alphonso	25	
2.	Bennet Alphonso	27	
3.	Bangalora	23	
4.	Banganapalli	29	
5.	Allumpur Baneshan	32	
6.	Kalapady	30	3.89 NS
7.	Mundappa	31	
8.	Neelum	29	
9.	Prior	35	
10.	Chandrakaran	28	
11.	Goa	30	
12.	Chandanam	31	

NS = Non-significant at 5 per cent level

Table 8 Fluctuations of populations of I. clypealis on different mango varieties at fortnightly intervals (sweep counts)

Sl no	Varieties	November '80	December '80		January '81		February '81		March '81		April '81	Total
		2nd fortnight	1st fortnight	2nd fortnight	1st fortnight	2nd fortnight	1st fortnight	2nd fortnight	1st fortnight	2nd fortnight	1st fortnight	
1.	Alphonso	2	1	0	2	3	2	7	6	21	91	135
2.	Bennet Alphonso	0	2	0	0	5	5	6	4	5	6	33
3.	Bangalora	6	1	0	0	6	1	6	4	6	7	37
4.	Banganapalli	2	2	4	0	3	1	6	7	8	10	43
5.	Allumpur Baneshan	1	2	1	1	9	4	22	11	8	16	75
6.	Kalapady	0	2	0	4	7	0	10	1	3	0	27
7.	Mundappa	3	1	0	19	9	12	57	19	13	20	153
8.	Neelum	17	7	1	10	13	6	10	16	21	34	135
9.	Prior	8	3	2	12	15	3	19	21	11	6	100
10.	Chandrakaran	0	5	6	13	25	0	4	21	20	26	120
11.	Goa	0	2	2	15	10	24	7	9	8	5	82
12.	Chandanam	0	0	0	30	30	26	69	22	13	15	205
	Total	39	28	16	106	135	84	223	141	137	236	1145

*Total from four replications

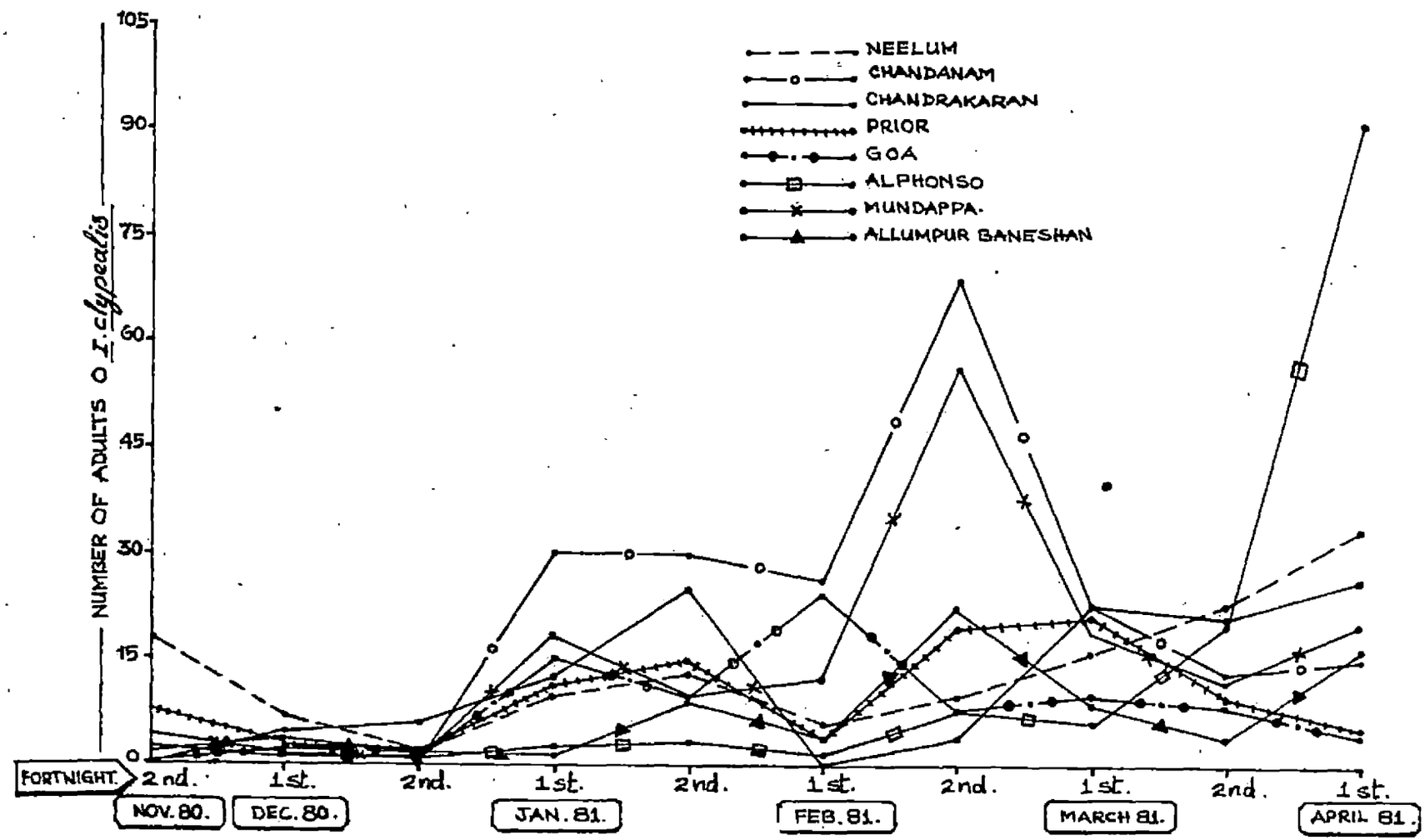


FIG.4a.- POPULATION FLUCTUATIONS OF *I. clypealis* ADULTS ON MANGO TREES OF DIFFERENT VARIETIES.

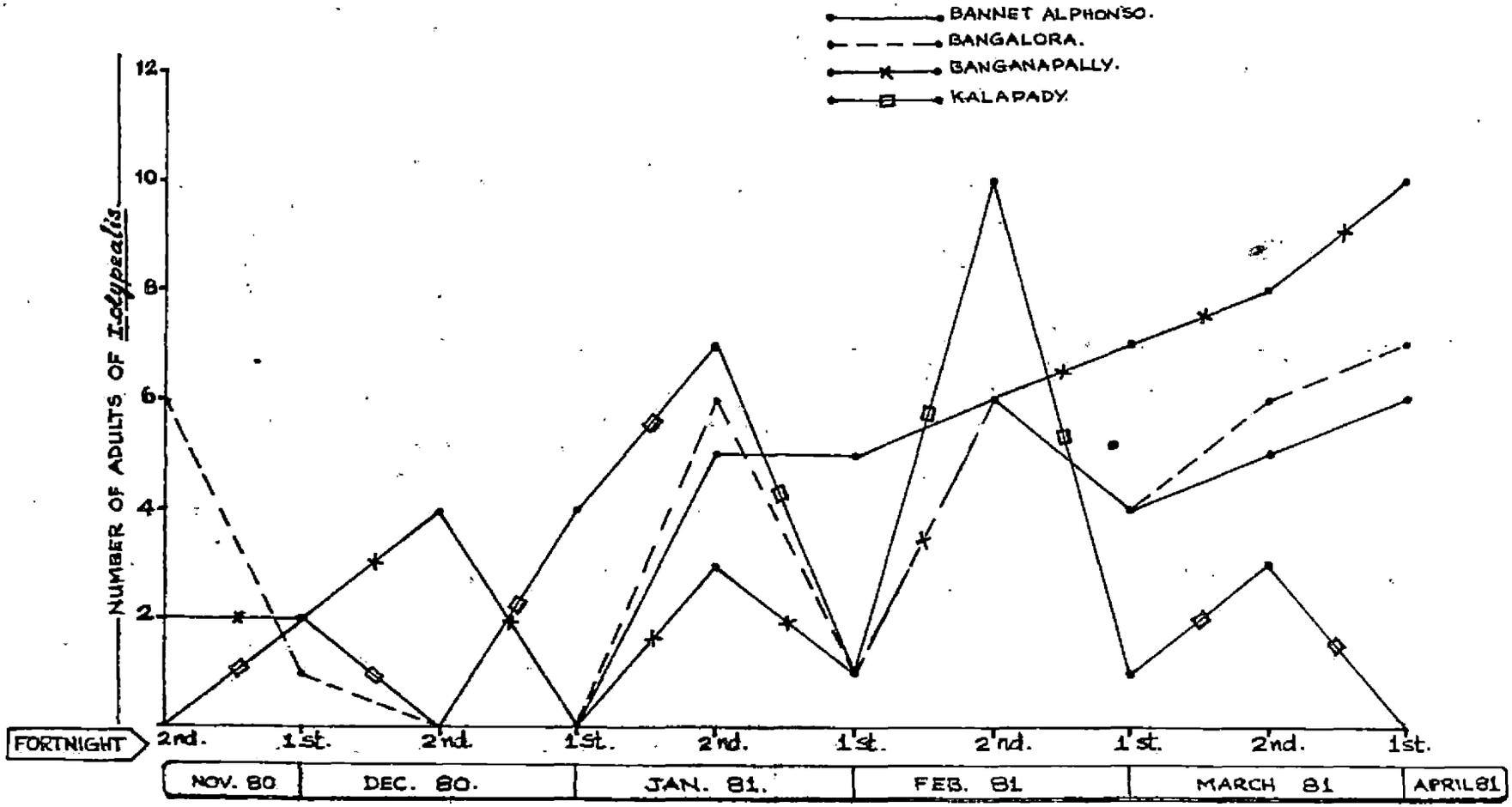


FIG. 4 b.– POPULATION FLUCTUATIONS OF *Ictypealis* ADULTS ON MANGO TREES OF DIFFERENT VARIETIES.

Table 9a Seasonal influence on population fluctuations of adults of I. olypealis during November 1980 - April 1981

Periods of sampling	Total number of adult I. olypealis occurring on tree canopy (sweep counts)	χ^2 value for the variations of the observed populations and the expected levels based on the mean values
November 1980		
2nd fortnight	39	
December 1980		
1st fortnight	28	
2nd fortnight	16	
January 1981		
1st fortnight	106	
2nd fortnight	135	
February 1981		451.16**
1st fortnight	84	
2nd fortnight	223	
March 1981		
1st fortnight	141	
2nd fortnight	137	
April 1981		
1st fortnight	236	

** Significant at 1 per cent level

The adult populations (total) of I. clypealis on different varieties ranged from 27 in Kalapady to 205 in Chandanam. In Bennet Alphonso and Bangalora the populations were relatively lower being 33 and 37 respectively. In Neelum and Alphonso the populations were 135 each while Mundappa supported a total of 153 I. clypealis adults. The χ^2 test results (Table 9b) indicated that there was significant influence of varieties on populations of I. clypealis.

The F_1 progeny production of I. niveosparsus under confinement on vegetative shoots and inflorescence of different mango varieties

Progeny production of I. niveosparsus on vegetative shoots

The F_1 progeny production from adults of I. niveosparsus bred under confinement on shoots was suppressed in the varieties Bangalora, Kalapady, Mundappa, Neelum, Chandanam (Table 10) while the mean emergence in the rest of the varieties, namely, Alphonso, Bennet Alphonso, Allumpur Baneshan, Banganapalli, Prior, Chandrakaran, Goa was too low with a range of 0.25 to 5.25.

Table 9b Varietal influence on population fluctuations of adults of *I. clypealis* during blossoming period

Sl no	Varieties	Total number of adult *I. clypealis* occurring on tree canopy (sweep counts)	χ^2 value for the variations of the observed populations and the expected levels based on the mean values
1.	Alphonso	135	
2.	Bennet Alphonso	33	
3.	Bangalora	37	
4.	Banganapalli	43	
5.	Allumpur Baneshan	75	
6.	Kalapady	27	396.32**
7.	Mundappa	153	
8.	Neelum	135	
9.	Prior	100	
10.	Chandrakaran	120	
11.	Goa	82	
12.	Chandanam	205	

** Significant at 1 per cent level

Table 10 F_1 progeny production (mean values) of *I. niveosparsus* on vegetative shoots of different mango varieties under confinement

Sl. no	Variety	F_1 progeny production (mean values)
1.	Alphonso	0.25
2.	Bennet Alphonso	1.50
3.	Bangalora	0
4.	Banganapalli	0.75
5.	Allumpur Baneshan	0.50
6.	Kalapady	0
7.	Mundappa	0
8.	Neelum	0
9.	Prior	5.25
10.	Chandrakaran	2.50
11.	Goa	2.75
12.	Chendanam	0

Progeny production of I. niveosparsus on inflorescence

The mean values of the progeny production by I. niveosparsus under confinement on floral branches are furnished in Table 11, represented graphically in Fig 5 and the raw data are furnished in Appendix-I. The data were transferred on the log scale in view of wide fluctuations of progeny production. The analysis of variance indicated significant varietal variability. The F_1 progeny production of I. niveosparsus under confinement on inflorescence of the variety Kalapady was 56.50 and this was significantly lower than in the varieties Neelum, Allumpur Baneshan, Chandanam, Mundappa and Bennet Alphonso, the range in the mean values for the latter group being from 96.83 in the Neelum to 146.80 in the variety Bennet Alphonso. The progeny production levels in the varieties Chandrakaran, Goa and Prior were 193.60, 245.30 and 269.30 respectively and these were significantly higher than in the rest of the varieties.

Table 11 F_1 progeny production (mean values) of *I. niveosparsus* on inflorescence of different mango varieties under confinement

Sl no	Varieties	F_1 progeny production (mean values)	Transformed values (Logarithmic values)
1.	Alphonso	157.90	2.1983
2.	Bennet Alphonso	146.80	2.1666
3.	Bangalora	58.66	1.7684
4.	Banganapalli	79.07	1.8980
5.	Allumpur Baneshan	117.10	2.0686
6.	Kalapady	56.50	1.7520
7.	Mundappa	130.60	2.1160
8.	Neelum	96.83	1.9860
9.	Prior	269.30	2.4300
10.	Chandrakaran	193.60	2.2870
11.	Goa	245.30	2.3900
12.	Chandanam	122.70	2.0887
		F test (0.05)	Significant
		CD (P = 0.05)	0.1986

P = 0.05 indicated the 5% level of probability

Influence of biochemical factors on progeny production of I. niveosparsus on inflorescence of different mango varieties

The Nitrogen content (%) of the shoots of different varieties ranged from 1.94 in Bangalora to 2.60 in Alphonso. The percentage nitrogen content of inflorescence of the varieties Kalapady, Neelum, Prior was 1.83, while in the rest of the varieties, the range was 1.87 to 2.46% (Table 12).

The soluble sugar contents (%) in shoots and floral branches of different varieties are given in Table 13. The soluble sugar content of the shoots of different varieties ranged from 1.94 in Alphonso to 3.17 in Goa. The soluble sugars (%) in floral branches ranged from 1.72 in Bangalora to 3.01 in Neelum.

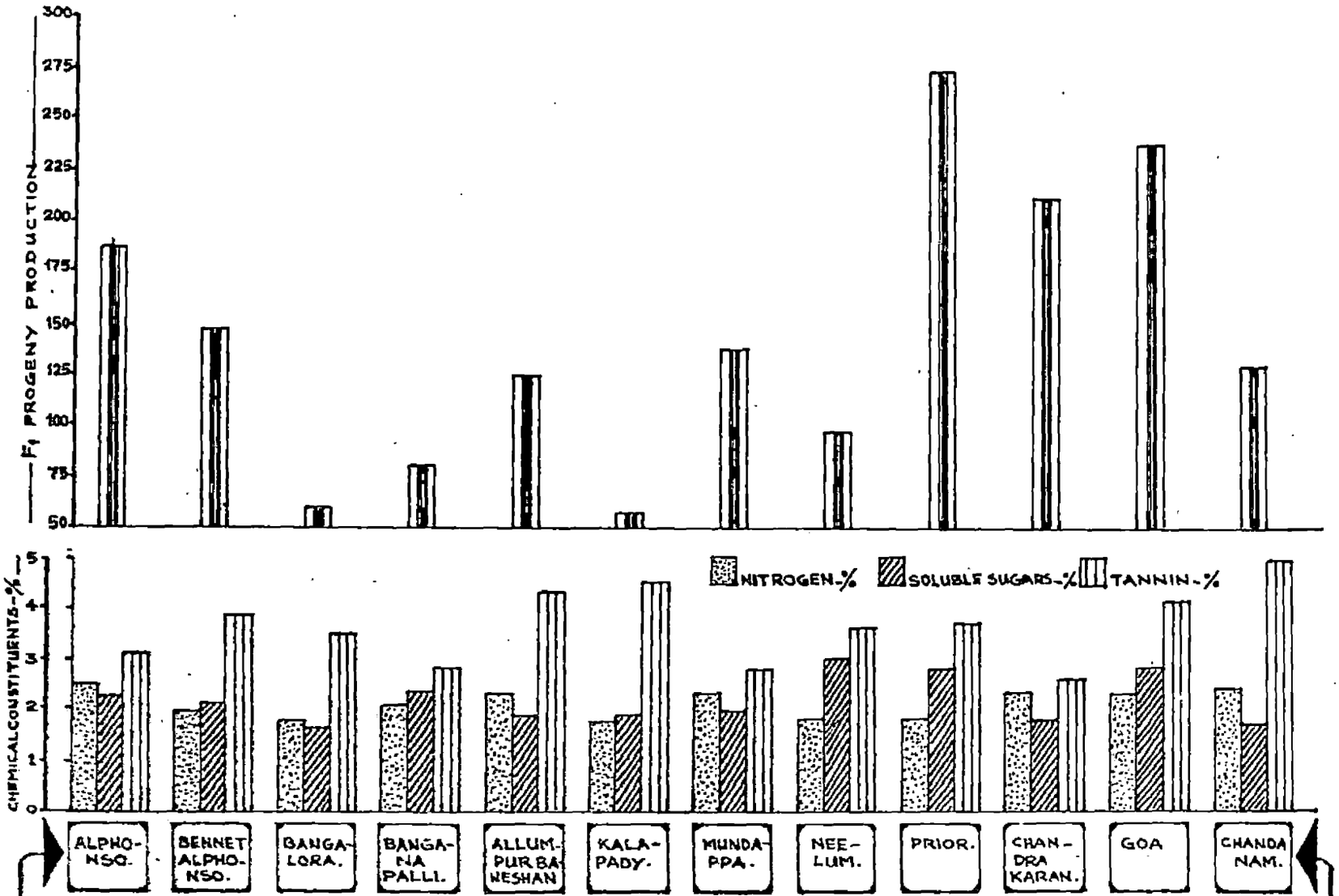
The shoots and floral branches of different varieties were analysed for tannin content and are given in Table 14 as percentage values. The tannin content (%) of the shoots of different varieties ranged from 0.77 in Banganapalli to 1.76 in Chandanam. The tannin content of floral branches of different varieties ranged from 2.68 in Chandrakaran to 4.89% in Chandanam.

Table 12 Nitrogen content in shoots and floral branches of different mango varieties

Sl no	Varieties	Nitrogen content (%)	
		Shoot	Floral branches
1.	Alphonso	2.60	2.46
2.	Bennet Alphonso	2.35	2.01
3.	Bangalora	1.94	1.87
4.	Banganapalli	2.20	2.16
5.	Allumpur Baneshan	2.38	2.38
6.	Kalapady	2.16	1.83
7.	Mundappa	2.20	2.31
8.	Neelum	2.05	1.83
9.	Prior	2.02	1.83
10.	Chandrakaran	2.20	2.35
11.	Goa	2.13	2.38
12.	Chandanam	2.05	2.46

Table 14 Tannin content in shoots and floral branches of different mango varieties

Sl no	Varieties	Tannin content (%)	
		Shoots	Floral branches
1.	Alphonso	1.25	3.06
2.	Bennet Alphonso	1.12	3.93
3.	Bangalora	1.08	3.53
4.	Banganapalli	0.77	2.87
5.	Allumpur Baneshan	1.45	4.28
6.	Kalapady	1.22	4.54
7.	Mundappa	1.32	2.83
8.	Neelum	1.00	3.63
9.	Prior	1.16	3.77
10.	Chandrakaran	1.27	2.68
11.	Goa	1.25	4.12
12.	Chandanam	1.76	4.89



F1 PROGENY PRODUCTION OF *I. niveosparsus* UNDER CONFINEMENT ON FLORAL BRANCHES OF MANGO VARIETIES IN RELATION TO TOTAL NITROGEN, SOLUBLE SUGARS AND TANNIN CONTENTS OF INFLORESCENCE.

Correlation coefficients involving the biochemical constituents of floral branches of different varieties on the one hand and the progeny production of hoppers on inflorescence of different varieties on the other were worked out and these are presented in Table 15, along with the partial Correlation coefficients. Significant positive correlation was detected between progeny production and nitrogen content, while in the case of soluble sugars and tannin contents the correlations were not found to be significant. Partial correlation coefficients involving the character associations indicated that the positive correlation between the progeny production on the one hand and nitrogen content of floral branches on the other retained the same trend even after elimination of the influence of soluble sugars and tannins. This clearly reveals that the total nitrgoen content of floral branches is relatively of greater importance in regulating the progeny production of I. niveosparsus on the floral branches.

Extent of damage (flower shedding) in different varieties of mango, consequent on feeding/ovipositional activity of I. clypealis

Table 15 Simple and partial correlation coefficients involving the bio-chemical constituents of the floral branches of different varieties and progeny production of *I. niveospersus* under confinement

Character associations	Simple correlation coefficients	Character associations	Partial correlation coefficients
r_{12}**	0.298*	$r_{13.4}$	0.0895
r_{13}	0.09	$r_{23.4}$	0.0341
r_{14}	-0.007	$r_{12.4}$	0.2979
		$r_{12.34}$	0.296*

* Significant at 5 per cent level

** 1 - Progeny production; 2 - Nitrogen content; 3 - Soluble sugar content; 4 - Tannin content.

Extent of damage to hermaphrodite flowers

The percentage values (transformed) for flower shedding in mango varieties consequent on confinement of *I. olypealis* for a period of 6 days are indicated in Table 16 and the raw data are given in Appendix-II. Significant varietal variability was detected with respect to flower shedding percentage values. The hermaphrodite flower shedding was the least in Kalapady (5.50%) as compared to the rest of the varieties and this was the maximum in Goa (90%). The flower shedding in the varieties Chandanam, Allumpur Baneshan, Chandrakaran and Prior ranged from 55.45% to 71.25%, but these were statistically on par. The hermaphrodite flowers damaged in the varieties Alphonso, Nellum, Bangalora, Bennet Alphonso, Banganapalli were 20.00, 21.15, 30.57, 35.62, 38.09 respectively, but these differences were not significant.

Extent of damage to male flowers

The extent of damage caused to the male flowers

Table 16 Extent of damage in hermaphrodite flowers due to feeding/ovipositional activity of *I. olypealis*

Sl no	Varieties	Percentage of flower shedding (mean values)	Transformed data(Angular values)
1.	Alphonso	20.00	26.39
2.	Bennet Alphonso	35.62	36.21
3.	Bangalora	30.57	33.32
4.	Banganapalli	38.09	38.11
5.	Allumpur Baneshan	63.21	52.66
6.	Kalapady	5.50	13.55
7.	Mundappa	40.94	39.74
8.	Neelum	21.15	27.29
9.	Prior	71.25	57.62
10.	Chandrakaran	63.22	52.68
11.	Goa	90.00	71.56
12.	Chondanam	55.45	48.18
		F test (0.05)	Significant
		CD (P =0.05)	12.12

P = 0.05 indicates the 5 per cent level of probability

Table 17 Extent of damage to male flowers due to feeding/ovipositional activity of *I. clypealis*

Sl no	Varieties	Percentage of flower shedding (mean values)	Transformed data(Angular values)
1.	Alphonso	37.25	37.58
2.	Bennet Alphonso	24.03	28.97
3.	Bangalora	41.68	40.15
4.	Banganapalli	25.01	29.45
5.	Allumpur Baneshan	21.59	27.65
6.	Kalapady	8.56	16.54
7.	Mundappa	31.17	33.92
8.	Neelum	23.41	28.57
9.	Prior	73.41	59.52
10.	Chandrakaran	80.00	63.44
11.	Goa	75.00	60.11
12.	Chandanam	57.68	49.40
		F test(0.05)	Significant
		CD (P =0.05)	12.87

P = 0.05 indicates the 5 per cent level of probability

in the inflorescence as the result of feeding ovipositional activity of I. clypealis is furnished in Table 17 and the raw data are given in Appendix II, Kalapady registered a flower drop of 8.56%, while in Chandrakaran, the damage was relatively higher, being 80%. The varietal differences were found to be statistically significant. In the varieties Kalapady, Allumpur-Baneshan, Neelum and Bennet Alphonso the flower drop (%) values were 8.56, 21.59, 23.41, 24.03 respectively and these were on par. With reference to the damage to male flowers these varieties showed relatively less damage as compared to the varieties Bangalora, Chandanam, Prior, Goa and Chandrakaran, the damage in the latter group being of the order of 41.68% to 80.00%.

DISCUSSION

DISCUSSION

Occurrence of *I. niveosparsus* and *I. clypealis* (adults and nymphs) on different mango varieties during the pre-flowering and flowering stages on the vegetative shoots

Pre-flowering period

Periodic sweep sampling of the canopy revealed that the adults and nymphs of *I. niveosparsus* and *I. clypealis* occurred at extremely low levels during the period from June to September 1980 (Table 1) on the vegetative shoots. Therefore, a rating of the varieties with reference to their relative susceptibility cannot be attempted with reference to the adult population levels during the pre-flowering stage.

Post-flowering period

The maximum number of adult hoppers were found on shoots of the variety Chandanam, while the variety Kalapady supported the minimum number (Table 2, Fig 1a, 1b). However, the varietal differences with respect to the adult

populations occurring on vegetative shoots were not found to be significant (Table 3a).

The adult population level was the lowest in the first fortnight of March 1981 and the highest in the second fortnight of January 1981 (Table 2, Fig 1a, 1b). The seasonal population fluctuations were not found to be significant (Table 3b).

During the flowering season, the nymphal populations on vegetative shoots were not observed at all in most of the varieties throughout the season. In some varieties, negligible populations were found.

Since the adult populations of I. niveosparsus and I. clypealis occurring on the vegetative shoots during the flowering and post-flowering stages did not show significant differences in different varieties, it would appear that this criterion cannot be relied upon as an index of the relative susceptibility of the mango trees.

Throughout the flowering and post-flowering period, the nymphal populations of the two species were found to be quite negligible on shoots of almost all the varieties (Table 4a). The complete absence or the occurrence of very low population

loads of hopper nymphs on vegetative shoots might either be due to the unsuitability of the shoots for rapid population build-up or due to unfavourable weather conditions. This being the case, nymphal populations occurring on vegetative shoots of mango trees during the pre-flowering and flowering periods also cannot be considered as a factor regulating the susceptibility spectrum of the varieties.

Population fluctuations of nymphs of I. niveosparsus and I. clypealis on floral branches during the flowering season

With the commencement of the flowering season, the nymphal populations outnumbered the adults and the susceptibility spectrum appeared to be regulated by the pattern of nymphal population build-up.

On the floral branches of different varieties, significant variations in the nymphal populations of I. niveosparsus and I. clypealis were recorded (Table 4b, 5a, Fig 2a, 2b). The variety Goa supported the maximum number of hopper

nymphs on the floral branches, while the variety Alphonso supported relatively low population loads.

Significant seasonal population fluctuations of the nymphs on the floral branches were detected and there was a striking progressive increase in the population levels of nymphs during the blossom season and the population peak was monitored in the first fortnight of February (Table 4b, 5b, Fig 2a, 2b).

The nymphal population build-up in the different varieties showed divergent phenological trends. Thus in Allumpur Baneshan, Kalapady and Mundappa, the nymphs were observed from the first fortnight of December onwards while in Bennet Alphonso, Banganapalli, Prior, Chandrakaran and Goa, the nymphal populations appeared only in the second fortnight of December. The variety Chandanam was exceptional and on this, the nymphal populations appeared quite late in the season by the first fortnight of January 1981.

Patel et al. (1975) reported that in south Gujarat, the populations of the mango hopper A. atkinsoni increased with the commencement of

the flowering season, with a distinct peak in June. In the Bombay Presidency, Idioscopus atkinsoni was reported to be abundant during the summer and the monsoon seasons, whereas I. niveosparsus and I. clypealis were practically absent during these periods (Anon, 1941). Wagle (1929) found that I. niveosparsus the principal species occurring in the Bombay Presidency were abundant in January and early February.

The simultaneous occurrence of I. niveosparsus, I. clypealis and Amritodus atkinsoni in mango trees as well as the sharp increase in their activity with the commencement of the flowering season have been already reported. The egg laying by the adult females was greatly increased as the atmospheric temperature levels dropped to about 55-60°F (Rao, 1930). The present finding that the nymphal populations registered progressive increase in the blossom season is in conformity with the above report. The variations in the seasonal occurrence of the hoppers in South India and in the other mango growing regions of the Country are quite expected on the basis of climatic variations.

Population fluctuations of adult hoppers on different varieties at fortnightly intervals (sweep counts)

In order to study the population fluctuations of adults of the different species of hoppers during the flowering and post-flowering stages composite samples were drawn by net sweepings from all over the canopy.

Populations of I. niveosparsus

The adult populations did not show any significant variations during the flowering period (Table 6, 7a, 7b, Fig 3a, 3b) and the populations were somewhat stable without distinct peaks. That the populations of I. niveosparsus did not show any progressive increase during the flowering season is explicable either on the basis of unfavourable meteorological conditions or on the basis of the availability of floral branches being of no consequence to the insects with reference to the quality of food. The adult population

trends on the vegetative shoots (Table 2) during the flowering season were also on similar lines. It would, therefore, appear that the mango varieties included in the present study do not show variability with reference to their susceptibility to infestation by I. niveosparsus.

Populations of I. clypealis

The adult populations of I. clypealis revealed significant fluctuations during the period from November 1980 to April 1981 (Table 8, 9a, 9b, Fig 4a, 4b).

The lowest population level was recorded in the second fortnight of December and the highest level was registered in the first fortnight of April. The build-up of the population towards the fag end of the post-flowering season is perhaps due to improvement in progeny production due to ovipositional stimulus provided by the floral branches as reported by Serrano and Palo (1933) from Philippines or due to higher survival rates due to superior nutritional status of the floral tissues. The earlier finding that

the vegetative shoots did not harbour sizable population of the insect during the pre and post-flowering stages also suggests this possibility.

The adult populations of I. clypealis in different varieties were found to be significantly different. Thus, in Kalapady, Bennet Alphonso and Bangalora, the populations were relatively lower while in the varieties Chandanam, Neelum, Alphonso and Mundappa the populations were relatively higher. The significantly higher levels of populations supported by these varieties reveal the relatively higher susceptibility of these varieties to the infestation by I. clypealis.

The F_1 progeny production of I. niveosparsus under confinement on vegetative shoots and floral branches

Sweep counts as well as direct counts on vegetative shoots and floral branches revealed the dominance of I. niveosparsus at the commencement of the flowering season. Therefore, the progeny production studies were carried out with

I. niveosparsus under confinement on the shoots. These studies were conducted by confining five pairs of freshly emerged adults separately on the shoots and floral branches.

The F_1 progeny production from adults of I. niveosparsus was either suppressed or was found to be extremely low in vegetative shoots (Table 10). However, on the floral branches, the progeny production of I. niveosparsus showed significant variation in different varieties (Table 11). The progeny production in the variety Kalapady was significantly lower than in the varieties Chandrakaran, Goa and Prior. The relatively higher rates of progeny production by I. niveosparsus on the inflorescence clearly show that this insect could sustain also on the floral branches. The dominance of I. clypealis at the fag end of the flowering season and the concomitant dwindling of I. niveosparsus populations might then be due to progressive changes in the meteorological conditions which tend to be selectively favourable to I. clypealis. The seasonal conditions at the fag end of the flowering season are characterised by low minimum temperatures and high maximum temperatures. The

fluctuations of temperature within such wider limits during the fag end of the blossom season may perhaps accelerate the speed of development of I. clypealis, while such conditions may not have any influence on the speed of development of I. niveosparsus.

Influence of biochemical factors on progeny production of I. niveosparsus on inflorescence of different mango varieties

In order to ascertain whether the susceptibility of mango varieties to infestation by the Idiocerine hoppers was influenced by certain bio-chemical constituents of the target tissues, correlation studies involving percentage total nitrogen, soluble sugars and tannins on the one hand and the F_1 progeny production by I. niveosparsus under confinement of floral branches were carried out.

The F_1 progeny production from I. niveosparsus was suppressed under confinement on vegetative shoots of the varieties Bangalora, Kalapady, Mundappa, Neelum and Chandanam (Table 10) and progeny production

was too low in the rest of the varieties, the range being 0.25 to 5.25. Correlation studies involving the progeny production on vegetative shoots and the biochemical constitution of the shoots were not attempted in view of this trend.

Significant positive correlation was detected between the progeny production under confinement on floral branches and the nitrogen content. In the case of soluble sugars and tannins, the correlations were not found to be significant (Table 15). The partial correlation coefficients involving the character associations indicated that the positive correlation between progeny production by I. niveosparsus on the one hand and the nitrogen content of floral branches on the other retained the positive trend even after elimination of the influence of soluble sugars and tannin. This reveals that the total nitrogen content of the floral branches is relatively more important in regulating progeny production of I. niveosparsus on the floral branches.

In many crop varieties, the total nitrogen content has been reported to be implicated in the regulation of pest population loads. The higher susceptibility of rice varieties to infestation by Nephotettix bipunctatus Fabr.

and Nilaparvata lugens Stål as a result of increased tissue nitrogen content has been reported by Ananthanarayanan and Abraham (1956). Viswanath and Nair (1969) obtained positive correlation between the higher doses of fertiliser nitrogen and the infestation by Aphis gossypii Glover on bhendi. That the bhendi varieties susceptible to infestation by Amrasca devastans (Dist.) contained higher levels of nitrogen has been reported by Uthamasamy et al. (1971). Balasubramanian (1975) found that the Cotton varieties susceptible to infestation by Amrasca biguttula biguttula Ishida contained more total nitrogen than in the susceptible ones. Benepal and Hall (1967) found that the total free amino acids and total soluble nitrogen content were relatively higher in the Cauliflower varieties which were susceptible to Pieris rapae. Sugars and amino acids have additive effects on sustained feeding of the corn borer Pyrausta nubinalis Hiibn. (Beck and Hence, 1958) and also in the case of several grass hoppers (Thorsteinson, 1960). The strong trend of the favourable influence of nitrogen on the F_1 progeny production of I. niveosparsus on the floral branches

could be explained either on the basis of the quantitative requirements of the amino acids or on the basis of the involvement of any of these components as phagostimulants. However, Salama and Saleh (1972) in the case of mango infested by the scale insect Myoetaspis personatus (Comstock) and Thomas (1981) in the case of Cashew infested by Tea mosquito bug Helopeltis antonii Signoret reported that total nitrogen was not implicated in the susceptibility trends of varieties. These variations are perhaps due to the differences in the nutritional requirements of these species.

It has already been discussed that the progressive increase in the population of I. clypealis during the flowering and the post-flowering stages in mango could be due to the favourable environmental conditions towards fag end of the blossom season. In the light of the correlation studies, it is also possible that the progressive increase in population might also be due to increasing concentrations of the total nitrogen content of the floral branches. Kennedy (1958) found that the water stress in plants is usually accompanied by increase in the nitrogen

content of the phloem sap which is brought about by premature hydrolysis in the leaves. In Kerala, the period from November to April corresponding to the flowering and post-flowering stages of the mango crop is characterised by the absence of precipitation and there is thus a progressive reduction in the soil moisture content. With increasing soil moisture stress, the nitrogen content of the floral branches are likely to increase considerably as already reported by Kennedy (1958) and this being favourable for the progeny production of I. niveosparsus, the progressive population increase of this is normally expected. Since, this trend of population increase is not realised, it is quite possible that the meteorological factors are selectively unfavourable to I. niveosparsus during the flowering and post-flowering stages. The progressive increase in the populations of I. clypealis might then be due to increasing concentrations of total nitrogen and due to the realisation of the innate capacity of numerical increase of the species under congenial weather conditions.

Neither the soluble sugars nor the tannin contents in the floral branches had any influence on the progeny production of I. niveosparsus under confinement on the floral branches. There are numerous reports of soluble sugars being implicated in the resistance of the crop varieties to insect pests. Corn varieties with higher carbohydrate content as reported to be resistant to corn borer Pyrausta nubinalis (Beck, 1956). Maltais and Auclair (1957) found that the pea aphid Acyrthosiphon pisum (Harr.) has relatively lower content of sugars as compared to resistant varieties. Hibbs et al. (1964) found that high concentrations of sugars increased resistance in potato varieties to infestation by the leaf hopper Empoasca fabae (Harr.). Reports on higher concentration of sugars being implicated in susceptibility of crop varieties are quite negre. Knap et al. (1966) and Singh et al. (1972) reported such trends in Maize with reference to Pyrausta nubinalis and in Cotton with reference to Amrasca devastans. In the case of I. niveosparsus,

it is found that the soluble sugars are relatively unimportant in the nutritional requirements of I. niveosparsus, as in the case of the Scale insect Mycetaspis personatus infesting mango in Egypt (Salama and Saleh, 1972).

The broad spectrum of defensive mechanisms provided by tannins in crop plants due to repellency or antibiosis have been already reported by many workers (Goldstein and Swain (1965); Singh, 1970; Chelliah, 1971; Sivasubramanian, 1978). The present finding that tannin is not implicated in resistance to I. niveosparsus is not in consonance with the general trend, but is perfectly in agreement with the finding reported by Thomas (1981) that the tannin content in floral branches of Cashew did not influence its relative susceptibility to infestation by Helopeltis antonii.

Extent of damage

Significant varietal variability was detected with respect to the shedding of the hermaphrodite and the male flowers caused by the feeding/ ovipositional activity of five pairs of I. clypealis confined on freshly emerging terminal inflorescences.

The shedding of both hermaphrodite and male flowers was relatively lower in the variety Kalapady being 5.5% and 8.56% respectively (Table 16, 17). The variety Goa showed maximum shedding of the hermaphrodite flowers (90%). The damage to the male flowers was the maximum in the variety Chandrakaran. Chandanam, Allumpur Baneshan, Chandrakaran and Prior showed fairly high damage intensities with respect to hermaphrodite flower shedding. The varietal differences in the shedding of hermaphrodite and male flowers consequent on feeding/ovipositional activity of I. clypealis might either be due to the mechanical injury or due to the toxaemia. The quantitative yield losses as the result of infestation by Idiocerine hoppers is directly related to the damage caused to the floral branches particularly to the hermaphrodite flowers. The varieties Kalapady, Alphonso, Neelum, Bangalora appears to be relatively more promising than Chandanam, Allumpur Baneshan, Chandrakaran and Prior in the above context.

An overall consideration of the results with reference to the adult and nymphal population loads of I. niveosparsus and I. clypealis supported on

the floral branches, the F_1 progeny production trends and the extent of damage to the hermaphrodite flowers, reveals that the variety Kalapady is least prone to infestation by I. clypealis and I. niveosparsus while the variety Goa is more prone to infestation by the two species. Kalapady is a regularly heavy bearing variety suitable for the West coast and the fruit quality of this variety is considered to be excellent. The popularisation of this variety for cultivation in Kerala appears to be useful from the point of view of its lesser susceptibility to the mango hoppers.

SUMMARY

SUMMARY

Studies on the relative susceptibility of twelve mango varieties, Alphonso, Bennet Alphonso, Bangalora, Banganapalli, Allumpur Baneshan, Kalapady, Mundappa, Neelum, Prior, Chandrakaran, Goa and Chandanam to infestation by I. niveosparsus and I. clypealis were carried out in the Instructional Farm and Research Station attached to the College of Horticulture, Vellanikkara, during June 1980 to April 1981.

The survey during the pre-flowering period from June to September 1980 revealed that the varieties supported extremely low populations of I. niveosparsus and I. clypealis. Therefore, a rating of the varieties with reference to the population loads during the pre-flowering stages could not be attempted.

During the flowering season, the adults and nymphs of I. niveosparsus and I. clypealis occurring on vegetative shoots of different varieties did not show any significant varietal or seasonal variations.

With reference to the nymphal population levels on floral branches, the varieties Alphonso, Neelum and Kalapady were found to be least susceptible than the rest of the varieties.

Studies on seasonal and varietal preferences of adults of I. niveosparsus and I. clypealis during the blossoming season and thereafter revealed that I. niveosparsus remained at low levels without significant fluctuations on different varieties. However, I. clypealis showed seasonal fluctuations and varietal preferences. The varieties, Kalapady, Bennet Alphonso and Bangalora were significantly less susceptible to infestation by this species. The populations of I. clypealis showed progressive increase during the blossoming season.

The F_1 progeny production from adults of I. niveosparsus bred under confinement on shoots were extremely low as compared to the progeny production on floral branches. With reference to the F_1 progeny production by I. niveosparsus on floral branches under confinement, the variety Kalapady was found to be significantly less susceptible than the varieties Chandrakaran, Goa and Prior.

The nature of influence of biochemical constitution of the floral branches (total nitrogen, soluble sugars and tannins) on the progeny production of I. niveosparsus under confinement was ascertained by working out simple and partial correlation coefficients and a strong positive correlation between nitrogen content on the one hand and the F_1 progeny production of I. niveosparsus on the other was detected.

In studies on the extent of damage to the hermaphrodite flowers due to feeding/oviposition by I. clypealis, it was found that the varieties Kalapady, Alphonso, Neelum, Bangalora, Bennet Alphonso, Banganapalli were significantly less susceptible than the rest of the varieties. The extent of damage to the male flowers was the lowest (8.56%) in the variety Kalapady.

The seasonal and varietal preferences of the hoppers and the fluctuations of the population loads of the hoppers on vegetative shoots and floral branches and the implication of the population trends on the susceptibility spectrum have been discussed. The overall considerations indicated that the variety Kalapady was less prone to infestation by I. niveosparsus and I. clypealis.

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* Originals not seen

APPENDIX - I

Progeny production of *I. niveosparsus* on inflorescence of different mango varieties *

Sl no	Varieties	Replication I	Replication II	Replication III	Replication IV
1.	Alphonso	102**	153	187	213
2.	Bennet Alphonso	151	123	176	142
3.	Bangalora	51	67	63	55
4.	Banganapalli	86	68	76	88
5.	Allumpur Baneshan	119	70	113	201
6.	Kalapady	27	56	96	47
7.	Mundappa	134	188	94	123
8.	Neelum	96	91	87	117
9.	Prior	202	342	308	250
10.	Chandrakaran	157	254	105	336
11.	Goa	204	155	440	261
12.	Chandanam	206	105	77	136

* Replication means furnished in Table 1ϕ

** means from four cages

APPENDIX - II

Extent of damage of flowers of mango due to feeding/ovipositional activities of *I. clypealis*

Sl no	Varieties	Flower drop due to feeding (%)		Control (%)		Actual flower drop due to feeding (%)	
		Hermaphrodite flowers	Male flowers	Hermaphrodite flowers	Male flowers	Hermaphrodite flowers	Male flowers
1.	Alphonso	30.00*	66.66	10.00	29.41	20.00	37.25
2.	Bennet Alphonso	73.12	66.53	37.50	42.50	35.62	24.03
3.	Bangalora	41.68	63.90	11.11	22.22	30.57	41.68
4.	Banganapalli	38.09	66.44	-	41.43	38.09	25.01
5.	Allumpur Baneshan	73.21	71.59	10.00	50.00	63.21	21.59
6.	Kalapady	34.20	37.26	-	28.70	5.50	8.56
7.	Mundappa	60.94	81.17	20.00	50.00	40.94	31.17
8.	Neelum	96.15	92.16	75.00	68.75	21.15	23.41
9.	Prior	71.25	88.41	-	15.00	71.25	73.41
10.	Chandrakaran	73.22	100.00	10.00	20.00	63.22	80.00
11.	Goa	90.00	85.00	-	10.00	90.00	75.00
12.	Chandanam	55.45	57.68	-	-	55.45	57.68

* means from two replications

SUSCEPTIBILITY OF MANGO (*Mangifera indica* Linnaeus) VARIETIES TO INFESTATION BY IDIOCERINE SPECIES (IDIOCERINAE: JASSIDAE: HOMOPTERA) OF HOPPERS

BY

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ABSTRACT OF A THESIS

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ABSTRACT

In studies on the relative susceptibility of twelve Mango varieties, Alphonso, Bennet Alphonso, Bangalora, Banganapalli, Allumpur Baneshan, Kalapady, Mundappa, Neelum, Prior, Chandrakaran, Goa and Chandanam to infestation by I. niveosparsus and I. clypealis, conducted at the Instructional Farm and Research Station, College of Horticulture, it was found that the varieties supported extremely low populations of the two species during the pre-flowering period from June to September 1980.

During the flowering and post-flowering season from November 1980 to April 1981, the adults and nymphs of the two speoies occurring on vegetative shoots of different varieties did not show any significant varietal or seasonal variations.

With reference to the nymphal population levels of the two species of hoppers occurring on the floral branches, the varieties Alphonso, Neelum and Kalapady were found to be less susoeptible than the rest of the varieties.

During the blossoming season and thereafter upto April 1981, I. niveosparsus remained at very

low population levels and significant varietal preferences were not manifested. However, I. clypealis showed seasonal fluctuations and varietal preferences and the population showed progressive increase during this period. The varieties Kalapady, Bennet Alphonso, Bengalora were found to be less susceptible to infestation by this species. The F_1 progeny production by I. niveosparsus was extremely low under confinement on vegetative shoots but on floral branches, the progeny production was quite satisfactory, the range being from 56.50 in the variety Kalapady to 269.30 in the variety Prior. The F_1 progeny production by I. niveosparsus on the floral branches was found to be significantly lower in the variety Kalapady as compared to the varieties Goa, Chandrakaran and Prior.

Studies on the nature of influence of biochemical constitution of the floral branches (nitrogen, soluble sugars and tannin) on the progeny production of I. niveosparsus revealed strong positive correlation between the nitrogen content on the one hand and the F_1 progeny production on the other.

Significant variability was detected among mango varieties with reference to the extent of damage inflicted to the hermaphrodite and male flowers on the sixth day of confinement of I. clypealis adults on fresh floral branches. The extent of damage to the hermaphrodite flowers consequent on feeding and oviposition by this species ranged from 5.5% to 90% and the varieties Kalapady, Alphonso, Neelum, Bangalora, Bennet Alphonso, Banganapalli were significantly less susceptible than the rest of the varieties. The damage caused to the male flowers ranged from 8.56% in the variety Kalapady to 80% in the variety Chandrakaran.

The seasonal population fluctuations of the hoppers and their varietal preferences in relation to the population loads and progeny production trends on vegetative shoots and floral branches have been discussed. The overall considerations indicated that the variety Kalapady was less susceptible to infestation by I. niveosparsus and I. clypealis.