Survey of Animal Pests

SURVEY OF ANIMAL PESTS

INTRODUCTION

By simple definition, pests are insects or any other living being whose population increases to such an extent as to cause economic losses to crops or a nuisance and health hazard to man and his livestock. As a process of civilisation, cultivation of crops led to a concentration of host plants providing easily available food to enable the insects to flourish. Deforestation, as another factor, necessitated by man's need for greater cultivation, habitation etc made forest insects migrating to fields and becoming pests of such plants and which they otherwise would have not cared for. In fact, insects and other beings are designated as pests only when they are sufficiently numerous to cause economic losses. Many factors are tied with the problems of pest outbreaks in the agricultural fields. Favourable weather conditions may lead to a rapid multiplication of an insect and the same condition may turn out to be unfavourable to its natural enemies giving an added impectus for the growth of the pest to cause an outbreak. Secondly, large scale mono culture of crops may be suitable for specific insects to thrive.

Existing literature on the animal pests of cucurbetaceous plants reveals that there occurs a number of vexatious pests which cause extensive damage to the whole plants. Leaves of plants attacked by certain pests rapidly wilt as if the sap flow had been cut or poisoned. Presence of permicious borer may destroy 25 per cent or more of the crop. Some worms whose larvae mature later in the season may even totally destroy late maturing pest populations results in extensive damage of chayote plants. Like other cucurbits, one of the severe problems as to the maximum productivity of chayote plants is attack by some animal pests on the foliage, inflorescence and stem of the plant particularly during assimilate filling phase, rendering the growing fruits less saturated or unsatured sinks thereby resulting in smaller size of fruits and consequently serious impairment of crop yield. Even the life cycle of the plant is terminated shortly and yield becomes negligible or nil under severe infection. Again yield of the underground tuberous root is sometimes reduced by some animal pests and soil nematods. To get rid of such biotic hazards in higher productivity, the population dynamics of animal pests appearing on the plants have to be ecologically analysed, the study of which is totally lacking in the literature. The present study therefore has been aimed to 1) identify and document different pestiferous populations on the stem, foliage and inflorescence 2) record the population fluctuations of different species in different months of the year in relation to climatology as well as growth phase of the plant 3) analyse such fluctuations in order to assess the ecological status of the agroecosystem and 4) to compare between wild and cultivated areas of plants growth. Although information are available on different pests in general on cucurbitaceous plants (Dhillon and Sharma, 1987) in India, specific and detailed information on chayote pests in Darjeelling hill areas are yet to be documented. Existing literatures also indicate that pest infectations to crop may be controlled by natural mortality factors like weather, hyperparasitism etc. (Walker et al., 1984, Soteres *et al.*, 1984 ; Williamson *et al.,* 1985 and Singh *et al.*, 1991). Such factors acting on chayote pests provide effective natural control in wild areas.

MATERIALS AND METHODS

Area of Study : The study area was located at Darjeeling, West Bengal, India at an altitude of 2100 m (approx). Two sites, were selected, one remained as uncared area of chayote plantation, herein referred to as 'wild' and another was a cultivated area by a farm herein referred to as 'cultivated'. For this study, 1000 m^2 area of both the sites were earmarred for sampling of pest populations on the said plantations. In the wild, the plants needed no extra maintenance but were naturally provided with good drainage, sandy loamy soil with rich humus. The cultivated area was a waste land where the fruit was sown in the month of January, in the levelled bed. The seed bed was prepared by filling the soil to make it loose and then decomposed organic manure (cowdung or compost) was added, on which the mature viable fruit was sown, slightly obliquely facing the seeded part towards the upperside, making an angle of 30°-40° with ground level. The fruit was covered with soil not exceeding 4 inches to 5 inches in thickness. Next, the decomposed organic manure was again spread all over the bed, propagation of the plant may either be through seed or fruit or vegetative propagation through the perennial underground tuberous roots.

3 Methodologies for population study :

In order to study the pestiferons population on *S. edule,* weekly observations were made from the very beginning of sprouting time of the plant. Juvenile and adult morphs of different pestiferous populations invading the crop were collected and maintained in the laboratory under preservation for identification. The population density of different species was enumerated both in wild and cultivated fields. The feeding niche of each population was observed carefully throughout the study period to ascertain species interactions if any. To estimate the population density and dynamics of different pest species a unit of 10 infested plants were considered (mostly the aerial parts were observed i.e. stem, leaves and reproductive parts) both in wild and cultivated fields. Meteorological data with respect to precipitation (ie rainfall, snow etc), temperature and relative humidity were collected throughout the study period to analyse their impact on the pest species.

RESULTS AND DISCUSSION

In the present study, the following pestiferous populations were collected throughout the life cycle of plant, *Sechium edule.*

1. Hadda Beetle :- *Epilachna demurili*

   (Coleoptera : Coccinelhidae)

2. Red pumpkin Beetle :- *Rabphidopalpa foveicollis*

   (Coleoptera : Chrysomelidae)

3. Pickleworm :- *Diaphania nitidalis*

   (Lepidoptera : Pyralididae)

4. Squash bug :- *Anasa tristis*

   (Hemiptera : Coreidae)

The snail,

5. *Macrocalamys* sp :- Phylum Mollusca

   Class – Gastropoda.

The objective of this study was to throw light on the following characteristics of the community.

1. Comparative survey of the abundance of various population in Wild and Cultivated areas.
2. Total community structure in every month of plant life as regards populations of different species and a comparison between wild & cultivated areas.
3. Dominance Diversity curve for study in species importance at each month of plant's occurrence.

Comparative survey of each population in wild and cultivated areas : The results of this study has been depicted in Figs 1 to 5 .

In the Fig 1, abundance of *Epilachna demurili* on *Sechium edule* has been shown. The population is represented by large number of individuals both in wild and cultivated areas during the month of July and dwindles to certain extent in August. Then onwards, the population is shown to steadily decrease and in maintained at low level.

Fig 2 shows the abundance of *Diaphania nitidalis* during the months of occurrence. It shows that in cultivation, the population increases exponentially in August and then declines steadily over time. However, in the wild the population increase is not as great as that in cultivation and was maintained at a comparatively low levels to go to dormant phase during December.

Similar trends were also observed for *Rabphidopalpa foveicollius* (Fig 3) In the cultivated men from an initial low level in July, population increased from August but started to decline after October to a sudden low population density in December. The population showed slightly higher rate of increase in the cultivated than in wild, in which, notable population increase took place only during October, maintained at equilibrium till November and then sharply declined to a dormant level in December.

In the case of *Anasa tristis* (Fig, 4) , population growth in the cultivated areas increases exponentially from August and reaches its peaks in October but a population crash is obtained afterwords as evident from a steadily debilitating population in November and December. In the wild, population increase is however not as rapid as in the cultivation but a rising trend is maintained till October, after which the population decline following a short interval of equilibrium.

The population of *Macrocalamys* sp, has shown a fluctuating trend as seen in Fig 5. In the cultivated area, it shows an initially higher rate of growth in August and grows rapidly in September but falls to a low level in October. It again rises in November to finally decline in December. In the wild, similar fluctuations are observed although, the rate of growth is lower than that in the cultivation.

Explanations : Although variations in the abundance of different species are evident, yet a general trend is still existing. The changes in the population density can firstly be correlated with the metrological factors viz. rainfall, humidity, temperature & photoperiod and the life cycle of the plant itself. Fruiting of the plant is from the end of June to and of December and the incidence of pest population has also been recorded during this phase only.

The climatic factors during this period ensures a moist but frost free atmosphere with good rainfall to about 1500 – 6257 mm and temperature from 10^0c to 25^0c which is the most favourable for the plant growth and thereby associated pestiferous population. A relative humidity (RH%) averaging 80-90% has been very much favourable and 100% RH can be tolerated by the plant.

Hence, with the atmospheric factors for plant growth being favourable, the plant life is spanned from end of June to end of December and peals of propagation during August to October. During July to September both the cultivated and wild field get maximum abundance of pestiferous populations belonging to species *Epilachna demurilii* and *Diaphania nitidalis.* During September to November the most abundant populations of pests belong to *Rabphidopalpa foveicollis* , *Anasa tristis* and *Macrocalamys.*sp. Therefore both the periods (i.e July to September and September to November) need intensive observation to reduce the crop productions by the pests.

Monthwise Community structure of pest populations both in cultivated and wild fields:

The results of this study have been shown in Fig (6 –7). Among the reorded five pestiferous species. *Epilachna demurili* showed maximum abundance in July both in cultivated and wild fields, with a gradual decline upto December. *Diaphania nitidalis, Macrocalamys* sp and *Raphidopalpa foveicollis* had peak abundance during August to October in cultivated field. The senerio is to some extent different in case of wild field for these pest species. According to the magnitude of abundance of population, the pest species may be ordered, from highest to lowest, *Epilachna demurili, Diaphania nitidalis, Macorcalamys,*sp. *Rabphidopalpa foveicollis. Anasa tistis* in cultivated condition. The order is more or less similar in case of wild condition.

Explanations : *Sechium edule* supports a large number of pestiferous species with different degrees of manifestations. The recorded five species had a seggregated status trophic (feeding) niche, for example, defoliator, sucker, scraper, barer etc. Such a vast range of invasion pattern is a serious concern with regards to crop cultivation. The whole pesteferous community was very much static and stable one as all the thriving species were mutually exclusive with regards to their feeding as well breeding niches. Therefore, all the species need individual attention for the controlling programme taken, if any.

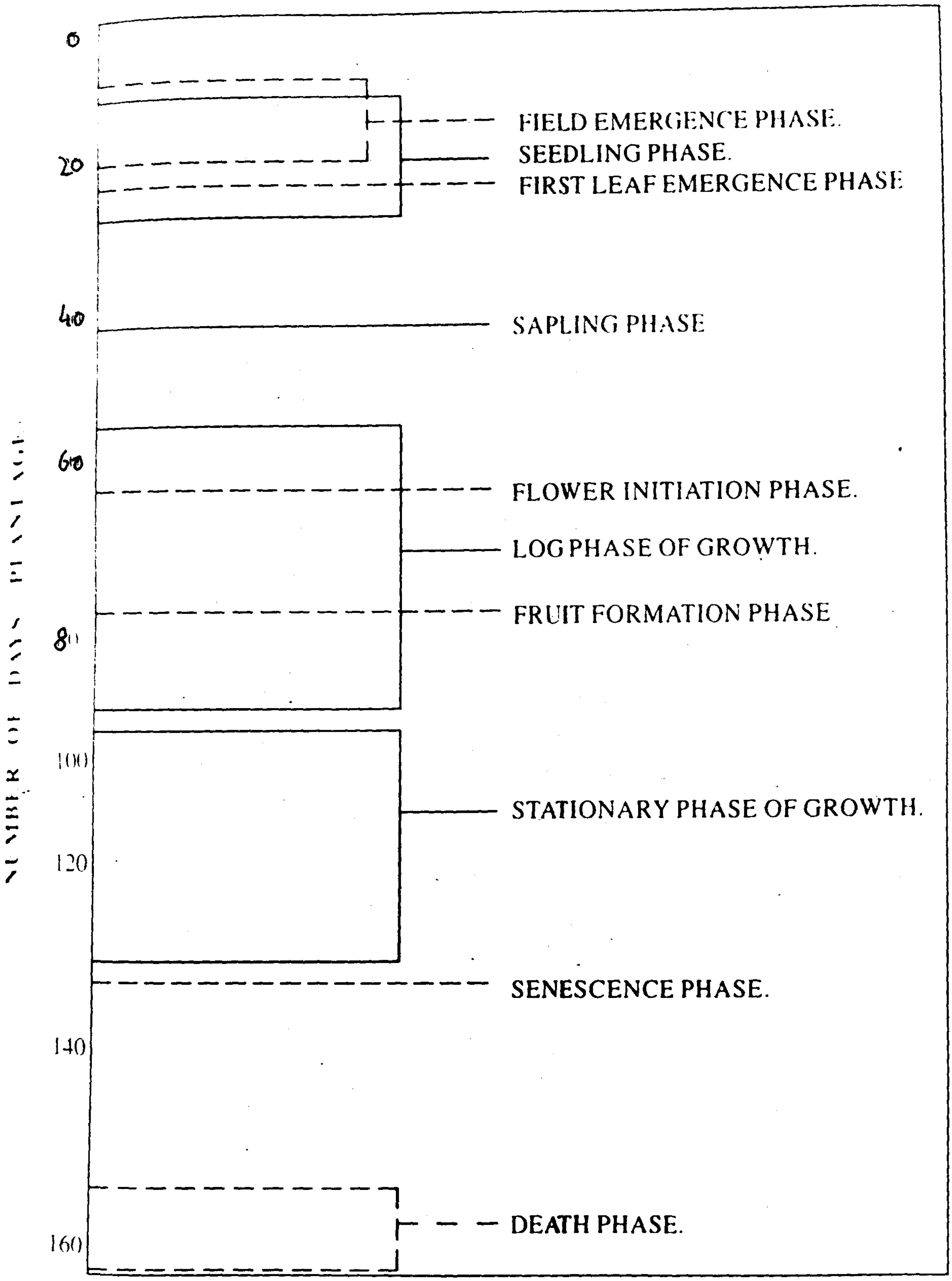
Month wise Dominance diversity of pestiferous species populations.

The results of this study has been shown in the figs (8 to 19).

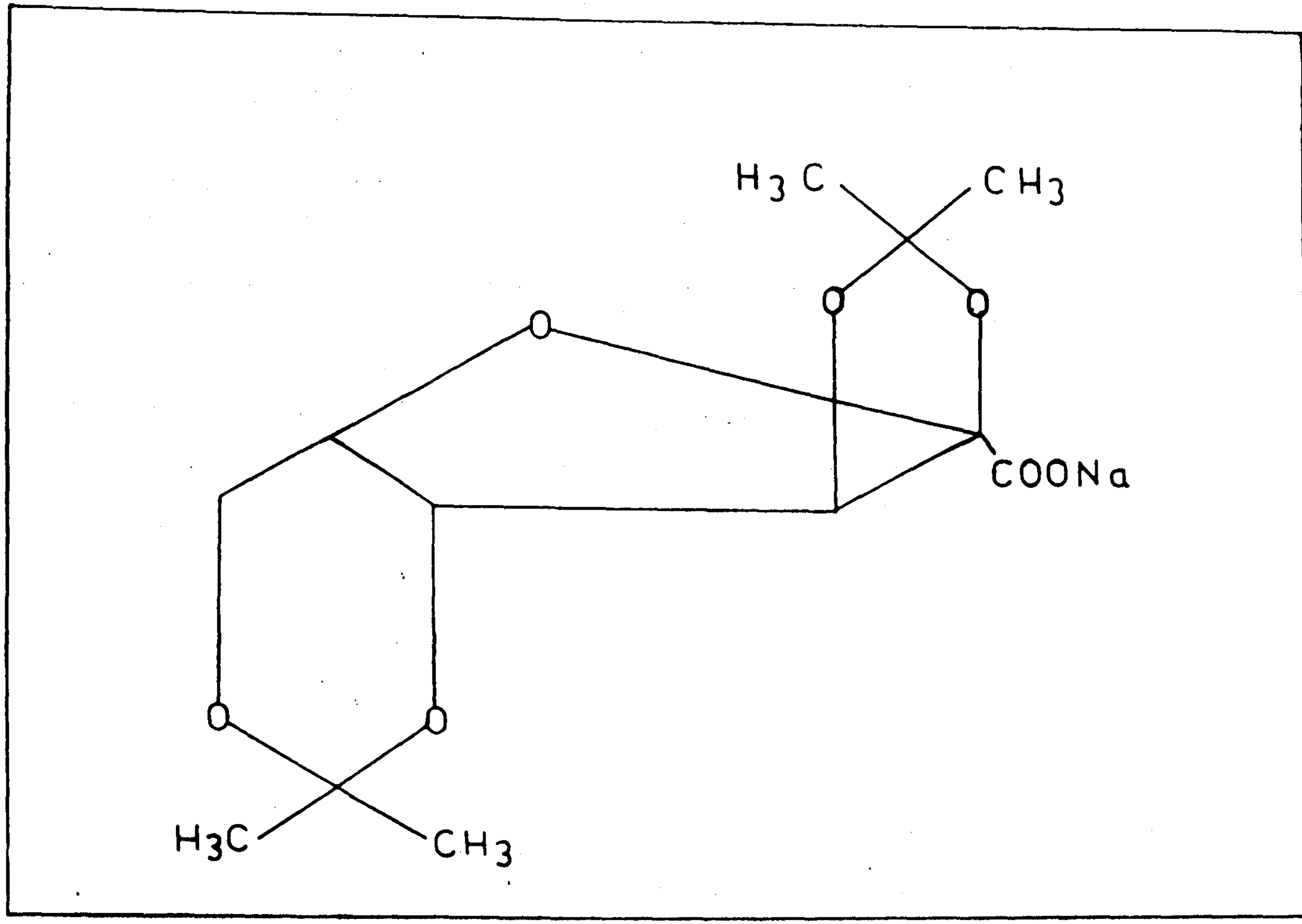
The species *Epilachna demurili* is represented as 'A' , *Diaphania nitidalis* is 'B', *Rabphilopalpa foveicollis* is 'C' *Anasa tristis* is 'D' and *Macrocalamys* sp. is 'E' for convenience. In August, the species dominance in order of magnitude, 'A', 'B', 'E', 'C', 'D' both in cultivated and wild conditions. September witnessed the same as 'A', 'B', 'E', 'C', 'D' in cultivated condition and 'A', 'B', 'E', 'C', 'D' in wild condition. October had the sequence as 'B', 'A', 'D','E', 'C', in cultivated condition and A', 'B', 'D', 'C' 'E', in wild condition. November showed 'B', 'E', 'A', 'D', 'C' sequence in cultivated and 'A', 'E', 'B', 'D', 'C' in wild conditions. Finally December witnessed the species sequence as **'B'**, 'A', 'E', 'D', 'C' in cultivated condition and A', 'B', 'E', 'D;', 'C', in wild condition. 'A' and 'B' appears to be the most dominant species.

Explanations : From the study it appears that in all month of study period 'A', **'B'**, 'E' are the most dominant pestiferous species amongst the five except in October, when first three dominant species are 'A' 'B' 'D'. Therefore, 'A', 'B', 'D', 'E' may be considered as first four dominant species during the study period. This result is equally reflected in all the parameters of this study under consideration. Hence, the whole survey reveals that 'A', 'B', 'D', 'E' i.e. *Epilachana demurili, Diaphania nitidalis, Anasa tistis, Macrocalamys* sp. are the most prominent pests of *Sechium edule* throughout the study period with the some less important pest species. Therefore, all these species need intensive surveillance for the better production of *Sechium edule* crop.

Diagram

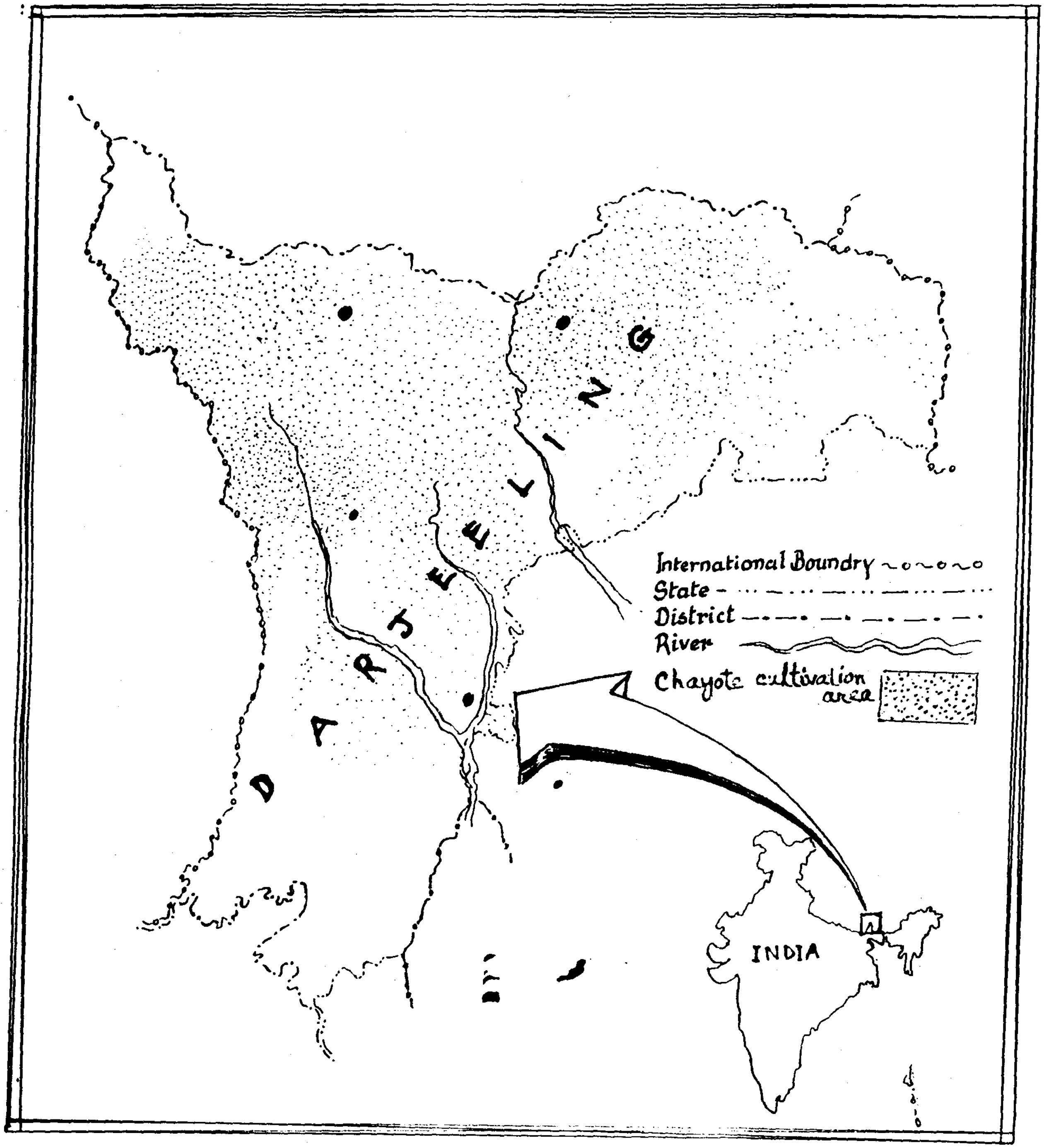


Dia 1 GRAPHICAL REPRESENTATION OF THE LIFE CYCLE OF *Sechium edule*.



Structure of sodium dikegulac

Dia 2



Dia 3 A map of Darjeeling district showing chayote cultivation area

Tables

Table 1. Varietal differences of *Sechium edule* on the basis of morphological characteristics of nature fruits. Data were recorded from 10 Mature fruits of each variety and the average values were incorporated in the Table.

Varietal type	Length (cm)	Breadth (cm)	Girth (cm)	Weight (g)	Colour	Hair density (per cm)	Hair length (mm)	Pattern of distribution
A	12.2	8.6	19.0	469.5	Greenish white	0	-	Hairless fruits
B	15.5	8.9	22.8	570.8	Green	0	-	Hairless fruit
C	14.0	8.2	20.9	425.0	Yellow green	10	3	Evenly distributed on the whole surface
D	8.7	7.2	14.8	208.9	Yellow green	22	5	Hairs coarse, uniformly
E	7.4	4.5	11.2	105.7	Yellow green	6	3	Arranged on the longitudinal surface of the fruit
F	10.9	7.0	15.9	292.9	Yellow green	12	4	Randomly scattered over the whole surface
G	11.8	6.8	16.0	327.7	Yellow green	4	2	Arranged around
H	9.1	5.8	14.0	140.5	Greenish white	Only a few per fruit	2	Evenly distributed evenly distributed around the apical notch
I	11.9	8.8	19.0	370.2	Whitish green	4	2	Sparsely distributed over the whole surface
J	10.0	8.9	17.7	290.5	Yellow green	0	-	Hairless fruits
LSD (P=0.05)	1.02	0.68	1.28	14.0		0.35	0.19	-

Table 2. Important phases occurring in the life cycle of *Sechium edule*. Data were recorded from five uniformly grown plants, developed from five uniformly sprouted fruits.

Phases in life cycle	Days required after sowing	Remarks
Field emergence phase	15±5	Sprouting takes place from the apical notches of the propagating fruit.
First leaf emergence phase	21±3	First leaf emerges from the tip of the tender epicotyl without tendrillar initiation.
Seedling phase	15-30±5	Leaves arise alternately with distinct reticulate palmate divergent venation; trailing habit noted, rudimentary tendrils initiate.
Sapling phase	30-48±5	Branched tendrils appear, plants start climbing holding a support.
Flower initiation phase	68±7	Male and female flowers appear at leaf axils; female flower solitary per node with short pedicel; male flowers (20-30) appear on long peduncle.
Fruit formation phase	77±7	Single fruit with apical notch and several deep longitudinal groves or channels, more pronounced toward the ends; surface hairs prominent.
Log phase of growth	55-90±10	Active and indeterminate growth of shoot tip results in vigorous vegetative growth.
Stationary phase of growth	90-130±10	Active apical growth retarded; fruit production maximum.
Senescence phase	135±8	Leaf yellowing starts, overall vigour reduced, underground tubers maximally developed.
Death phase	160±8	Above ground part dies, underground part remains fully viable with abundant starchy storage.

Table 3. Some vegetative and reproductive characteristics of three different varieties of *Sechium edule* collected from three different altitudinal places of Darjeeling hills. Data were recorded from five uniformly grown mature plants of each locality.

Locality	**Length of main vine (cm)**	**Total number of leaves per plant**	**Total number of flowers per plant**		**Total fruit yield per plant (kg)**
			Female	**Male**	
Mirik	965	422	272	6690	95.5
Sukhia Pokhri	770	307	210	5125	82.5
Darjeeling Town	550	255	182	3645	70.7
LSD (P=0.05)	55.28	28.19	15.92	298.40	7.50

Table 4. Summary of meteorological observations during the year 1992 at Darjeeling*

MONTH	**TEMPERATURE(^{0}C)**		**RELATIVE HUMADITY (%)**		**TOTAL RAINFALL mm**
	MEAN MIN	**MEAN MAX.**	**8.30 HRS.**	**17.30 HRS.**	
JANURAY	7.11	9.28	83.71	85.27	NIL
FEBRUARY	8.96	11.72	85.88	89.21	43.0
MARCH	9.72	12.78	72.81	75.75	54.0
APRIL	14.28	18.77	82.11	83.87	132.0
MAY	19.70	20.08	83.11	85.57	252.6
JUNE	20.70	22.00	86.47	87.83	607.10
JULY	20.34	22.85	94.78	97.17	859.0
AUGUST	19.50	20.00	85.70	87.44	84.0
SEPTEMBER	20.00	23.34	93.28	95.70	309.2
OCTOBER	19.35	20.00	85.70	87.44	84.0
NOVEMBER	14.78	17.67	84.03	85.91	NIL
DECEMBER	9.23	11.78	80.78	82.98	NIL
AVERAGE	15.30	17.58	85.77	87.16	T = 2704.40

*Longitude : 88°12′E Place : Darjeeling Town Altidue : 2134M Latitude : 26°55′N

Table 5. Summary of Meteorological observations during the year 1993 at Darjeeling*

MONTH	TEMPERATURE°C		RELATIVE HUMADITY (%)		TOTAL RAINFALL mm
	MEAN MIN	MEAN MAX.	8.30 HRS.	17.30 HRS.	
JANURAY	7.07	7.07	83.78	84.50	48.0
FEBRUARY	8.78	12.98	85.21	86.71	6.0
MARCH	13.48	17.22	72.11	73.25	25.5
APRIL	17.17	19.20	80.12	81.23	39.0
MAY	19.15	20.88	84.88	84.90	281.0
JUNE	18.77	19.88	86.77	90.11	587.0
JULY	20.78	21.74	93.77	97.11	594.0
AUGUST	20.58	22.44	96.77	98.38	651.4
SEPTEMBER	20.95	21.75	94.22	95.71	532.5
OCTOBER	17.75	19.28	85.70	86.29	2.0
NOVEMBER	15.19	17.00	82.17	83.21	NIL
DECEMBER	10.01	12.78	80.11	82.28	9.0
AVERAGE	15.80	17.68	85.46	86.97	T = 2775.4

*Longitude : 88°12′E Place : Darjeeling Town Altidue : 2134M Latitude : 26°55′N

Table 6. **Summary of** Meteorological **observations** during the year 1994 at Darjeeling*

MONTH	TEMPERATURE(°C)		RELATIVE HUMADITY (%)		TOTAL RAINFALL mm
	MEAN MIN	MEAN MAX.	8.30 HRS.	17.30 HRS.	
JANURAY	6.14	10.17	73.44	75.81	NIL
FEBRUARY	7.01	13.18	78.71	79.71	28.5
MARCH	10.11	16.44	75.81	76.71	NIL
APRIL	15.35	21.19	80.88	83.73	95.0
MAY	16.78	23.12	84.55	86.93	109.5
JUNE	18.84	24.19	86.17	89.90	313.9
JULY	20.18	24.78	94.27	96.39	725.5
AUGUST	21.15	25.00	96.88	98.22	517.5
SEPTEMBER	20.98	25.15	92.11	94.17	288.0
OCTOBER	17.17	21.78	84.22	85.15	68.0
NOVEMBER	13.18	18.77	82.12	83.11	NIL
DECEMBER	10.00	12.33	77.11	80.01	3.4
AVERAGE	14.74	19.67	83.85	85.82	T = 2149.3

*Longitude : 88° 12′E Place : Darjeeling Town Altitude 2134M Latitude : 26°55′N

Table 7. Meterological data recorded during tye year 1995 at Darjeeling*

MONTH	TEMPERATURE(⁰C)		RELATIVE HUMADITY (%)		TOTAL RAINFALL mm
	MEAN MIN	MEAN MAX.	8.30 HRS.	17.30 HRS.	
JANURAY	7.12	12.05	64.45	86.59	0.00
FEBRUARY	8.59	13.85	75.88	64.85	07.0
MARCH	10.38	15.09	78.59	70.77	21.5
APRIL	12.87	20.28	72.85	80.69	33.5
MAY	14.36	22.06	92.29	91.33	97.0
JUNE	16.01	20.08	89.75	100.00	613.0
JULY	18.15	19.57	90.88	100.00	806.0
AUGUST	19.75	20.08	91.66	91.57	520.0
SEPTEMBER	20.21	18.17	82.77	100.00	398.0
OCTOBER	16.90	17.28	77.84	69.21	032.7
NOVEMBER	14.01	15.36	89.63	67.95	142.0
DECEMBER	8.14	14.01	68.21	77.66	20.8
AVERAGES	13.87	17.32	81.23	83.38	T=2691.49

*Longitude : 88°12′E Place : Darjeeling Town Altitude 2134M Latitude : 26°55′N

Table 8. Effect of pretreatment with Atrinal (0, 500, 1000 and 2000 µg/ml) on intact and defleshed fruit of chayote on chlorophyll (Chl, mg/g fresh weight) and protein (Pr, mg/g fresh weight) contents in leaves at different developmental stages of the plant.

Sprouting fruits (intact or defleshed) were pretreated with the test solutions or distilled water for 24 hours and then sown in the experimental field. Data were recorded at 5 developmental stages i.e., seedling stage, sapling stage, preflowering stage, fruiting stage and senile stage which correspond to 20-, 40-, 60-, 80- and 140 days of plant age respectively.

Pretreating Sample	Concn. of Atrinal (µg/ml)	Developmental Stages									
		Seedling		Sapling		Preflowering		Fruiting		Senile	
		Chl	Pr	Chl	Pr	Chl	Pr	Chl	Pr	Chl	Pr
Intact Fruit	0	2.49	22.50	3.10	65.51	3.55	74.20	2.81	62.50	0.32	19.80
	500	2.72	35.75	3.45	78.55	3.61	80.71	2.88	65.01	0.35	21.70
	1000	3.05	38.80	4.02	84.25	3.65	80.25	2.94	66.45	0.35	21.01
	2000	2.75	33.70	3.50	70.69	3.52	75.50	2.85	63.10	0.34	20.50
	LSD (P=0.05)	0.210	3.50	0.28	6.15	NS	NS	NS	NS	NS	NS
Defleshed fruit	0	2.78	28.75	3.40	75.05	3.85	85.70	3.05	66.01	0.49	25.55
	500	2.95	40.50	3.88	85.40	3.98	88.76	3.20	70.81	0.58	25.95
	1000	3.25	46.65	4.60	90.30	4.02	92.38	3.25	72.60	0.58	27.01
	2000	2.68	40.15	3.35	80.12	3.70	86.01	3.25	67.11	0.62	26.15
	LSD (P=0.005)	0.19	3.50	0.30	6.69	NS	NS	NS	NS	NS	NS

NS = Not significant

Table 9. Effect of pretreatment with Atrinal (0, 500, 1000 and 2000 μg/ml) on intact and defleshed fruit of chayote on soluble (Sol, mg/g fresh weight) and insoluble (Insol, mg/g fresh weight) carbohydrate contents in leaves at different developmental stages of the plant.

Treatments and recording of data are the same as in Table 8

Pretreating Sample	Concn. of Atrinal (μg/ml)	Developmental Stages									
		Seedling		Sapling		Preflowering		Fruiting		Senile	
		Sol	Insol	Sol	Insol	Sol	Insol	Sol	Insol	Sol	Insol
Intact Fruit	0	5.47	60.18	7.23	75.70	10.90	81.10	8.01	52.71	4.35	25.15
	500	6.70	72.75	10.90	86.70	11.15	83.65	8.20	51.90	4.35	25.00
	1000	7.20	75.80	12.25	90.39	11.72	85.80	8.65	55.01	4.40	26.25
	2000	5.89	68.85	10.05	78.18	11.88	78.01	7.78	52.41	4.32	25.20
	LSD (P=0.05)	0.75	6.19	1.08	6.90	NS	NS	NS	NS	NS	NS
Defleshed fruit	0	6.50	67.10	8.50	83.20	12.95	86.69	8.38	54.15	5.05	30.08
	500	8.20	79.67	10.25	92.15	13.05	90.01	8.40	57.10	5.10	32.05
	1000	8.66	78.35	12.05	98.72	13.60	92.40	8.52	58.91	5.25	33.19
	2000	7.58	76.66	9.98	94.50	12.99	88.20	8.44	55.36	5.10	30.95
	LSD (P=0.005)	0.70	5.90	0.89	7.10	NS	NS	NS	NS	NS	NS

NS = Not significant

Table 10. Effect of pretreatment with Atrinal (0, 500, 1000 and 2000 µg/ml) on intact and defleshed fruit of chayote on RNA (µg/g fresh weight) and DNA (µg/g fresh weight) contents in leaves at different developmental stages of the plant.

Treatments and recording of data are the same as in Table 8.

Pretreating Sample	Concn. of Atrinal (µg/ml)	Developmental Stages									
		Seedling		Sapling		Preflowering		Fruiting		Senile	
		RNA	DNA	RNA	DNA	RNA	DNA	RNA	DNA	RNA	DNA
Intact Fruit	0	470.5	70.5	535.8	82.7	548.7	78.6	515.9	60.9	288.7	38.7
	500	5.60.8	85.2	633.9	85.0	580.8	82.7	528.5	63.0	307.2	40.1
	1000	590.2	90.8	649.8	88.5	585.5	85.0	540.7	65.5	310.9	41.5
	2000	550.9	80.6	598.9	84.6	557.2	82.8	520.5	61.8	297.5	38.9
	LSD (P=0.05)	38.80	8.50	48.05	NS	NS	NS	NS	NS	NS	NS
Defleshed fruit	0	520.2	77.0	578.9	88.9	88.9	601.5	85.6	543.2	60.6	50.6
	500	570.6	88.0	645.7	92.0	92.0	635.1	88.7	560.5	63.3	52.0
	1000	629.8	92.9	666.9	95.8	95.8	639.5	90.0	569.9	64.8	52.5
	2000	588.7	84.5	630.4	91.3	91.3	633.6	87.7	556.1	60.9	49.8
	LSD (P=0.005)	42.95	7.05	50.75	NS	NS	NS	NS	NS	NS	NS

NS = Not significant

Table 11. Effect of pretreatment with Atrinal (0, 500, 1000 and 2000 µg/ml) on intact and defleshed fruit of chayote on catalase (Cat, unit/g fresh weight/h) and peroxidase (Per, unit/g fresh weight/h) activities in leaves of chayote plant.

Treatments and recording of data are the same as in Table 8.

Pretreating Sample	Concn. of Atrinal (µg/ml)	Developmental Stages									
		Seedling		Sapling		Preflowering		Fruiting		Senile	
		Cat	Per	Cat	Per	Cat	Per	Cat	Per	Cat	Per
Intact Fruit	0	120.7	30.5	139.5	78.2	146.5	85.9	130.7	96.7	60.6	25.6
	500	140.8	45.7	165.9	84.8	150.5	86.9	132.2	96.7	63.3	25.8
	1000	158.6	52.2	177.6	92.7	153.5	90.0	134.5	100.1	65.0	26.2
	2000	137.0	38.9	159.0	90.1	149.5	88.8	128.7	96.9	61.7	27.0
	LSD (P=0.05)	10.52	4.01	12.05	6.50	NS	NS	NS	NS	NS	NS
Defleshed fruit	0	140.5	38.5	157.6	90.0	159.9	97.1	139.5	100.8	77.9	36.5
	500	154.9	45.9	177.0	97.9	162.0	101.0	141.7	98.9	77.5	37.0
	1000	166.9	56.7	187.5	114.7	165.2	105.2	148.0	103.0	82.5	37.1
	2000	153.4	43.8	180.2	98.8	158.9	99.5	142.8	98.5	80.8	36.9
	LSD (P=0.005)	11.80	4.05	13.80	8.15	NS	NS	NS	NS	NS	NS

NS = Not significant

Table 12. Effect of pretreatment with Atrinal (0, 500, 1000 and 2000 µg/ml) on intact and defleshed fruit of chayote on IAA-oxidase (IAAox, unit/g fresh weight) and RNase (unit/g fresh weight) activities in leaves of chayote plant.

Treatments and recording of data are the same as in Table 8.

Pretreating Sample	Concn. of Atrinal (µg/ml)	Developmental Stages									
		Seedling		Sapling		Preflowering		Fruiting		Senile	
		IAA ox	RNase	IAAox	RNase	IAAox	RNase	IAAox	RNase	IAAox	RNase
Intact fruit	0	24.50	80.75	29.10	93.01	69.35	170.11	80.69	215.52	96.40	292.70
	500	18.01	72.72	25.01	89.90	70.16	162.51	81.15	210.80	94.25	288.15
	1000	16.50	60.59	22.50	80.98	67.95	161.80	77.90	206.10	92.29	282.75
	2000	19.90	66.40	27.25	85.54	68.80	169.50	80.05	213.22	96.20	285.65
	LSD (P=0.05)	1.50	6.90	2.01	6.98	NS	NS	NS	NS	NS	NS
Defleshed fruit	0	22.70	77.34	25.91	87.90	61.82	150.90	70.24	198.72	86.85	244.44
	500	16.95	68.75	22.01	80.14	60.15	148.34	68.80	190.31	85.50	238.14
	1000	15.80	65.05	19.95	77.33	58.90	144.90	66.88	188.90	84.19	232.92
	2000	18.40	70.15	23.14	78.75	59.75	149.11	70.01	193.75	86.05	240.70
	LSD (P=0.005)	1.48	6.01	2.04	7.05	NS	NS	NS	NS	NS	NS

NS = Not significant

Table 13. Effect of pretreatment with Atrinal (0, 500, 1000 and 2000 µg/ml) on intact and defleshed fruit of chayote on vine length (V.L., cm) and stem circumference (S.C., cm) at different developmental stages of the plant.

Treatments and recording of data are the same as in Table 8.

Pretreating Sample	Concn. of Atrinal (µg/ml)	Developmental Stages									
		Seedling		Sapling		Preflowering		Fruiting		Senile	
		V.L.	S.C.	V.L.	S.C.	V.L.	S.C.	V.L.	S.C.	V.L.	S.C.
Intact fruit	0	52.7	1.05	131.5	1.98	319.2	3.66	530.9	5.58	550.4	5.70
	500	45.8	1.45	112.9	2.40	312.9	3.85	528.5	5.70	542.7	5.78
	1000	43.6	1.59	108.4	2.52	309.8	3.88	520.7	5.75	538.6	5.85
	2000	38.5	1.64	100.7	2.60	305.2	3.90	510.1	5.75	532.9	5.92
	LSD (P=0.05)	4.01	0.13	10.52	0.20	NS	NS	NS	NS	NS	NS
Defleshed fruit	0	58.6	1.25	148.9	2.30	340.5	3.89	562.8	5.90	505.9	6.10
	500	50.1	1.53	132.7	2.60	338.7	3.98	548.7	5.98	585.2	6.21
	1000	45.9	1.60	125.8	2.66	335.9	4.05	540.2	6.18	579.8	6.30
	2000	40.9	1.68	120.3	2.74	326.5	4.08	536.9	6.24	568.7	6.33
	LSD (P=0.005)	4.20	0.15	12.50	0.21	NS	NS	NS	NS	NS	NS

NS = Not significant

Table 14. Effect of pretreatment with Atrinal (0, 500, 1000 and 2000 μg/ml) on intact and defleshed fruit of chayote on changes in number of days required for inception of leaf senescence (Senes. days) total fruit number (Fruit No.), total fruit weight (Fruit wt.) and total tuberous root weight (Root wt.) per plant.

Treatments and recording of data are the same as in Table 8. Data were recorded from 5 uniformly grown plants of each treatment.

Pretreating sample	Concn. of Atrinal (μg/ml)	Senes. days	Fruit No.	Fruit wt. (kg)	Root wt. (kg)
Intact fruit	0	142	155	57.5	13.0
	500	145	157	60.0	13.0
	1000	145	158	58.9	13.5
	2000	142	155	57.0	12.9
	LSD (P=0.05)	NS	NS	NS	NS
Defleshed fruit	0	142	165	63.5	14.5
	500	143	167	65.2	15.0
	1000	139	167	66.0	14.2
	2000	143	166	62.9	14.7
	LSD (P=0.05)	NS	NS	NS	NS

NS = Not significant

Table 15. Effect of foliar treatment with Atrinal (0, 500, 1000 and 2000 μg/ml) at the sapling stage of the plant on chlorophyll (Chl, mg/g fresh weight) and protein (Pr, mg/g fresh weight) contents in leaves of chayote.

Thirty-day-old field grown saplings raised from intact and defleshed fruits, were sprayed with Atrinal or distilled water for 3 consecutive days. Data were recorded at 4 developmental stages i.e, sapling stage, preflowering state, fruiting stage and senile state which correspond to 40-, 60-, 80- and 140 days of plant age respectively.

Plants raised from	Concn. of Atrinal (μg/ml)	Developmental Stages							
		Sapling		Preflowering		Fruiting		Senile	
		Sol	Insol	Sol	Insol	Sol	Insol	Sol	Insol
Intact fruit	0	7.19	71.90	10.05	79.15	8.20	52.90	4.32	24.88
	500	6.05	62.50	10.50	77.90	11.20	70.12	6.52	33.70
	1000	5.90	58.90	11.01	77.88	12.72	75.90	7.90	38.90
	2000	5.82	56.69	10.05	75.05	10.90	65.70	6.23	33.05
	LSD (P=0.05)	0.40	5.04	NS	NS	0.80	5.25	0.48	2.90
Defleshed fruit	0	8.45	82.21	12.82	85.90	8.25	53.86	4.98	29.75
	500	6.25	69.50	11.99	86.28	11.57	73.05	7.05	36.95
	1000	5.99	66.29	12.50	88.20	12.85	76.45	9.05	44.80
	2000	5.90	62.50	11.98	82.01	11.05	68.51	7.10	38.80
	LSD(P=0.05)	0.48	6.60	NS	NS	0.92	5.65	0.45	3.01

NS = Not significant

Table 16. Effect of foliar treatment with Atrinal (0, 500, 1000 and 2000 µg/ml) at the sapling stage of the plant on soluble (Sol, mg/g fresh weight) and insoluble (Insol, mg/g fresh weight) carbohydrate contents in leaves of chayote.

Plant development and treatments are the same as in Table 15. Data were recorded at 4 developmental stages as metioned in the same Table.

Pretreating Sample	Concn. of Atrinal (µg/ml)	Developmental Stages							
		Sapling		Preflowering		Fruiting		Senile	
		Chl	Pr	Chl	Pr	Chl	Pr	Chl	Pr
Intact fruit	0	3.07	63.79	3.50	72.58	2.80	60.80	0.32	20.15
	500	2.43	57.59	3.82	70.57	3.25	68.50	0.48	28.28
	1000	2.30	54.10	3.90	73.90	3.66	75.58	0.66	35.75
	2000	2.18	52.25	3.75	69.95	3.15	67.19	0.40	27.80
	LSD (P=0.05)	0.20	5.01	0.24	NS	0.28	6.05	0.03	NS
Defleshed fruit	0	3.41	72.90	3.83	86.77	3.12	67.31	0.52	26.88
	500	3.02	62.90	4.20	82.50	3.49	76.10	0.70	36.75
	1000	2.95	58.85	4.35	81.95	3.78	80.80	0.85	40.90
	2000	2.90	55.99	4.09	79.80	3.48	75.20	0.69	35.95
	LSD(P=0.05)	0.29	6.11	0.35	NS	0.30	6.20	0.05	3.01

NS = Not significant

Table 17. Effect of foliar treatment with Atrinal (0, 500, 1000 and 2000 µg/ml) at the sapling stage of the plant on RNA (µg/g fresh weight) and DNA (µg/g fresh weight) contents in leaves of chayote.

Plant development and treatments are the same as in Table 15. Data were recorded at 4 developmental stages as metioned in the same Table.

Plants raised from	Concn. of Atrinal (µg/ml)	Developmental Stages							
		Sapling		Preflowering		Fruiting		Senile	
		RNA	DNA	RNA	DNA	RNA	DNA	RNA	DNA
Intact fruit	0	528.9	78.8	550.8	77.8	511.3	62.1	285.5	39.0
	500	460.5	61.6	530.1	76.8	570.1	70.1	360.8	55.9
	1000	440.9	56.9	518.9	72.9	592.7	75.2	395.1	62.0
	2000	426.2	51.8	515.2	70.9	561.6	69.5	352.7	58.8
	LSD (P=0.05)	38.75	5.95	NS	NS	42.50	5.80	25.95	4.16
Defleshed fruit	0	577.5	85.9	595.2	85.0	548.4	64.7	340.1	53.8
	500	522.6	70.0	579.0	82.5	601.4	70.6	398.9	62.7
	1000	511.3	64.2	564.8	80.9	640.0	76.9	440.7	69.8
	2000	480.5	59.5	560.9	80.5	592.7	71.8	407.5	60.9
	LSD(P=0.05)	42.80	6.08	NS	NS	45.5	5.34	32.95	5.00

NS = Not significant

Table 18. Effect of foliar treatment with Atrinal (0, 500, 1000 and 2000 μg/ml) at the sapling stage of the plant on catalase (Cat, unit/g fresh weight/h) and peroxidase (Per, unit/g fresh weight/h) activities in leaves of chayote.

Plant development and treatments are the same as in Table 15. Data were recorded at 4 developmental stages as metioned in the same Table.

Plants raised from	Concn. of Atrinal (μg/ml)	Developmental Stages							
		Sapling		Preflowering		Fruiting		Senile	
		Cat	Per	Cat	Per	Cat	Per	Cat	Per
Intact fruit	0	138.9	81.8	142.6	85.7	128.6	94.9	92.0	27.1
	500	110.7	65.2	138.7	82.5	148.7	112.7	76.8	38.8
	1000	101.5	60.7	135.2	80.8	160.8	119.8	88.9	49.6
	2000	92.8	57.9	132.9	79.6	142.7	103.5	77.1	40.9
	LSD (P=0.05)	9.01	5.98	NS	NS	10.95	8.57	6.05	3.00
Defleshed fruit	0	154.9	91.6	159.0	98.1	137.6	97.5	78.4	37.8
	500	109.8	78.1	152.7	95.5	156.8	120.7	89.7	48.6
	1000	102.5	76.0	149.8	93.7	167.2	128.1	108.7	54.9
	2000	95.8	70.9	147.9	92.5	149.9	115.9	92.8	45.5
	LSD (P=0.05)	9.14	6.66	NS	NS	11.90	9.01	7.50	3.95

NS = Not significant

Table 19. Effect of foliar treatment with Atrinal (0, 500, 1000 and 2000 μg/ml) at the sapling stage of the plant on IAA-oxidase (IAAox, unit/g fresh weight/h) and RNase (unit/g fresh weight/h) activities in leaves of chayote.

Plant development and treatments are the same as in Table 15. Data were recorded at 4 developmental stages as metioned in the same Table.

Plants raised from	Concn. of Atrinal (μg/ml)	Developmental Stages							
		Sapling		Preflowering		Fruiting		Senile	
		IAAox	RNase	IAAox	RNase	IAAox	RNase	IAAox	Rnase
Intact fruit	0	30.90	92.50	68.75	174.70	78.80	210.7	94.50	288.75
	500	38.76	107.50	60.10	162.62	64.05	182.6	81.90	230.60
	1000	44.10	111.35	57.25	153.74	59.90	171.8	73.49	201.59
	2000	45.90	118.05	61.10	163.81	65.81	185.5	85.81	236.95
	LSD (P=0.05)	3.01	8.98	5.01	9.05	5.20	15.50	7.10	19.90
Defleshed fruit	0	23.88	88.24	59.50	152.72	66.99	196.65	84.50	241.18
	500	35.70	98.90	50.02	138.51	56.05	172.70	69.90	195.80
	1000	40.02	108.70	47.59	125.91	52.18	153.61	58.50	172.05
	2000	46.15	117.35	53.01	141.01	58.10	167.90	68.88	198.80
	LSD (P=0.05)	3.05	8.10	4.90	10.50	4.80	14.90	6.00	16.19

Table 20. Effect of foliar treatment with Atrinal (0, 500, 1000 and 2000 μg/ml) at the sapling stage of the plant on vine length (V.L., cm), and stem circumsference (S.C., cm) at different developmental stages of chayote.

Plant development and treatments are the same as in Table 15. Data were recorded at 4 developmental stages as metioned in the same Table.

Plants raised from	Concn. of Atrinal (μg/ml)	Developmental Stages							
		Sapling		Preflowering		Fruiting		Senile	
		V.L.	S.C.	V.L.	S.C.	V.L.	S.C.	V.L.	S.C.
Intact fruit	0	128.6	2.01	314.7	3.61	524.8	5.65	546.7	5.65
	500	110.9	2.28	287.6	4.05	475.5	5.98	489.5	5.92
	1000	103.7	2.78	275.9	4.38	460.2	6.60	460.7	6.62
	2000	93.9	2.90	266.7	4.49	439.8	6.78	445.8	6.78
	LSD (P=0.05)	9.01	0.20	23.08	0.35	40.55	0.50	35.51	0.49
Defleshed fruit	0	145.5	2.35	337.2	3.86	554.9	6.10	612.8	6.10
	500	126.2	2.78	283.6	4.38	468.7	6.44	571.0	6.42
	1000	105.9	3.01	264.8	4.75	451.0	6.68	536.5	6.78
	2000	95.8	3.20	250.1	4.86	443.7	6.80	518.9	6.96
	LSD (P=0.05)	9.00	0.27	25.09	0.30	40.50	0.40	58.25	5.01

Table 21. Effect of foliar treatment with Atrinal (0, 500, 1000 and 2000 µg/ml) at the sapling stage of the plant on chages in number of days required for inception of leaf senescence (Senes. days), total fruit number (Fruit No.), total fruit weight (Fruit wt.) and total tuberous root weight (Root wt.) per plant.

Plant development and treatments are the same as in Table 15. Data were recorded from 5 uniformly grown plants of each treatment.

Plants raised from	Concn. of Atrinal (µg/ml)	Senes. days	Fruit No.	Fruit wt. (kg)	Root wt (kg)
Intact fruit	0	142	155	57.9	12.8
	500	148	158	62.5	13.9
	1000	154	160	65.4	14.8
	2000	159	159	58.5	14.5
	LSD (P=0.05)	10.01	NS	4.00	1.20
Defleshed fruit	0	142	165	64.0	13.8
	500	168	168	69.8	14.9
	1000	175	175	73.8	16.2
	2000	163	163	64.5	15.7
	LSD (P=0.05)	11.80	NS	4.50	1.10

NS = Not significant

Table 22. Effect of foliar treatment with Atrinal (0, 500, 1000 and 2000 µg/ml) at the preflowering stage of the plant on chlorophyll (Chl, mg/g fresh weight) and protein (Pr, mg/g fresh weight) contents in leaves of chayote.

Sixty-day-old field grown plants, raised from intact and defleshed fruits, were sprayed with Atrinal or distilled water for 3 consecutive days. Data were recorded at 2 developmental stages i.e., fruiting stage and senile stage which correspond to 80- and 140-days of plant age respectively.

Plants raised from	Concn. of Atrinal (µg/ml)	Developmental Stages			
		Fruiting		Senile	
		Chl	Pr	Chl	Pr
Intact fruit	0	2.85	63.15	0.33	21.07
	500	3.38	76.10	0.58	37.14
	1000	3.75	80.01	0.80	47.10
	2000	3.26	72.19	0.49	36.01
	LSD (P=0.05)	0.21	5.90	0.03	2.15
Defleshed fruit	0	3.05	67.15	0.52	27.01
	500	3.55	88.95	0.83	42.27
	1000	3.92	99.01	0.98	48.98
	2000	3.54	82.54	0.77	39.90
	LSD (P=0.05)	0.28	6.20	0.05	4.01

Table 23. Effect of foliar treatment with Atrinal (0, 500, 1000 and 2000 µg/ml) at the preflowering stage of the plant on soluble (Sol, mg/g fresh weight) and insoluble (Insol, mg/g fresh weight) carbohydrate contents in leaves of chayote.

Plant development and treatments are the same as in Table 22. Data were recorded at 2 developmental stages as mentioned in the same Table.

Plants raised from	Concn. of Atrinal (µg/ml)	Developmental Stages			
		Fruiting		Senile	
		Sol	Insol	Sol	Insol
Intact fruit	0	8.20	52.50	4.41	26.01
	500	11.98	82.50	7.58	38.95
	1000	13.88	86.80	8.95	48.80
	2000	12.15	77.29	7.80	39.50
	LSD (P=0.05)	0.90	5.15	0.45	3.05
Defleshed fruit	0	8.38	55.01	5.02	31.18
	500	13.01	87.10	8.25	44.05
	1000	14.50	89.90	11.37	53.80
	2000	12.80	77.58	8.05	42.04
	LSD (P=0.05)	0.98	6.10	0.52	3.18

Table 24. Effect of foliar treatment with Atrinal (0, 500, 1000 and 2000 µg/ml) at the preflowering stage of the plant on RNA (µg/g fresh weight) and DNA (µg/g fresh weight) contents in leaves of chayote.

Plant development and treatments are the same as in Table 22. Data were recorded at 2 developmental stages as mentioned in the same Table.

Plants raised from	Concn. of Atrinal (µg/ml)	Developmental Stages			
		Fruiting		Senile	
		RNA	DNA	RNA	DNA
Intact fruit	0	510.5	59.5	301.1	37.6
	500	595.7	75.1	397.9	62.8
	1000	623.8	82.7	436.8	73.4
	2000	588.5	76.6	378.6	66.6
	LSD (P=0.05)	40.54	4.01	28.29	3.50
Defleshed fruit	0	545.8	61.7	335.8	52.0
	500	648.5	76.9	438.7	69.5
	1000	701.0	85.2	486.9	78.8
	2000	639.8	72.8	442.2	65.4
	LSD (P=0.05)	45.80	50.95	30.04	4.95

Table 25. Effect of foliar treatment with Atrinal (0, 500, 1000 and 2000 μg/ml) at the preflowering stage of the plant on catalase (Cat, unit/g fresh weight/h) and peroxidase (Per, unit/g fresh weight/h) activities in leaves of chayote.

Plant development and treatments are the same as in Table 22. Data were recorded at 2 developmental stages as mentioned in the same Table.

Plants raised from	Concn. of Atrinal (μg/ml)	Developmental Stages			
		Fruiting		Senile	
		Cat	Per	Cat	Per
Intact fruit	0	130.5	95.0	62.1	26.5
	500	162.7	126.3	85.1	42.6
	1000	175.9	139.5	96.9	57.0
	2000	157.8	120.6	85.9	45.9
	LSD (P=0.05)	12.05	9.50	6.14	2.50
Defleshed fruit	0	136.9	98.6	79.1	35.8
	500	171.0	132.2	96.9	56.8
	1000	185.8	147.8	122.7	66.7
	2000	160.9	130.5	101.6	54.9
	LSD (P=0.05)	12.80	8.98	6.69	3.05

Table 26. Effect of foliar treatment with Atrinal (0, 500, 1000 and 2000 µg/ml) at the preflowering stage of the plant on IAA-oxidase (IAAox, unit/g fresh weight/h) and RNase (unit/g fresh weight/h) activities in leaves of chayote.

Plant development and treatments are the same as in Table 22. Data were recorded at 2 developmental stages as mentioned in the same Table.

Plants raised from	Concn. of Atrinal (µg/ml)	Developmental Stages			
		Fruiting		Senile	
		IAAox	RNase	IAAox	RNase
Intact fruit	0	78.25	211.75	94.90	296.50
	500	67.25	185.80	75.95	226.40
	1000	61.19	166.65	65.70	188.55
	2000	68.25	182.59	82.01	224.24
	LSD (P=0.05)	6.50	15.05	6.42	16.60
Defleshed fruit	0	69.95	201.75	88.01	241.75
	500	52.01	162.74	61.25	162.74
	1000	44.75	135.71	45.45	140.92
	2000	52.96	157.10	57.92	170.54
	LSD (P=0.05)	5.01	15.57	4.50	12.44

Table 27. Effect of foliar treatment with Atrinal (0, 500, 1000 and 2000 μg/ml) at the preflowering stage of the plant on vine length (V.L., cm) and stem circumference (S.C., cm) of chayote.

Plant development and treatments are the same as in Table 22. Data were recorded at 2 developmental stages as mentioned in the same Table.

Plants raised from	Concn. of Atrinal (μg/ml)	Developmental Stages			
		Fruiting		Senile	
		V.L.	S.C.	V.L.	S.C.
Intact fruit	0	525.8	5.49	554.9	5.65
	500	462.7	6.02	478.7	6.15
	1000	451.9	6.75	455.9	6.80
	2000	430.6	6.80	436.7	6.80
	LSD (P=0.05)	35.25	0.48	35.80	0.50
Defleshed fruit	0	567.7	5.85	598.9	6.05
	500	455.9	6.50	542.7	6.58
	1000	437.5	6.72	520.8	6.80
	2000	432.7	6.80	505.8	6.88
	LSD (P=0.05)	38.32	0.48	45.10	0.55

Table 28. Effect of foliar treatment with Atrinal (0, 500, 1000 and 2000 μg/ml) at the preflowering stage of the plant on changes in number of days required for inception of leaf sencscence (Senes. days), total fruit number (Fruit No.), total fruit weight (Fruit wt.) and total tuberous root weight (Root wt.) per plant.

Plant development and treatments are the same as in Table 22. Data were recorded from 5 uniformly grown plants of each treatment.

Plants raised from	Concn. of Atrinal (μg/ml)	Senes. days	Fruit No.	Fruit wt. (kg)	Root wt. (kg)
Intact fruit	0	142	155	56.8	12.9
	500	150	158	63.0	13.8
	1000	155	162	66.8	15.0
	2000	155	158	59.99	14.7
	LSD (P=0.05)	9.98	NS	5.05	1.20
Defleshed fruit	0	143	165	62.0	14.2
	500	150	170	70.1	15.0
	1000	156	178	74.0	16.8
	2000	156	165	65.8	15.9
	LSD (P=0.05)	11.01	NS	6.05	1.35

NS = Not Singnificance

Table 29. Effect of foliar treatment with Atrinal (Atl, 0 and 1000 µg/ml) at the preflowering stage followed by GA_3 (100 µg/ml) and kinetin (Kin, 100 µg ml application at the flowering stage of the plant on changes in chlorophyll (Chl, mg/g fresh weight) and protein (Pr, mg/g fresh weight) contents in leaves of chayote.

Sixty-day-old field grown plants, raised from intact and defleshed fruits, were sprayed with Atrinal or distilled water for 3 consecutive days at the preflowering stage. Such plants were subsequently treated with GA_3 or kinetin for 3 consultive days at the flowering stage (70-day-old). Data were recorded at fruiting stage and senile stage which correspond to 80- and 140 days of plant age respectively.

Plants raised from	Treatments (µg/ml)	Developmental Stages			
		Fruiting		Senile	
		Chl	Pr	Chl	Pr
Intact fruit	Atl. 0	2.85	63.15	0.33	21.07
	Atl 0 + GA_3	2.86	65.10	0.33	22.90
	Atl 0 + Kin	3.80	73.80	0.86	32.10
	Atl 1000	3.75	80.01	0.80	47.10
	Atl 1000 + GA_3	3.75	83.05	0.85	50.20
	Atl 1000 + Kin	4.05	92.80	1.20	55.65
	LSD (P=0.05)	0.20	5.08	0.04	3.08
Defleshed fruit	Atl. 0	3.05	67.15	0.52	27.01
	Atl 0 + GA_3	3.12	69.55	0.52	26.98
	Atl 0 + Kin	3.95	75.41	0.98	39.80
	Atl 1000	3.92	99.01	0.98	48.98
	Atl 1000 + GA_3	3.95	98.59	0.99	49.05
	Atl 1000 + Kin	4.33	120.69	1.35	60.25
	LSD (P=0.05)	0.30	6.01	0.50	3.05

Table 30. Effect of foliar treatment with Atrinal (Atl, 0 and 1000 μg/ml) at the preflowering stage followed by GA_3 (100 μg/ml) and kinetin (Kin application at the flowering stage of the plant on changes in soluble carbohydrate (Sol, mg/g fresh weight) and insoluble carbohydrate (Insol, mg/g fresh weight) contents in leaves of chayote.

Plant development, hormonal treatments and recording of data are the same as in Table 29.

Plants raised from	Treatments (μg/ml)	Developmental Stages			
		Fruiting		Senile	
		Sol	Insol	Sol	Insol
Intact fruit	Atl. 0	8.20	52.50	4.41	26.01
	Atl 0 + GA_3	8.30	54.01	4.45	27.50
	Atl 0 + Kin	8.41	62.10	5.05	36.96
	Atl 1000	13.88	86.80	8.95	48.80
	Atl 1000 + GA_3	14.05	85.06	8.95	49.05
	Atl 1000 + Kin	15.80	98.75	10.15	58.90
	LSD (P=0.05)	0.72	5.88	0.50	2.90
Defleshed fruit	Atl. 0	8.38	55.01	5.02	31.18
	Atl 0 + GA_3	8.44	56.55	5.05	31.10
	Atl 0 + Kin	9.95	78.77	8.01	42.18
	Atl 1000	14.50	89.90	11.37	53.80
	Atl 1000 + GA_3	15.05	90.50	12.01	55.05
	Atl 1000 + Kin	17.56	122.75	14.50	72.95
	LSD (P=0.05)	0.80	5.98	0.60	3.99

Table 31. Effect of foliar treatment with Atrinal (Atl, 0 and 1000 µg/ml) at the preflowering stage followed by GA_3 (100 µg/ml) and kinetin (Kin, 100 µg/ml) application at the flowering stage of the plant on changes in RNA (µg/g fresh weight) and DNA (µg/g fresh weight) contents in leaves of chayote.

Plant development, hormonal treatments and recording of data are the same as in Table 29.

Plants raised from	Treatments (µg/ml)	Developmental Stages			
		Fruiting		Senile	
		RNA	DNA	RNA	DNA
Intact fruit	Atl. 0	510.5	59.5	301.1	37.6
	Atl 0 + GA_3	522.7	61.8	315.9	38.5
	Atl 0 + Kin	598.9	75.5	370.8	50.7
	Atl 1000	623.8	82.7	436.8	73.4
	Atl 1000 + GA_3	633.5	84.4	445.9	76.6
	Atl 1000 + Kin	705.8	95.6	502.8	88.50
	LSD (P=0.05)	40.66	5.16	28.33	
Defleshed fruit	Atl. 0	545.8	61.7	335.8	52.0
	Atl 0 + GA_3	557.9	66.0	242.9	54.1
	Atl 0 + Kin	601.8	75.8	408.8	69.5
	Atl 1000	701.0	85.2	486.9	78.8
	Atl 1000 + GA_3	702.5	85.9	477.6	79.90
	Atl 1000 + Kin	782.9	98.9	438.9	87.99
	LSD (P=0.05)	50.18	5.99	30.69	5.05

Table 32. Effect of foliar treatment with Atrinal (Atl, 0 and 1000 μg/ml) at the preflowering stage followed by GA_3 (100 μg/ml) and kinetin (Kin, 100 μg/ml) application at the flowering stage of the plant on changes in catalase (Cat, unit/g fresh weight/h) and peroxidase (Per, unit/g fresh weight/h) activities in leaves of chayote.

Plant development, hormonal treatments and recording of data are the same as in Table 29.

Plants raised from	Treatments (μg/ml)	Developmental Stages			
		Fruiting		Senile	
		Cat	Per	Cat	Per
Intact fruit	Atl. 0	130.5	95.0	62.1	26.5
	Atl 0 + GA_3	132.7	94.0	62.2	28.7
	Atl 0 + Kin	156.1	115.8	86.1	42.8
	Atl 1000	175.9	139.5	96.9	57.0
	Atl 1000 + GA_3	180.2	144.7	95.0	57.0
	Atl 1000 + Kin	209.5	176.5	138.5	72.9
	LSD (P=0.05)	11.88	9.01	6.05	2.15
Defleshed fruit	Atl. 0	136.9	98.6	49.1	35.8
	Atl 0 + GA_3	138.5	100.5	78.5	36.6
	Atl 0 + Kin	166.9	128.7	96.9	58.8
	Atl 1000	185.8	147.8	122.7	66.7
	Atl 1000 + GA_3	182.5	152.9	127.0	69.5
	Atl 1000 + Kin	235.8	177.8	154.9	105.9
	LSD (P=0.05)	12.79	9.90	6.85	4.05

Table 33. Effect of foliar treatment with Atrinal (Atl, 0 and 1000 μg/ml) at the preflowering stage followed by GA_3 (100 μg/ml) and kinetin (Kin, 100 μg/ml) application at the flowering stage of the plant on changes in IAA-oxidase (IAAox, unit/g fresh weight/h) and RNase (unit/g fresh weight/h) activities in leaves of chayote.

Plant development, hormonal treatments and recording of data are the same as in Table 29.

Plants raised from	Treatments (μg/ml)	Developmental Stages			
		Fruiting		Senile	
		IAAox	RNase	IAAox	RNase
Intact fruit	Atl. 0	78.25	211.75	94.90	296.50
	Atl 0 + GA_3	75.10	207.85	90.70	288.95
	Atl 0 + Kin	69.95	178.52	81.01	245.05
	Atl 1000	61.19	166.62	65.70	188.55
	Atl 1000 + GA_3	62.90	164.92	65.05	182.90
	Atl 1000 + Kin	50.05	143.25	51.20	149.66
	LSD (P=0.05)				
Defleshed fruit	Atl. 0	69.95	201.75	88.01	241.75
	Atl 0 + GA_3	68.68	189.80	85.20	236.80
	Atl 0 + Kin	56.65	162.75	63.74	168.78
	Atl 1000	44.75	135.71	45.45	140.92
	Atl 1000 + GA_3	42.79	130.88	45.00	143.19
	Atl 1000 + Kin	31.75	109.70	33.79	125.01
	LSD (P=0.05)	6.05	12.75	4.88	13.08

Table 34. Effect of foliar treatment with Atrinal (Atl, 0 and 1000 µg/ml) at the preflowering stage followed by GA_3 (100 µg/ml) and kinetin (Kin, 100 µg/ml) application at the flowering stage of the plant on changes in vine length (V.L., cm) and stem circumference (S.C., cm) of chayote.

Plant development, hormonal treatments and recording of data are the same as in Table 29.

Plants raised from	Treatments (µg/ml)	Developmental Stages			
		Fruiting		Senile	
		V.L.	S.C.	V.L.	S.C.
Intact fruit	Atl. 0	525.8	5.49	554.9	5.65
	Atl 0 + GA_3	598.9	5.49	639.5	5.62
	Atl 0 + Kin	544.7	5.89	593.9	5.93
	Atl 1000	451.9	6.75	455.9	6.80
	Atl 1000 + GA_3	530.7	6.80	565.7	6.87
	Atl 1000 + Kin	470.6	7.29	508.9	7.36
	LSD (P=0.05)	40.05	0.52	42.88	0.55
Defleshed fruit	Atl. 0	5.67.7	5.85	598.9	6.05
	Atl 0 + GA_3	6.51.9	5.92	663.8	5.98
	Atl 0 + Kin	609.8	6.20	615.9	6.35
	Atl 1000	437.5	6.72	520.8	6.80
	Atl 1000 + GA_3	495.0	6.75	578.8	6.82
	Atl 1000 + Kin	472.7	7.38	501.9	7.48
	LSD (P=0.05)	45.01	0.53	45.72	6.62

Table 35. Effect of foliar treatment with Atrinal (Atl, 0 and 1000 μg/ml) at the preflowering stage followed by GA_3 (100 μg/ml) and kinetin (Kin, 100μg/ml) application at the flowering stage of the plant on changes in number of days required for inception of leaf senescence (Senes. days), total fruit number (Fruit No.), total fruit weight (Fruit wt.) and total tuberous root weight (Root wt.) per plant.

Plant development, hormonal treatments and recording of data are the same as in Table 29.

Plants raised from	Treatments (μg/ml)	Developmental Stages			
		Fruiting		Senile	
		Senes. days	Fruit No.	Fruit wt. (kg)	Root wt. (kg)
Intact fruit	Atl. 0	142	155	56.8	12.9
	Atl 0 + GA_3	145	168	62.16	12.8
	Atl 0 + Kin	154	160	64.05	13.9
	Atl 1000	155	162	66.8	15.0
	Atl 1000 + GA_3	153	175	65.01	15.0
	Atl 1000 + Kin	152	164	68.20	16.4
	LSD (P=0.05)	9.87	10.01	4.01	1.10
Defleshed fruit	Atl. 0	143	165	62.0	14.2
	Atl 0 + GA_3	144	178	69.5	14.0
	Atl 0 + Kin	156	170	70.5	15.5
	Atl 1000	156	178	74.0	16.8
	Atl 1000 + GA_3	155	188	75.0	16.4
	Atl 1000 + Kin	166	176	78.5	17.8
	LSD (P=0.05)	9.78	11.90	5.42	1.25

Table 36. Effect of foliar treatment with Atrinal (Atl, 0 and 1000 µg/ml) at the preflowering stage followed by GA_3 (100 µg/ml) and kinetin (Kin, 100 µg/ml) application at the flowering stage of the plant on changes in total number of female and male flowers per plant.

Plant development and hormonal treatments are the same as in Table 29. Data were recorded from 100-day-old plants.

Plants raised from	Treatments (µg/ml)	No. of female flowers per plant	No. of male flowers per plant
Intact fruit	Atl. 0	182.0	3645.8
	Atl 0 + GA_3	215.8	4347.5
	Atl 0 + Kin	199.8	3980.7
	Atl 1000	180.5	4480.1
	Atl 1000 + GA_3	225.9	4598.0
	Atl 1000 + Kin	210.8	4272.9
	LSD (P=0.05)	16.75	300.95
Defleshed fruit	Atl. 0	182.5	4050.3
	Atl 0 + GA_3	228.6	4581.9
	Atl 0 + Kin	198.5	39966.6
	Atl 1000	183.7	3674.4
	Atl 1000 + GA_3	239.5	4795.1
	Atl 1000 + Kin	211.8	4195.3
	LSD (P=0.05)	17.20	328.87

Figures

Series -1 Cultivated
Series - 2 Wild

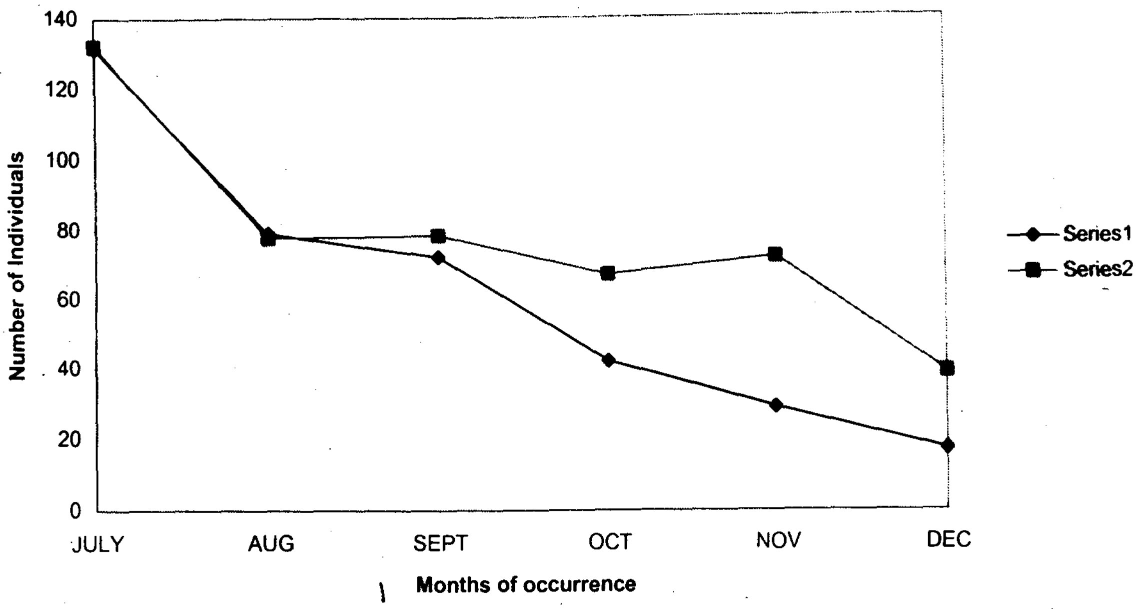


Fig - 1 Abundance of *Epilachna demurili* on *Sechium edule*

Series - 1 Cultivated
Series - 2 Wild

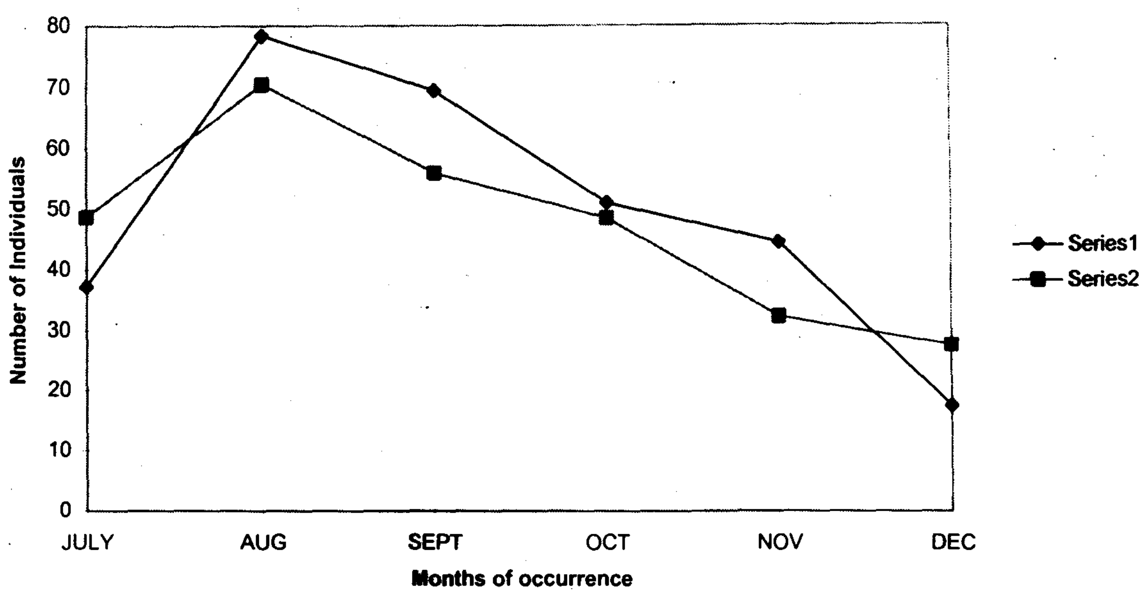


Fig - 2 Abundance of *Diapharia nitidalis* on *Sechium edule*

Series - 1 Cultivated
Series - 2 Wrild

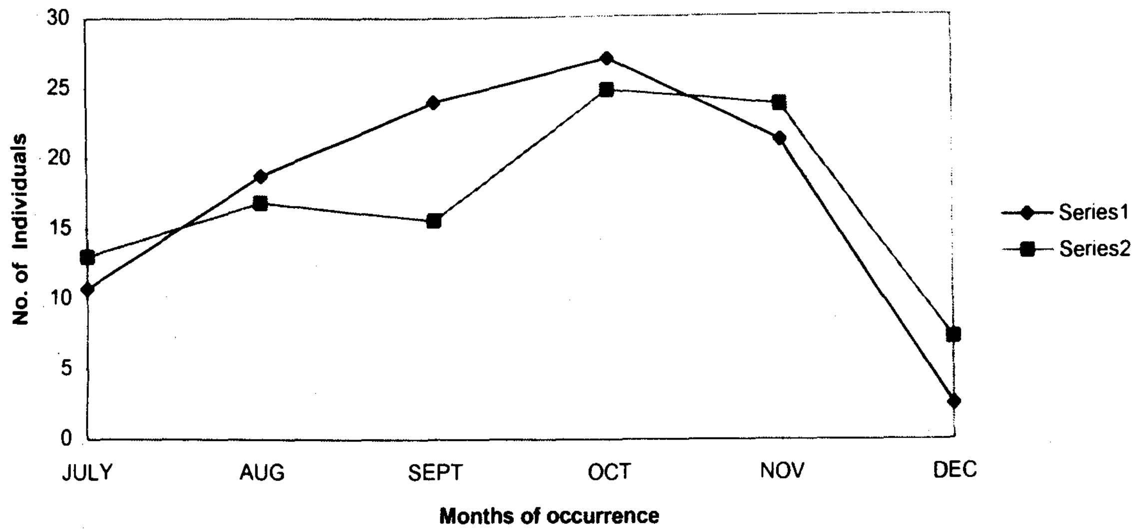


Fig - 3 Abundance of *Rabphidopalpa foveicollis* on *Sechium edule*

Series - 1 Cultivated
Series - 2 Wild

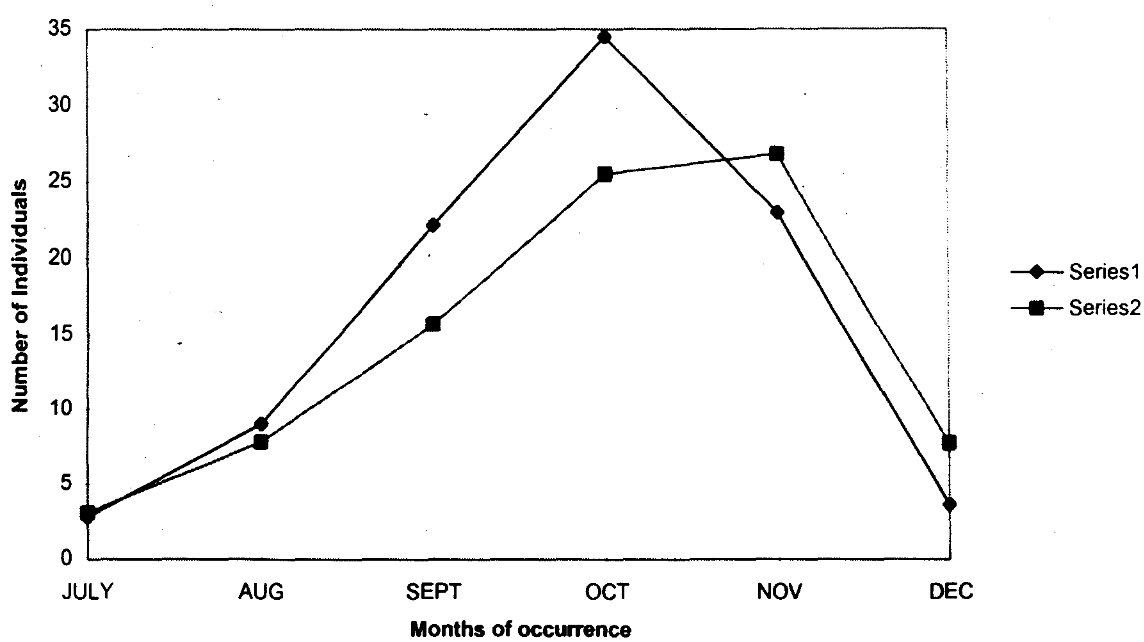


Fig - 4 Abundance of *Anasa tristis* on *Sechium edule*

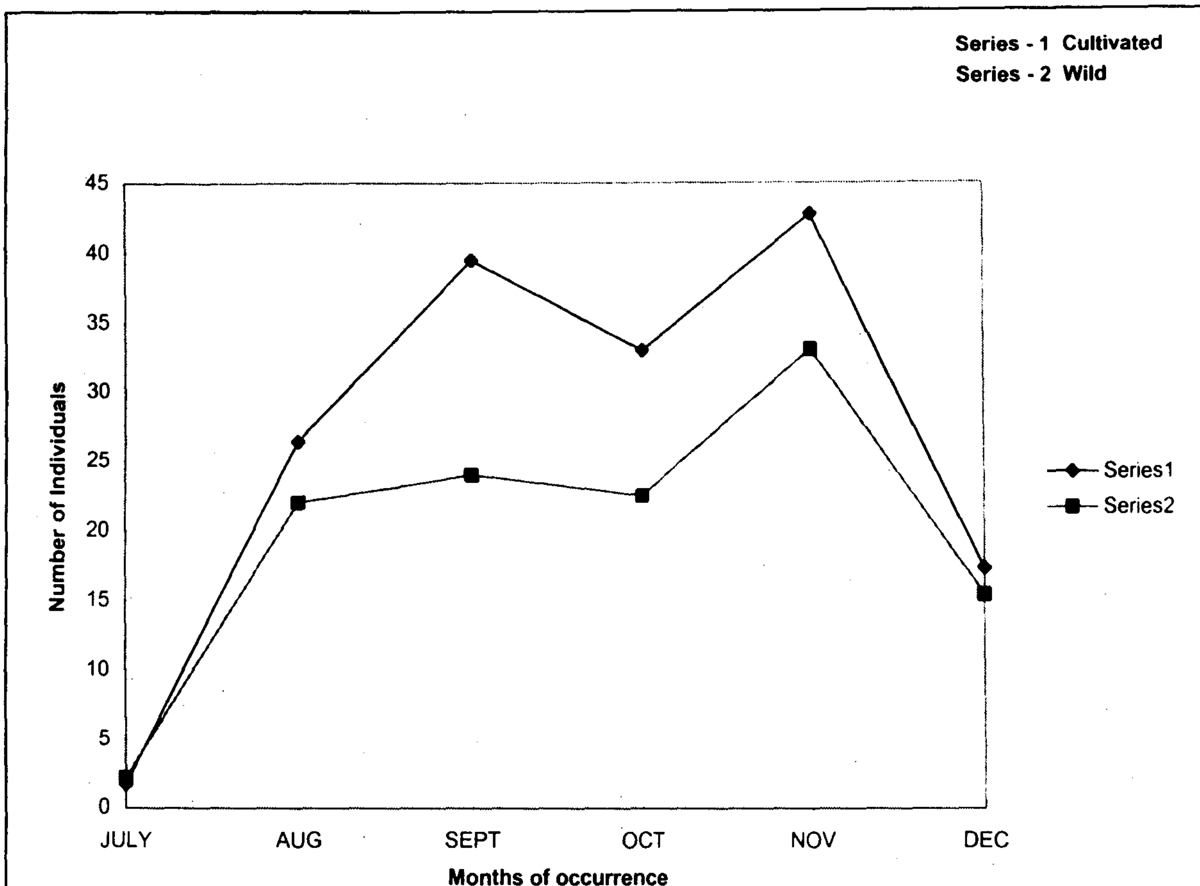


Fig - 5 Abundance of *Macrocalamys sp* on *Sechium edule*

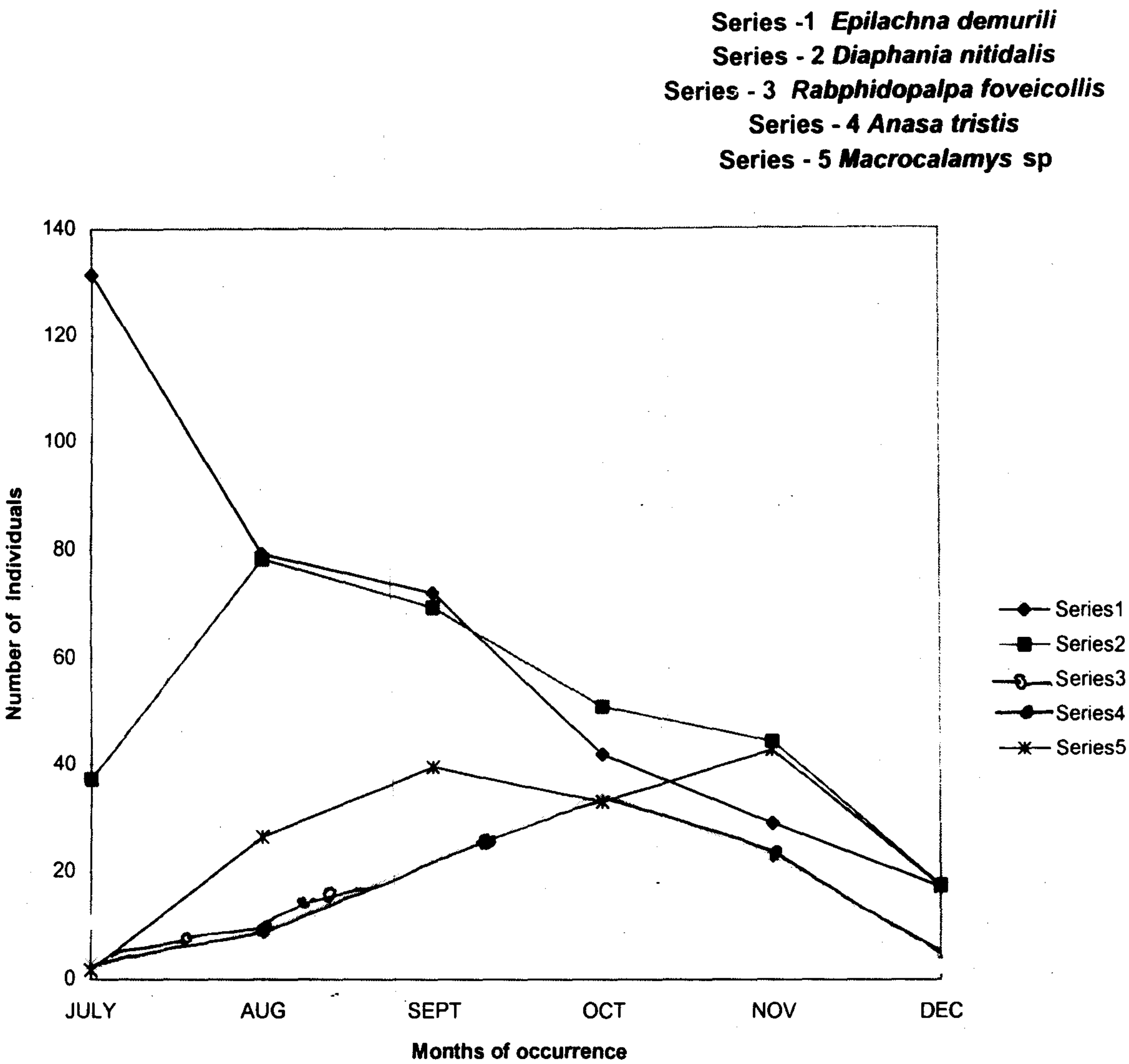


Fig - 6 Species abundance of pestiferous populations on *Sechium edule* in cultivation

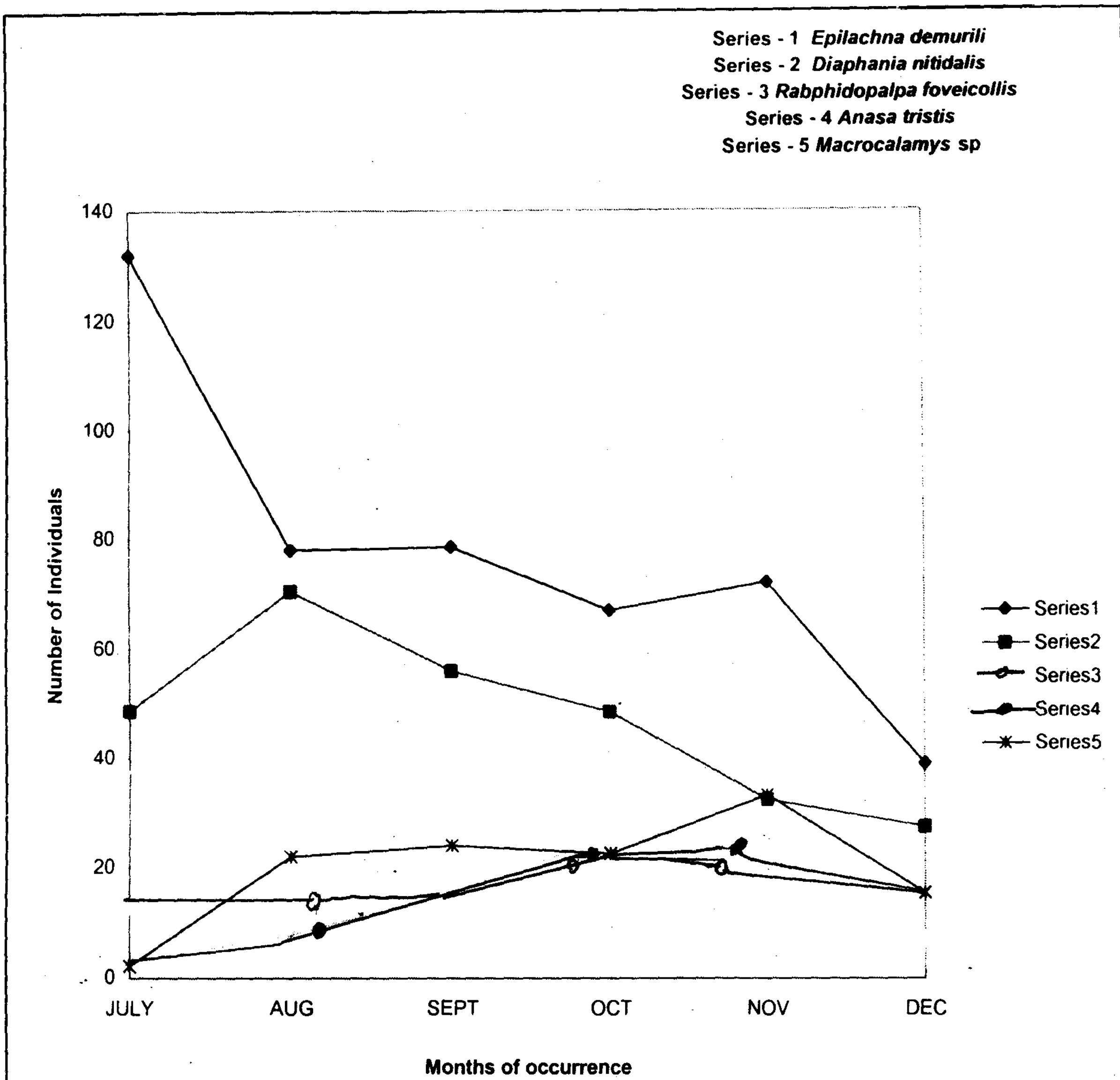


Fig - 7 Species abundance of pestiferous populations on *Sechium edule* in Wild

Fig. Dominance Diversity Curve of some Pestiferous invertebrate species on *Sechium edule* (SW)

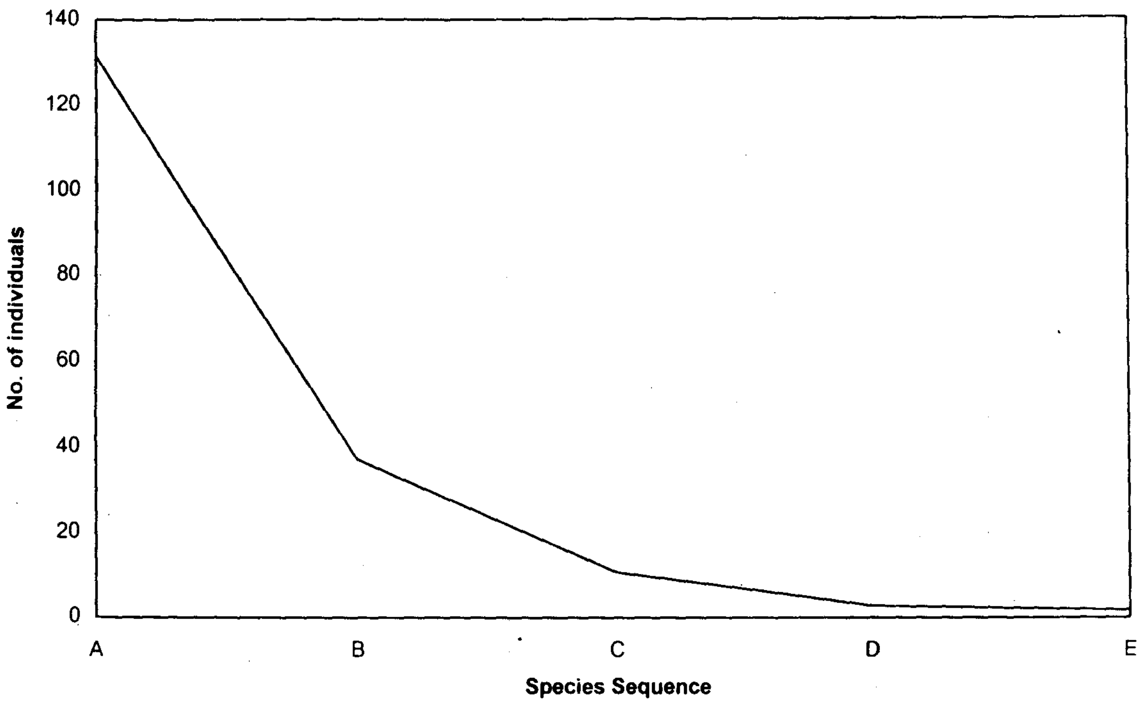


Fig - 8 July 1993 (Cultivated)

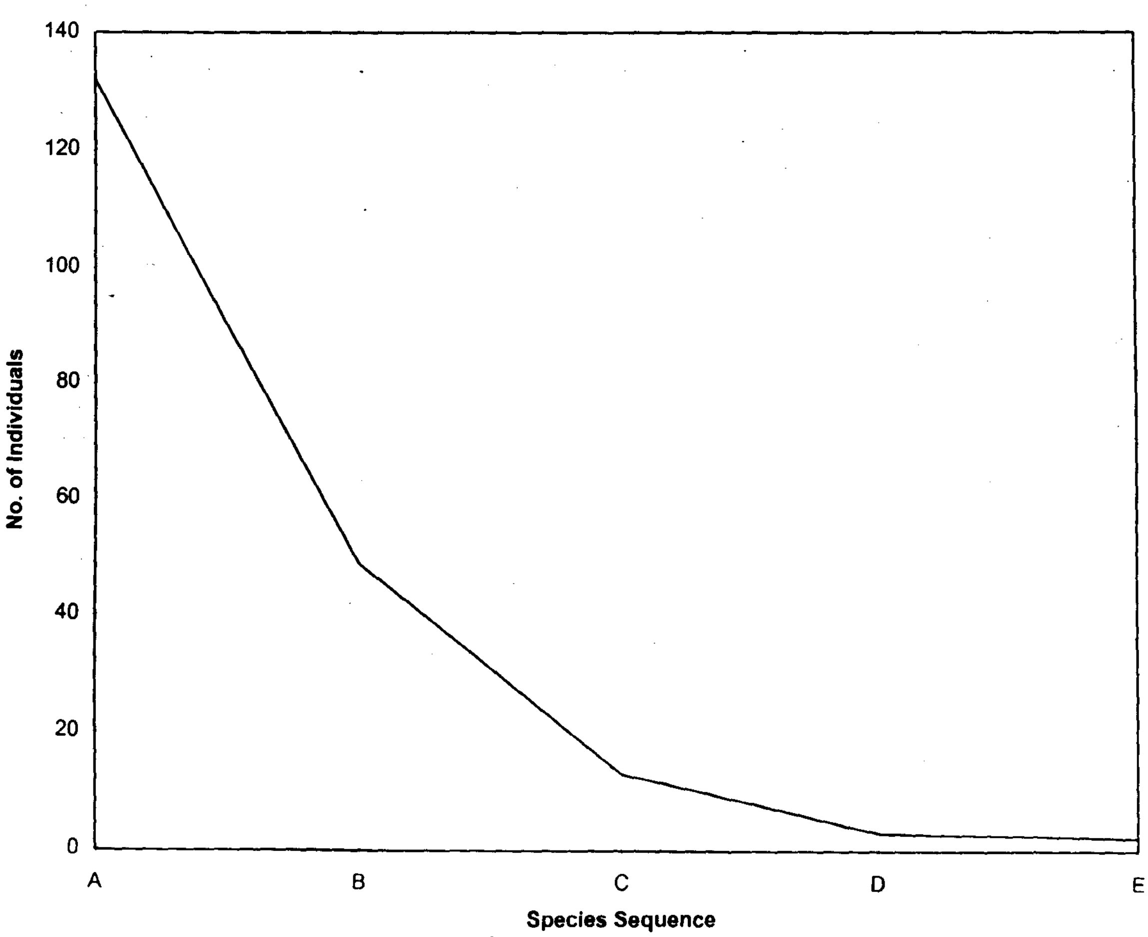


Fig - 9 July 1993 (Wild)

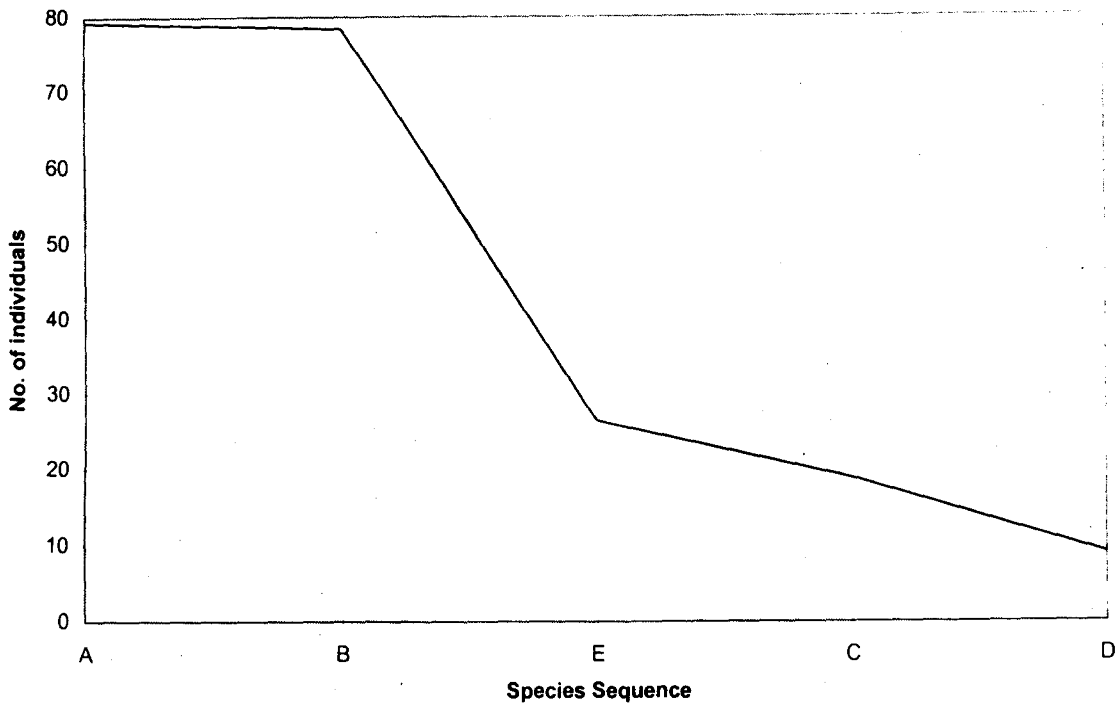


Fig - 10 August 1993 (Cultivated)

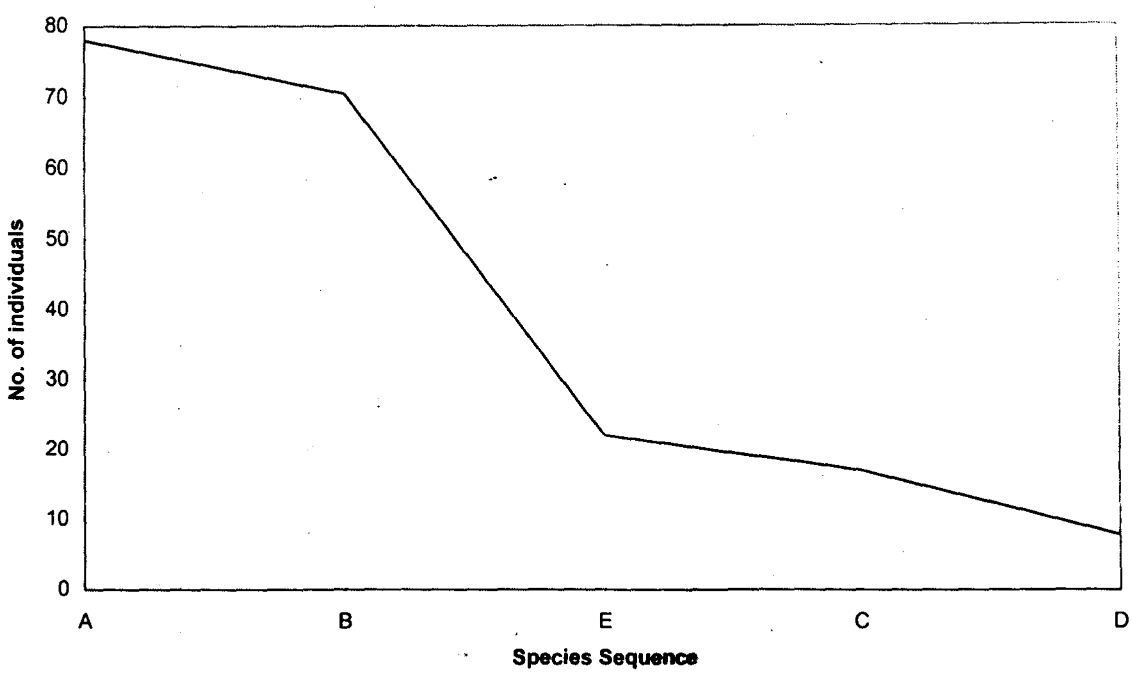


Fig - 11 August 1993 (Wild)

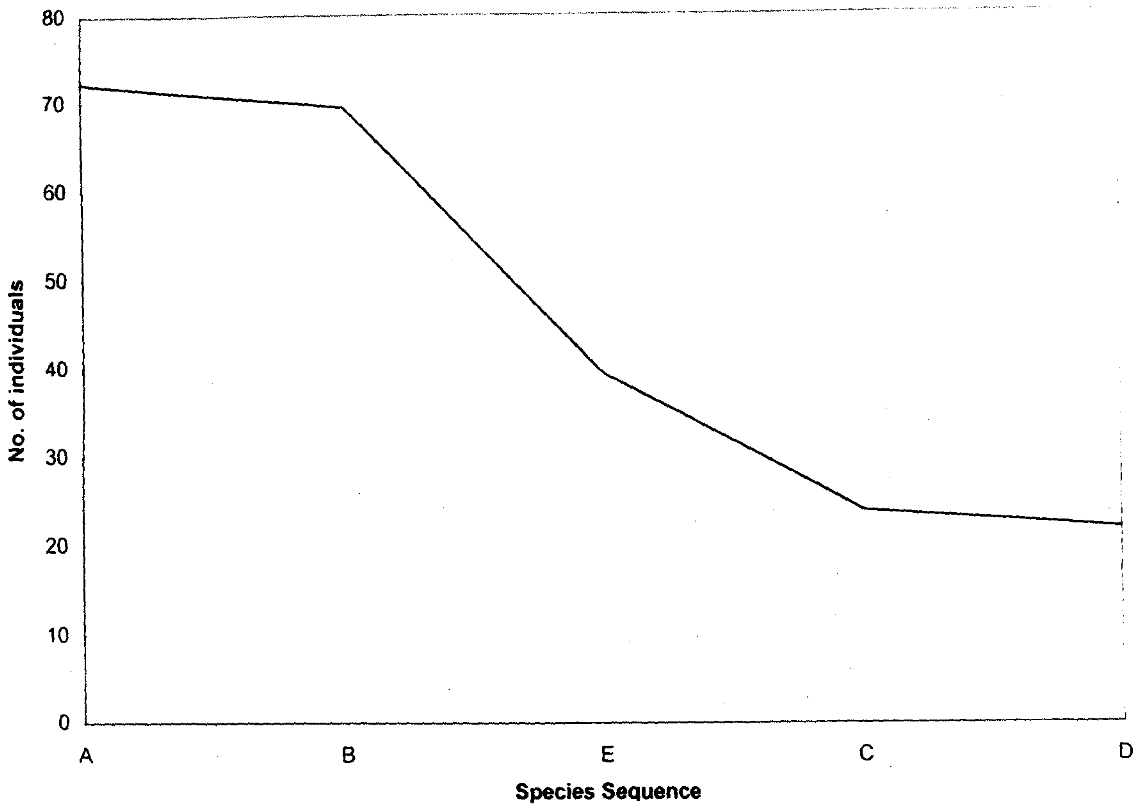


Fig - 12 September 1993 (Cultivated)

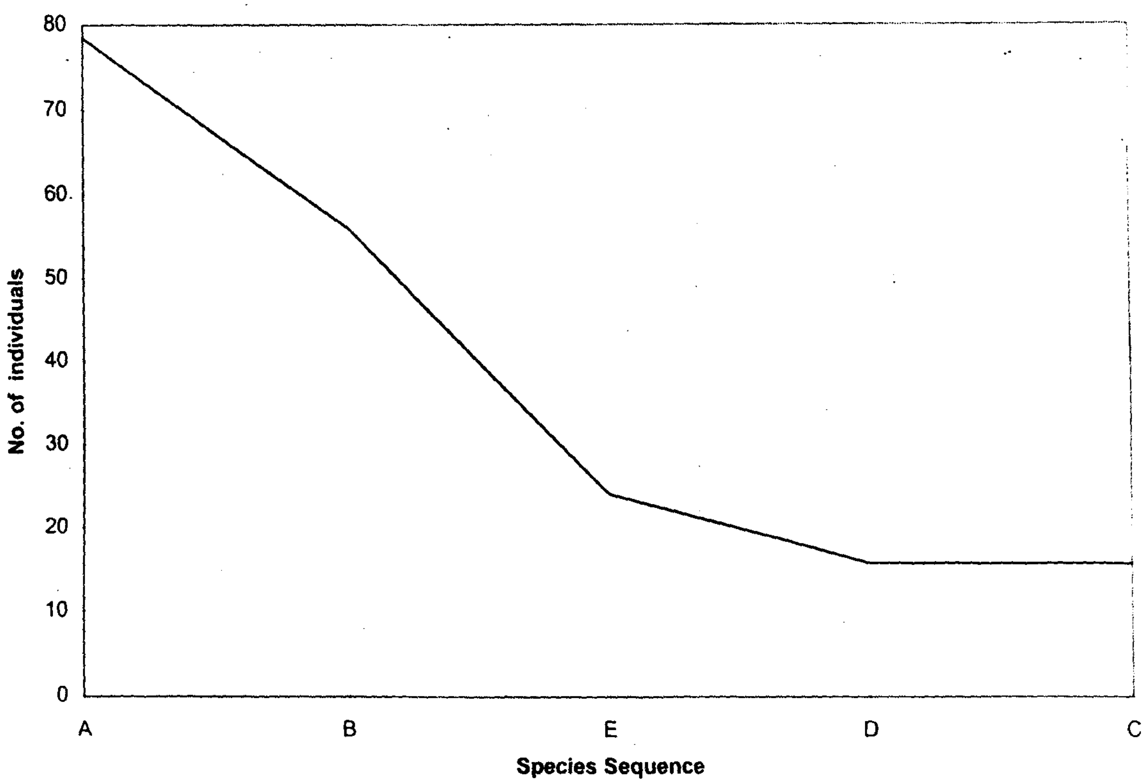


Fig - 13 September 1993 (Wild)

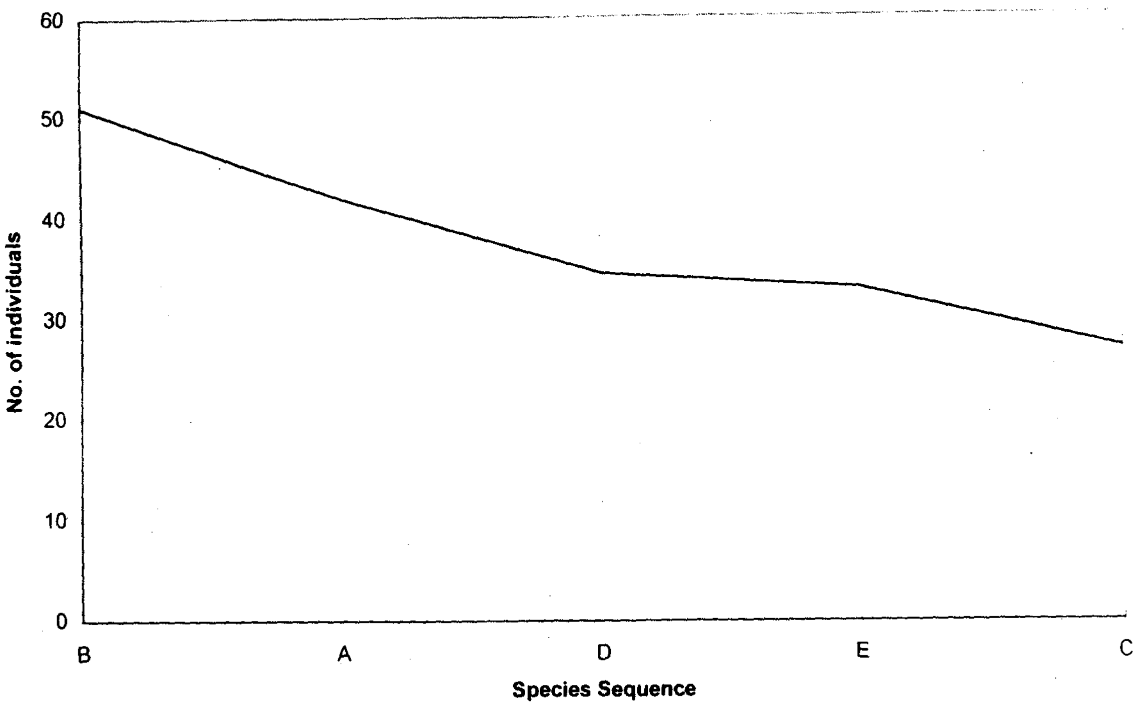


Fig - 14 October 1993 (Cultivated)

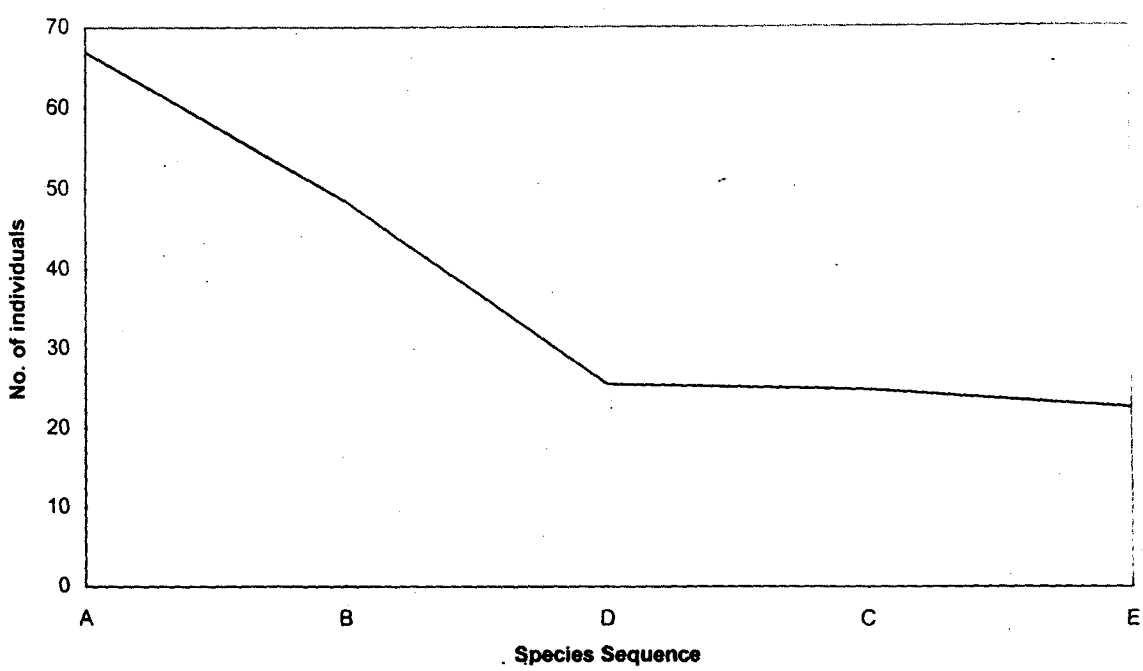


Fig - 15 October 1993 (Wild)

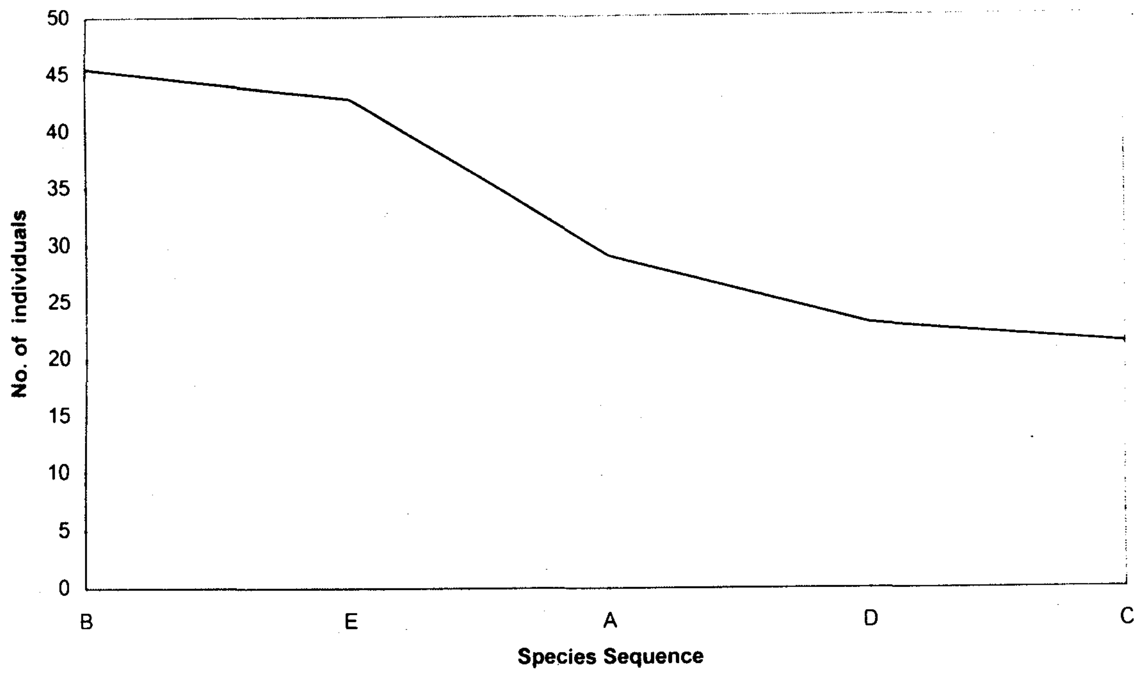


Fig - 16 November 1993 (Cultivated)

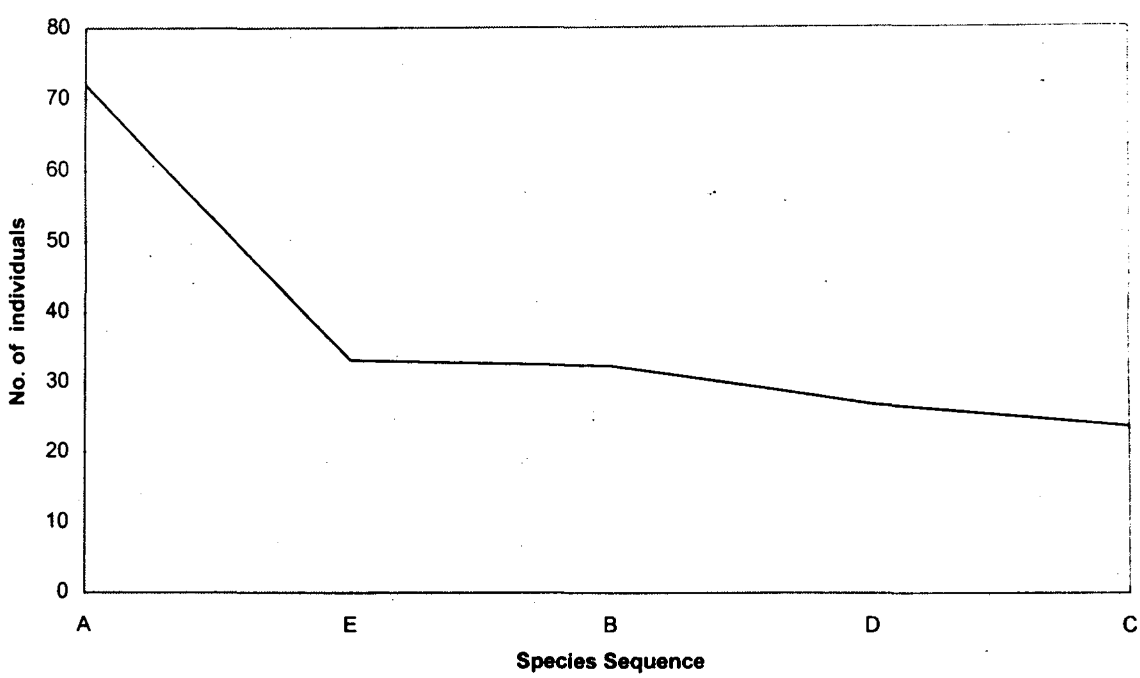


Fig - 17 November 1993 (Wild)

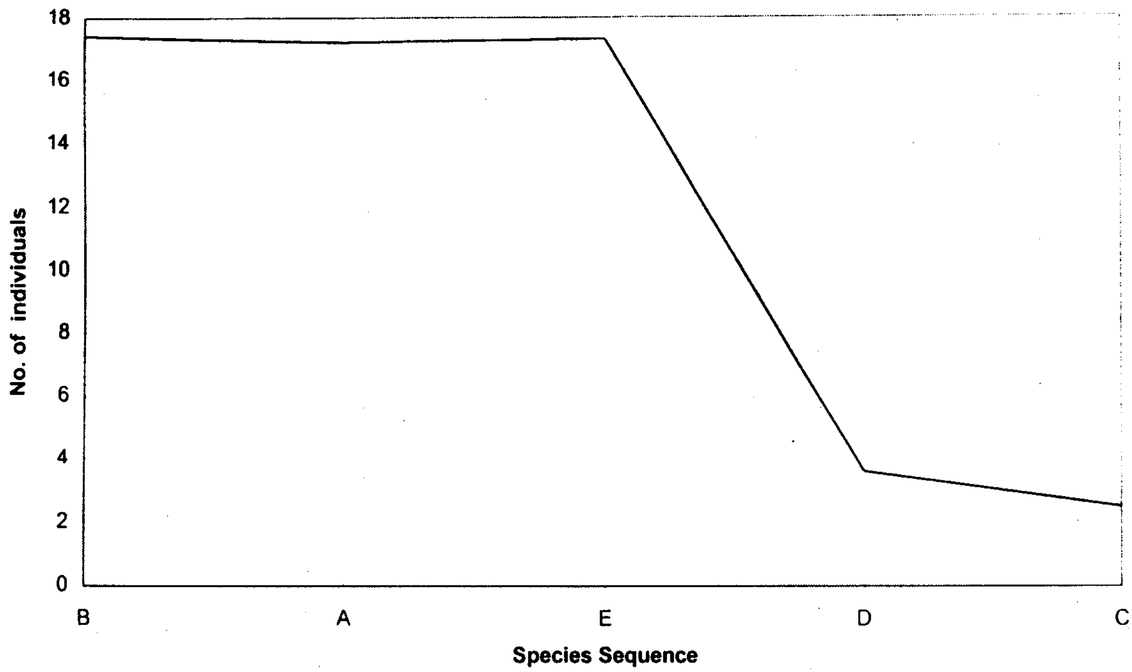


Fig - 18 December 1993 (Cultivated)

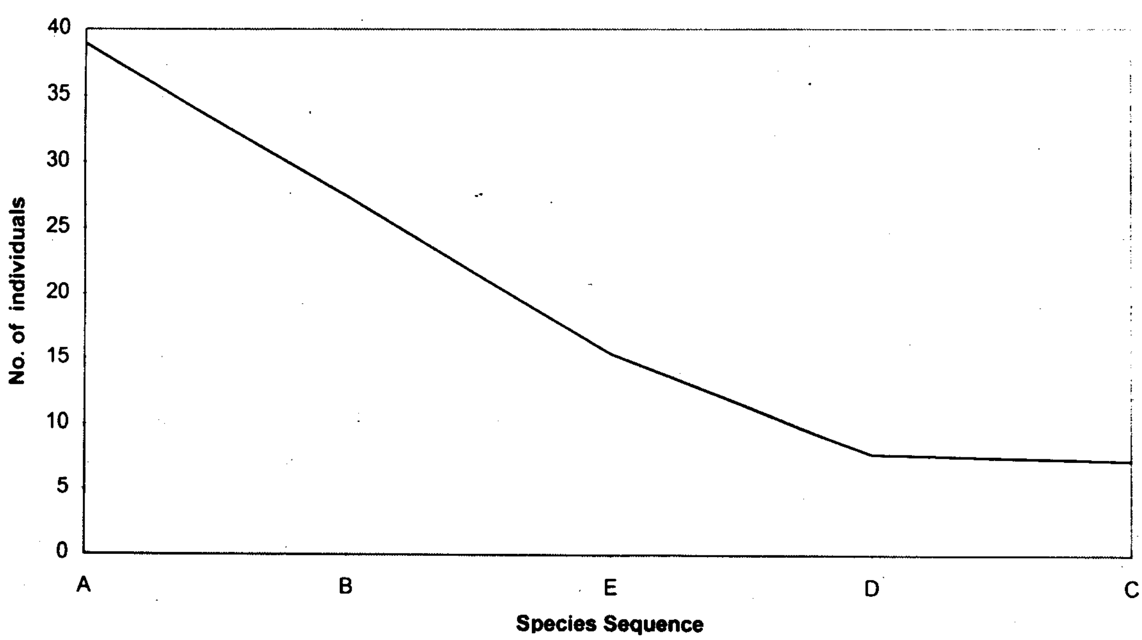


Fig - 19 December 1993 (Wild)

Photograps

Plate 1. A mature spiny sprouting fruit. The fruit reveals several distinct longitudinal grooves or channels and sprouting is found to develop from the distal part of the fruit.

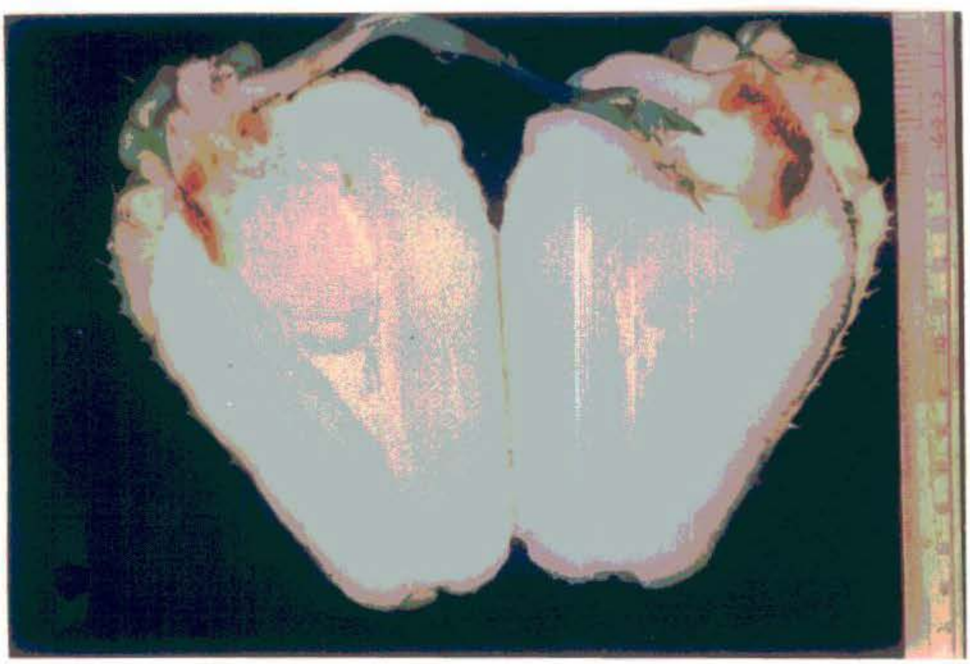


Plate 2. A longitudinally dissected sprouting fruit with distally located single large and abundant fruit flesh.

Plate 3. Developing chayote seedling with newly developing branched tendrils. Several plantlets are developed from a single pit.

Plate 4. A chayote vine is seen growing over a scaffold (machan) in the experimental field at Darjeeling Govt. College campus.

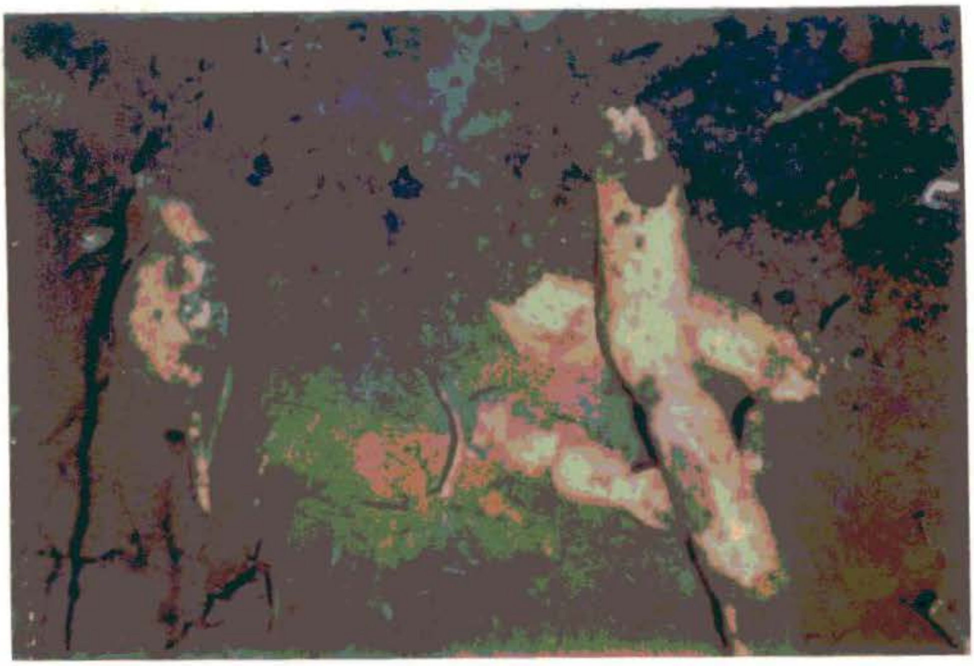


Plate 5. This plate shows tuberous underground roots. Unlike other cucurbits such tuberous roots with abundant carbohydrate reserve are unique in chayote.

Plate 6. A chayote vine with reproductive phase showing a long peduncle with a number of whitish male flowers. The infloresence arises from leaf axils.

Plate 7. This plate clearly reveals a female flower developing singly from leaf axils. Female flowers have inferior ovary surmounted by calyx and corolla. Calyx tube is hemispherical with 5 lobes, corolla rotate, deeply 5-partite.

Plate 8. A chayote vine is seen under fruiting condition. From leaf axil an young spiny fruit is found hanging beside a long-stalked peduncle with a few male flowers.

Plate 9. A spineless whitish variety of fruit with long stalk is developing from the leaf axil adjacent to a long peduncle with male flowers.

Plate 10. This plate reveals a freak of nature. Two fruits are developed from a single female flower. They are seen united at the proximal part, and the distal part tend to diverge.

Plate 11. A female flower is seen pollinated by insects which are attracted by nectors produced profusely in nectaries

Plate 12. A leaf plucked from a chayote vine is seen heavily infected with beetle. Scattered necrotic spots with chlorotic leaf lamina are characteristic of beetle attack on growing vine.

Plate 13. A voracious caterpillar is seen to defoliate chayote plant causing a strong impairment of crop yield.

Plate 14. Under severe infection young leaf twigs are seen to be eaten-up by caterpillars. Surviving leaves get convoluted and degreened.

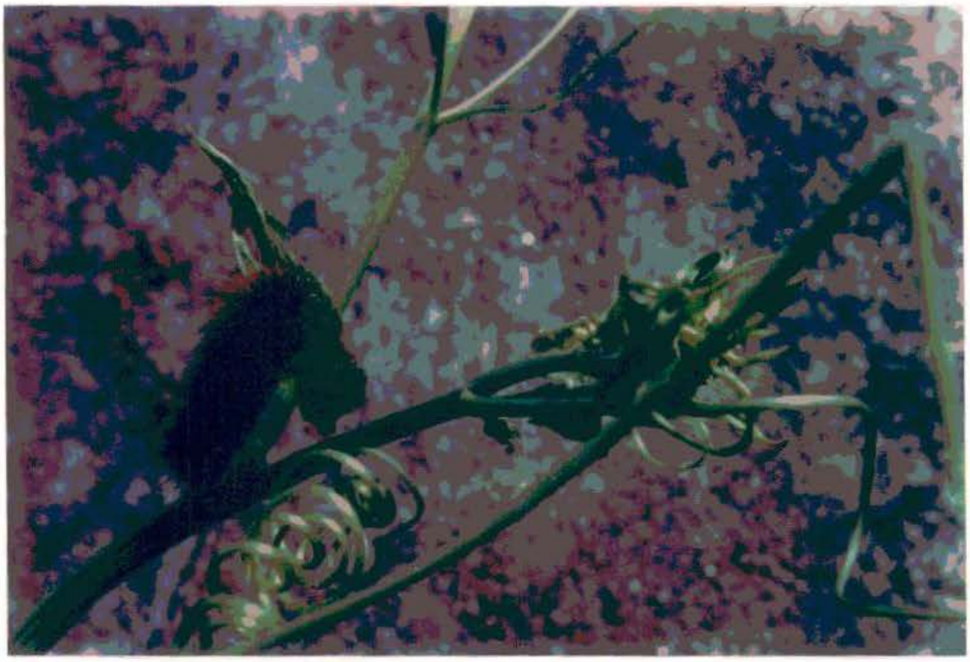


Plate 15. This plate shows crumpling of tendrils as well as tender twigs of chayote vine as a result of infection by caterpillars.

Plate 16. Golden bettle-induced leaf infection is seen in this plate. Such infection causig leaf chlorosis and leaf shot hole.

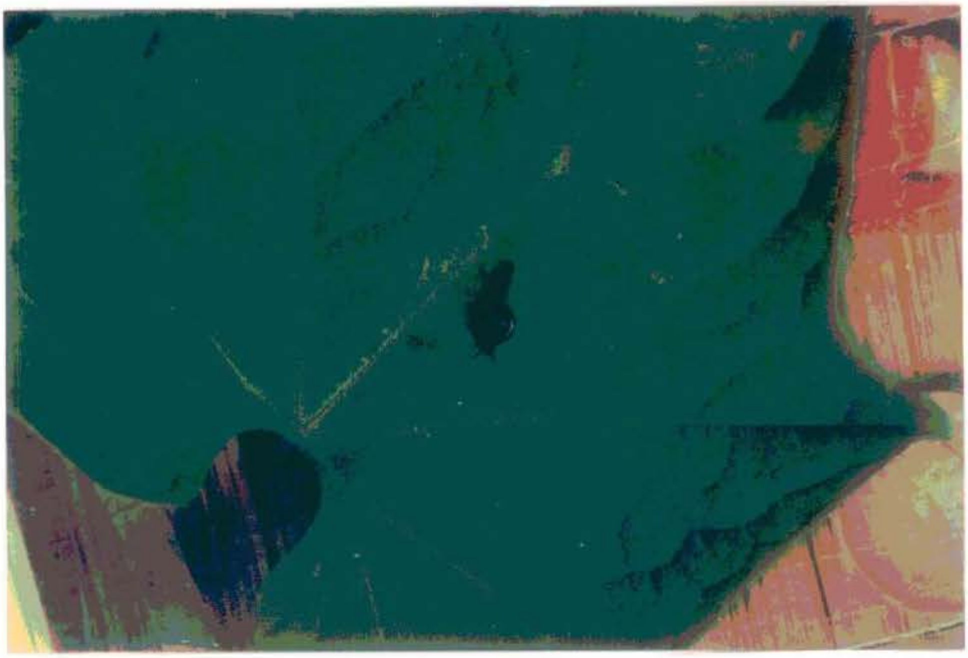


Plate 17. *Macrocalamys sp.* a Molluscan member is seen to thrive on leaf lamina of chayote. This attack is reported to be much less injurious.

Plate 18. An Insect is found to harbour on fleshy tuberous roots of chayote. Under severe infection this type of beetle is reported to rapidly exhaust carbohydrate reserve.

Plate19. Chayote fruits are often attacked by some insects which cause necrosis of fruits both under attached condition or under storage condition.

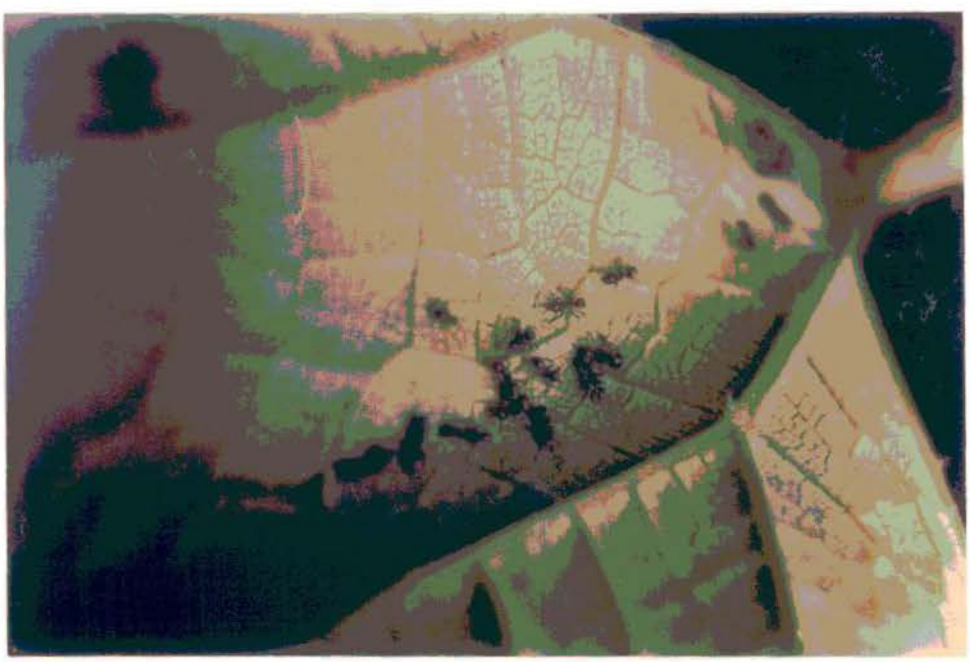


Plate 20. Some insects are seen which are reported to suck leaf juice and cause localized degreening and consequent damage.

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