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INTRODUCTION

In the face of abrupt changes in the global atmosphere in different parts of the world including third world countries, scientists have adopted different methods in order to monitor these changes in different facets of environmental components. Biological organisms are very much suitable in this respect, as they prefer special ecological niches, which are characterised by specific temperature, alkalinity, acidity, porosity, inorganic contents and many other parameters. Obviously any changes in these parameters of such habitats are reflected in the morphology and behaviour of each organism. So taking such changes of the specific biological organism in each ecosystem one can use those organisms as an index of environmental quality. For instance, for soil quality assessment microarthropods can act as bio-indicators.

Microarthropods, specially mites, the tiny eight legged creatures belonging to the order Acarina are a permanent habitat of soil, particularly humid soil. A thorough and regular survey of this mircoarthropod species can provide result in this line. Soil properties like acidity, low organic matter and high content of heavy metals can act as definite stress factors over organism's habitat.

The fertility of soil is an important factor for cultivation of different crops. Any sudden fall of the productivity of any soil cannot be answered within a very short time because it requires thorough soil testing for a number of years. But survey of soil organisms like microarthropods, specially mites, can reduce such a heavy task within a short period. Among the microarthropods mites belong to a very primitive group of arthropods, which requires special attention because the organisms are slowly declining from the cultivated areas. On the whole bio-monitoring is the only way to gather knowledge about the prevalence or declining trend of population of specified soil organisms under diverse stress conditions.

A good number of works have been conducted to understand the relationship of soil organisms vs. land use by studying the distribution of mites.

Furthermore, most of the studies on soil fauna in West Bengal and other states in India clearly depicted that edaphic factors play a great role with climatological parameters in the distribution of soil microarthropods specially mites. These differences in distribution may be further narrowed down to the level of physical and chemical properties of soil. There is also a great seasonal diversity of mite population in soil. Generally acarine population shows a primary peak in May and secondary peak in December. On the contrary in an uncultivated land annual maximum peak is usually observed in August.

The various soil factors like that of soil pH, soil moisture, nutrients like nitrate, phosphate and potassium (NPK), have a profound effect on mite distribution. The decomposition of organic matter in soil is further described on mite population. This might be one of the very important reasons, which effectively regulate the abundance and occurrence of various species of mites in soil.

The mechanical activities in soil like tillage by itself constitute a very important role not only in loosening of soil but also in effect incorporates crop residues, manures and fertilizers into the soil and thus play a significant role in soil faunal distribution.

In the present investigation an attempt has been made to study soil mite population in different crop fields and an orchard at Narendrapur, to estimate the population load and species richness of the population collected from each habitat, to study the soil quality through physical and chemical analysis and finally to correlate the physico-chemical characteristics of the soil with the population load and species of mites.

REVIEW OF LITERATURE

Diem (1903) first studied the soil fauna. Cameron (1917) first observed that environmental condition may cause differences in faunal make-up in two different habitats. The influence of vegetation on soil inhabiting fauna was opined by Buckle (1921). Thomson (1924) observed that in grassland Collembola and acarina were the dominant faunal groups with population maxima in winter months. Later several workers studied the acarine fauna in uncultivated land in different parts of the world including India.

The first study on ecological aspect of soil microarthropods including mites in India was done by Trehan (1945). Then after a long gap of about three decades, Mukherjee and Singh (1970) at the Benaras Hindu University, Uttar Pradesh initiated the studies on soil microarthropods in relation to different edaphic factors and soil ecosystems. Later several workers took up this field of studies and published a number of papers.

In West Bengal the studies on soil acarine fauna, which are restricted to uncultivated lands, were done by many workers. Notable among there are Banerjee (1973, 1974a, 1974b, 1988), Choudhuri and Banerjee (1975, 1977), Bhattacharya and Ray Choudhuri (1969), Bhattacharya *et al.*, (1980), Bhattacharya and Joy (1980a, 1980b), Sanyal (1981a, 1981b, 1982, 1988, 1991a, 1991b), Sanyal and Sarkar (1993), Prabhoo *et al.*, (1988), Hazra and

Sanyal (1989), Hazra and Choudhuri (1990), Banerjee and Sanyal (1991), Hatter *et al.*, (1992), Sanyal (1994) and Sanyal *et al.*, (1999).

The studies on effect of agricultural practices on soil fauna are done by a number of workers in India and abroad. Strickland (1947) showed that considerable difference exist between qualitative populations on two plots of similar soil types largely due to different plant associations on the plots changing the vegetation cover and quality of soil organic matter which in turn effects the faunal population. Tischèr (1955), Sheals (1956) and Edwards and Lofty (1969, 1975) reported reduction of soil arthropod population immediately following cultivation. Sheals (1957) also reported that the cultivated land left fallow results in persistant reduction in number of soil arthropod population. However, effects of cultivation on soil fauna were recognised by Edward and Lofty (1969). They emphasized that certain soil microarthropods like Symphyla, Protura, Mesostigmata and Prostigmata (mites), Collembola were more abundant in agricultural soils than elsewhere.

Bhattacharya *et al.*, (1980) reported that cultivation does not seem to have an immediate detrimental effect on soil inhabiting Cryptostigmata. Ploughing does not cause any qualitative or quantitative depletion of these mites. On the other hand, farmyard manuring has a definite boosting influence resulting in an increase in both the number of species and of individuals. Agricultural practices also reduced the species richness index. Anantha Pai and Prabhoo (1981) studied the microarthropod fauna of paddy fields and adjoining uncultivated soils in South Kerala and concluded that prolonged inundation was the most prominent factor adversely affecting the soil microarthropods in the paddy fields.

Sengupta and Sanyal (1991) reported that soil microarthropods in the fields in West Bengal, India suffers from a reduction in both number and species composition under the stress of agricultural practices. However, fertilizer application, ploughing, hand weeding, etc. seem to favour their population. They showed that Collembola seemed to be the best adapted of all microarthropods in quickly overcoming the stress of inundation of paddy fields while Cryptostigmata took longer time to do so.

STUDY SITES

The present study was conducted in the crop fields and orchard at the Agricultural Training Centre, Narendrapur, South 24 Parganas, West Bengal, India. Three sites were selected as the sampling plots from where soil samples were collected (Fig. 1).

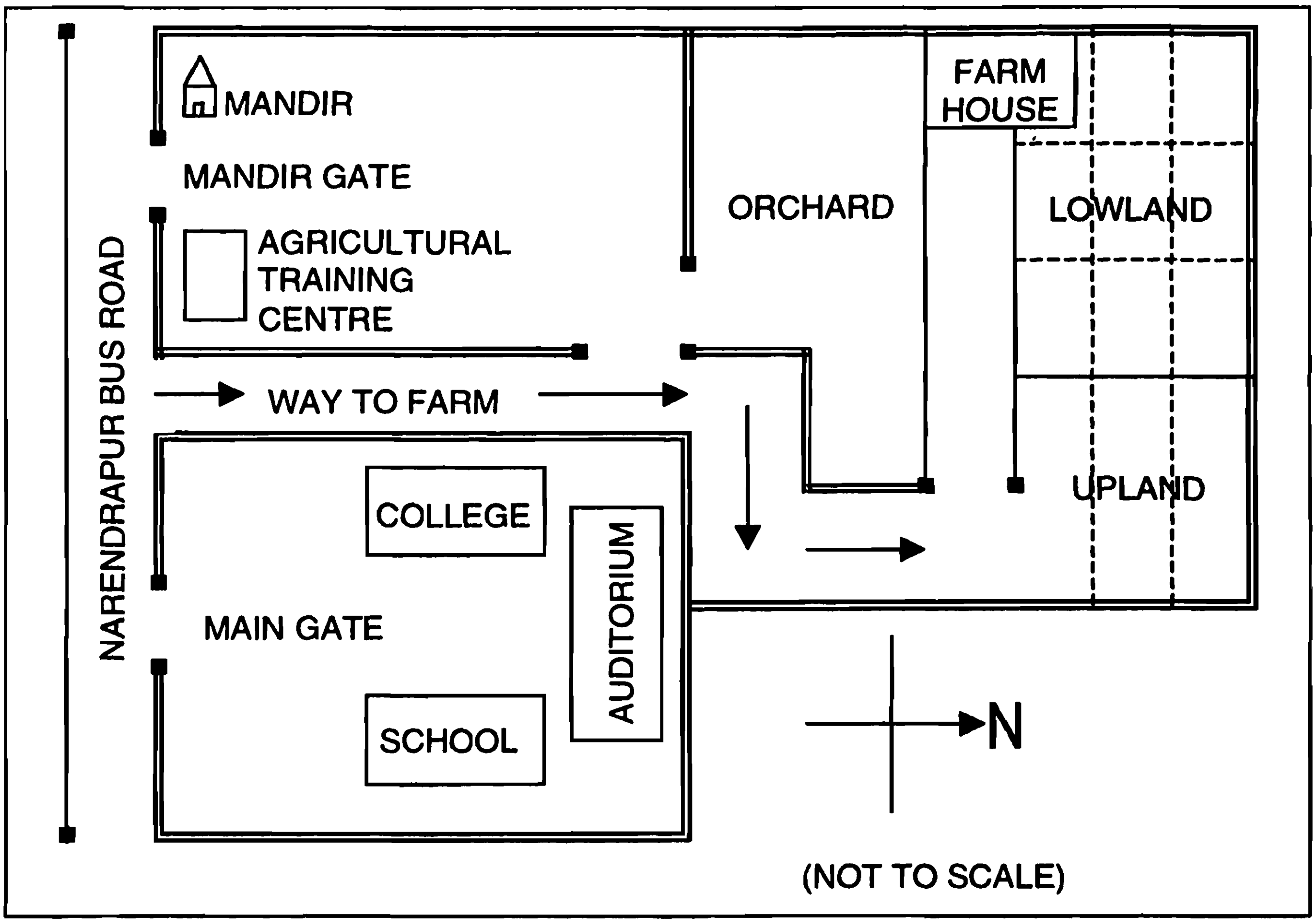

Fig. 1. A Schematic Diagram of the study sites.

SAMPLING SITE I (UPLAND)

The site was an upland under cabbage cultivation (Fig. 2). The field conditions observed during the study are mentioned in Table 1.

Table 1. Field conditions for 6 consecutive months in Site-I.

Months	Field Conditions
Sept.	Field has been ploughed with no crops.
Oct.	Cabbage seeds sown in late September '01 in a different plot prepared and small cabbage plants were planted in this study plot. The plants are of 2"–3" size and are with few, small leaves.
Nov.	The cabbage plants have grown in size to a height of about 10" or so. The number of leaves have also grown, some of the leaves are seen to be infected by insects.
Dec.	Many of the cabbage had attained full size and were therefore picked up. Some are still remaining in the field and are yet to attain the full size.
Jan.	All the cabbage had been picked up and the field has been ploughed for cultivation of brinjal, chillies, and tomato and seeds were sown (which were prepared in a different plot).
Feb.	Brinjal, chilly and tomato plants of 2"–3" have come up with small green leaves.

VEGETATION

This site was well vegetated and was covered by a thin layer of grass and scattered herbs and shrubs besides the main cultivated vegetables-cabbage, bringal, tomato and chilly. The plot contained herbs and shrubs like *Ilanthus* sp., *Parthenium* sp., *Eclipta alba, Aegeratum conizoides, Euphorbia hirta, Amaranthus viridis, Tridex procumbens* and some tall grass.

SAMPLING SITE II (LOW LAND)

The site was a lowland under paddy cultivation (Fig. 3). The field conditions observed during the study are mentioned in Table 2.

Table 2. : Field conditions for 6 consecutive months in site-II.

Months	Field Conditions
Sept.	Standing paddy crop of the length of 80 cm – 100 cm with water standing at the base of the crop upto a height of about 7"–9" (or more). Crops are brilliantly green.
Oct.	Water level has lowered to 3"–4" (or even less) and few paddy seeds are present in some of the crops but are green and young.
Nov.	Paddy in few rows have become yellow while in the other rows they are still green in colour. The water is no longer standing at the base. The soil has cracked though not totally dry.
Dec.	Some of the rows of paddy have been harvested leaving only the stubs. The other rows still have crops though they have turned yellow but are not fully matured to be harvested. The soil is very wet due to sudden heavy shower for a few days.
Jan.	The plot is left bare. All the crops have been harvested. The plot has been ploughed and irrigated for further cultivation. The ground has dried and water is sprinkled at times to moisten it.
Feb.	The plot has been left undisturbed and fertilizers have been applied to prepare the ground for further cultivation of pumpkin.

VEGETATION

This site had a vegetal cover consisting of few herbs and shrubs (besides the main cultivated crop–paddy) like *Aegeratum conizoides, Ilanthus* sp., *Hydralia genanica, Rungia* sp., *Vernonia cineria* and tall scattered grass.

SAMPLING SITE III (ORCHARD)

The site was an orchard of banana and guava trees (Fig. 4). The field conditions observed during the study are given in Table 3.

Table 3. : Field conditions for 6 consecutive months in Site-III.

Months	Field Conditions
Sept.	The field has been ploughed to kill unwanted weeds and grass. The trees of banana and guava are only present. Due to heavy shower the plot has been water logged.
Oct.	Grass and weeds have started to grow though in very small amount. The water is no longer logged.
Nov.	Bushes and shrubs of many types have grown but are small in size.
Dec.	The soil has become dry and bushes and shrubs which were already present have grown in size and many new varieties have come up.
Jan.	The new shrubs and bushes have attained height.
Feb.	The plot now shows no observable change from that of January. The plot is shady and no fertilizer management is practiced here.

VEGETATION

This site was well vegetated and was covered with grass and scattered herbs and shrubs. The plot mainly contained guava (*Psidium guajava*) trees and banana (*Musa* sp.) trees arranged in alternate rows. Besides these plants the other herbs and shrubs were *Aegeratum conizoides, Urena lobata, Tridex procumbens, Eupatorium odoratum, Commelina oblica, Triumpheda rhomboidea* and grass.

All the three sites were regularly subjected to application of fertilizers and pesticides. The details of which is shown in Table 4.

Table 4. : Showing the fertilizers and pesticides applied in the sites during study period.

Crops	Months	Fertilizers used	Pesticides
Cabbage	Sept.	Urea, Super Phosphate	Systemic pesticides and Fungicides
	Oct.	Mustard cake (50 kg / bigha) + cow dung (2.5–2.75 ton / bigha), Muriate of Potash	
Chilly, Tomato and Brinjal	Jan.	Urea	
Paddy	Sept.	Urea, Super Phosphate, Muriate of Potash.	Systemic pesticides and fungicides
Field preparation for other vegetable cultivation	Feb.	Urea, Super Phosphate	

MATERIALS AND METHODS

Methods of Sampling

Seven soil samples were drawn at random from each of the three sampling site from a depth of 9–10 cms at monthly interval over a period of six months (September '01 to February '02). The soil samples were drawn using stainless steel corers with an internal diameter of 5.8 cm.

Extraction of Samples

In the present study the extraction of soil samples were carried out by Tullgren Funnel apparatus as modified by Murphy (1962). A 25 watt electric bulb was used for illumination and heat. The extracted soil mites, collected and sorted out, were kept in separate vials containing 70% alcohol. For microscopic examination prior to identification the mites were cleared in lactic acid and then temporary mounting was done in lactic acid. The identified specimens were then kept in 70% alcohol with proper labels.

Analysis of Edaphic Factors

For the analysis of edaphic factors soil samples were taken in every month at random from different parts of each of the three sites and kept in polythene bags. The analysis of physico-chemical factors of soil, was done by using standard methods as mentioned below :

(i) Physical Parameters

1. Soil moisture – Using Infrared Moisture Balance.
2. Soil temperature – determined at the site using a thermometer which is inserted in the soil vertically so that the bulb is surrounded by soil, kept for 2–3 minutes and the reading is noted.

(ii) Chemical Parameters

1. Measurement of pH – using glass electrode pH meter dipped in soil solution consisting of soil and water in 1 : 5 ratio.
2. Measurement of conductivity – using conductivity meter dipped in soil solution consisting of soil and water in 1 : 5 ratio.
3. Organic carbon content measurement – using Walkley and Black method (1934).
4. Estimation of soil nitrogen (nitrate) – using phenol disulphonic acid method.
5. Estimation of available phosphorus – colorimetrically using spectrophotometer.
6. Estimation of exchangeable potassium – using flame photometer.

RESULTS

(A) Edaphic Factors

SITE I (UPLAND) :

Soil moisture content revealed a moderate range of variation from 17.45% to 25.5%. The minimum amount of moisture (17.45%) was found in February and the maximum amount of moisture (25.5%) was observed in September when there were frequent downpours. Soil temperature was found to be the maximum in October reaching 36.5°C and minimum in January and February, falling down to 20°C. The range of pH was 6.5 to 7.36. The lowest pH was found in December and the highest in September. In November the value of conductivity was as low as 0.080 and in January it was as high as 0.155 reaching the maximum. Organic carbon content in this plot varied between 0.95% (in September) to 1.77% (in January). The minimum amount of nitrate was found in November (0.00030%) and the maximum in January (0.00097%). Available phosphorus percentage was minimum (0.008%) in February and maximum (0.0306%) in September. The percentage of exchangable potassium was minimum (0.0008%) in February and maximum in October (0.0212%). The values of these factors are shown in Table 5 and Figs. 2–9.

Table 5. : Showing population and physico-chemical factors for 6 consecutive months in Site-I.

	MITE POPULATION (MEAN)	SOIL MOISTURE (%)	SOIL TEMPERATURE (ºC)	SOIL pH	CONDUCTIVITY (mmho)	ORG. CARBON (%)	NITRATE (%)	AVAILABLE PHOSPHORUS (%)	EXCHANGABLE POTASSIUM (%)
SEP.	9.29	25.5	31.5	7.36	0.14	0.95	0.002	0.0306	0.0094
OCT.	12.29	19.77	36.5	6.9	0.1	1.66	0.00051	0.024	0.0212
NOV.	11.29	20.7	28.0	7.3	0.08	1.29	0.0003	0.0216	0.0184
DEC.	12.57	17.75	21.0	6.5	0.13	1.69	0.00033	0.012	0.0014
JAN.	12.29	19.65	20.0	6.7	0.155	1.77	0.00097	0.01	0.0009
FEB.	11.43	17.45	20.0	7.36	0:145	1.42	0.00095	0.008	0.0008

SITE II (LOWLAND) :

Soil moisture content revealed a moderate range of variation from 13.86% in February to 27.36% in December. Soil temperature was found to be the maximum in October reaching 31°C and minimum in January and February falling down to 19°C. The lowest pH was observed in February (6.63) and the highest was in December (7.5). Conductivity reached a maximum of 0.22 in November and February and minimum of 0.13 in September. Organic carbon content varied between 0.204% in December and 1.362% in February. The minimum amount of nitrate was found in January (0.000205%) and the maximum in February (0.00087%). In September the available phosphorus content was highest rising to 0.0376% and in December it was minimum falling to 0.0058%. Exchangable potassium percentage was maximum in September (0.0114%) and minimum in February (0.0002%). The values of these parameters are shown in Table 6 and Figs. 2–9.

Table 6. : Showing population and physico-chemical factors for 6 consecutive months in Site-II.

	MITE POPULATION (MEAN)	SOIL MOISTURE (%)	SOIL TEMPERATURE (ºC)	SOIL pH	CONDUCTIVITY (mmho)	ORG. CARBON (%)	NITRATE (%)	AVAILABLE PHOSPHORUS (%)	EXCHANGABLE POTASSIUM (%)
SEP.	8.00	25	27	7.2	0.13	0.84	0.00038	0.0376	0.0114
OCT.	5.86	23.7	31	6.9	0.14	0.9715	0.0003	0.0304	0.0108
NOV.	8.29	18.5	28.5	7.05	0.22	0.631	0.00027	0.02228	0.0072
DEC.	2.57	27.36	21	7.5	0.16	0.204	0.00042	0.00058	0.0005
JAN.	4.71	18	19	7.11	0.154	0.9704	0.000205	0.0076	0.0003
FEB.	13.71	13.86	19	6.63	0.22	1.362	0.00087	0.0224	0.0002

SITE III (ORCHARD) :

Soil moisture content revealed a moderate range of variation from 14.12% in February to 25.5% in September. Soil temperature was found to be minimum in December and January (20ºC) and maximum in September, reaching 34ºC. The range of pH was from 6.4 (in February) to 7.3 (in October). Conductivity shows a moderate range of variation from 0.05 in October to 0.31 in September. The maximum amount of Organic carbon was found in February reaching to 1.43% and the minimum amount was found in September falling to 0.55%. The minimum amount of nitrate was found in October (0.00018%) and the maximum in September (0.00034%). Available phosphorus percentage was minimum in February (0.008%) and the maximum in November (0.04%). Exchangable potassium percentage was minimum in December and January falling to 0.0001% and maximum in October, reaching 0.0184%. The values of these parameters are shown in Table 7 and Figs. 2–9.

Table 7. : Showing population and physico-chemical factors for 6 consecutive months in Site-III.

	MITE POPULATION (MEAN)	SOIL MOISTURE (%)	SOIL TEMPERATURE (ºC)	SOIL pH	CONDUCTIVITY (mmho)	ORG. CARBON (%)	NITRATE (%)	AVAILABLE PHOSPHORUS (%)	EXCHANGABLE POTASSIUM (%)
SEP.	7.71	25.5	34	6.95	0.31	0.55	0.00034	0.019	0.014
OCT.	9.14	19.69	28	7.3	0.05	0.69	0.00018	0.029	0.0184
NOV.	9.86	20	25	7.1	0.07	0.76	0.00023	0.04	0.017
DEC.	12.71	17.75	20	6.82	0.15	0.84	0.00026	0.013	0.0001
JAN.	13.71	14.24	20	6.67	0.08	1.36	0.00028	0.012	0.0001
FEB.	16.57	14.12	21.5	6.4	0.067	1.43	0.00029	0.008	0.0003

(B) Faunal Composition

SITE I (UPLAND) :

The Cryptostigmatid fauna obtained from this site is represented by 10 families *viz.* Pthiracaridae, Haplochthoniidae, Epilohmanniidae, Nothridae, Trhypochthoniidae, Cepheidae, Oppiidae, Haplozetidae, Galumnidae and Oribatellidae. Pthiracaridae was represented by *Hoplophorella* sp.; Haplochthoniidae by *Haplochthonius* sp.; Epilohmanniidae by *Epilohmannia* sp.; Nothridae by *Nothrus* sp.; Oppiidae by *Oppia yodae;* Haplozetidae by *Pilobatella* sp., *Rostrozetes* sp. and *Xylobates* sp.; Galumnidae by *Galumna* sp. and Oribatellidae by *Scheloribates* sp., *Lamellobates* sp., *Paralamellobates* sp. Of these species *Scheloribates* sp. occupied the dominant position since it was the most numerous species. *Scheloribates* sp. was followed by *Galumna* sp. in the second position and *Haplochthonius* sp. and *Archegozetes* sp. are occupying the third and the fourth position respectively on the basis of their total number in the samples.

Astigmata was represented by Acaridae family of which only *Tyrophagus* sp., could be identified and the others remained undetermined. Many other mites belonging to suborder Astigmata could not be further identified.

Among Prostigmata families like Cunaxidae, Tydeidae, Erythraeidae, Scutacaridae, Pygmephoridae, Rhaphignathidae and Cheyletidae were present. In Tydeidae only *Pronematus* sp. could be identified and the rest could not be further identified. Cheyletidae occupied the dominant position followed by Cunaxidac and Tydeidae.

Mesostigmata mites were represented by families like Uropodidae, Phytoseiidae, Ascidae, Neoparasitidae, Laelapidae, Rhodacaridae, Parasitidae, Eviphidae and many mites could not be identitfied. Uropodidae was represented by *Fuscuropoda* sp. and the rest remained unidentified, in Phytoseiidae *Amblyseius* sp. was the only identified species. Laelapidae was represented by *Cosmolaelaps* sp., *Ololaelaps* sp. and Eviphidae by *Alliphis* sp., rest could not be identified further. In Neoparasitidae only *Gamasephis* sp. was the identified species. Rhodacaridae was represented by *Rhodocarus* sp. Of all the Mesostigmata mites Uropodidae was the most numerous and occupied the top position followed by Phytoseiidae in the second position, Rhodacaridae in the third position and Ascidae in the fourth position according to their numerical abundance.

The details of the species of mites and their number in Site-I during the period are shown in Table 8.

SITE II (LOWLAND) :

The Cryptostigmatid fauna obtained from this site was represented by 9 families *viz.* Haplochthoniiidae represented by *Haplochthonius* sp.; Epilohmannidae represented by *Epilohmannia* sp.; Nothridae represented by *Nothrus* sp.; Trhypochthoniidae represented by *Archegozetes* sp.; Oppiidae represented by *Oppia* sp.; Chaunoproctidae represented by *Chaunoproctus* sp.; Haplozetidae represented by *Xylobates* sp.; Galumnidae represented by *Galumna* sp.; Oribatellidae by *Scheloribates* sp. Of all the Cryptostigmata mites obtained the majority were immature and therefore could not be identified. Of the identified species, *Scheloribates* sp. occupied the top position since it was the most numerous. It was followed by *Oppia* sp. in the second position and *Galumna* sp. in the third position on the basis of their numerical abundance.

Astigmata was represented by Acaridae family, of which only *Tyrophagus* sp. could be identified (and the rest remained undetermined) and Anoetidae family. Acaridae occupied the dominant position among Astigmata mites.

Among Prostigmata families like Trombiculidae, Cunaxidae, Tydeidae, Stigmaeidae, Scutaridae, Rhaphignathidae, Cheyletidae and Eupodidae were present. In Cunaxidae only *Dactyloscirus* sp. could be identified, in Tydeidae only *Pronematus* sp. could be identified and the rest of the members of Tydeidae family could not be further identified, in Eupodidae only *Eupodes* sp. could be identified. Tydeidae occupied the dominant position followed by Cheyletidae on the basis of their number.

Mesostigmata mites were represented by 6 families *viz.* Uropodidae, Phytoseiidae, Ascidae, Neoparasitidae, Laelapidae, Rhodacaridae, Eviphidae and many could not be identified.

Table 8. : Showing species of soil Mites and their monthwise number of population in upland (September, 2001 to February, 2002).

SUBORDER	FAMILY	SPECIES	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	TOTAL
Cryptostigmata	Pthiracaridae	*Hoplophorella* sp.	–	–	–	1	1	–	2
	Haplochthoniidae	*Haplochthonius* sp.	6	5	15	–	–	–	26
	Lohmaniidae	*Haplacarus* sp.	–	–	–	–	–	–	–
		Vepracarus sp.	–	–	–	–	–	–	–
	Epilohmanniidae	*Epilohmannia* sp.	–	4	–	–	3	–	7
	Nothridae	*Nothrus* sp.	–	4	–	–	–	–	4
	Trhypochthoniidae	*Archegozetes* sp.	5	17	3	–	–	–	25
	Nanhermanniidae	*Cyrthermannia* sp.	–	–	–	–	–	–	–
	Cepheidae	*Cepheus* sp.	–	–	3	–	–	–	3
	Basilobelbidae	*Basilobelba* sp.	–	–	–	–	–	–	–
	Tectocepheidae	*Tectocepheus* sp.	–	–	–	–	–	–	–
	Oppiidae	*Oppia* sp.	–	3	5	–	2	6	16
	Chaunoproctidae	*Chaunoproctus* sp.	–	–	–	–	–	–	–
	Haplozetidae	*Peloribates* sp.	–	–	–	–	–	–	–
		Pilobatella sp.	–	1	–	–	–	–	1
		Rostrozetes sp.	4	–	–	–	–	–	4
		Xylobates sp.	–	–	–	1	–	–	1
	Galumnidae	*Galumna* sp.	–	2	5	10	7	11	35
	Oribatetellidae	*Lamellobates* sp.	–	2	3	1	–	2	8
		Paralamellobates sp.	–	–	–	–	–	1	1
		Scheloribates sp.	10	12	12	20	15	21	90
	Immature Cryptostigmata	*Unidentified* sp.	–	–	–	31	18	17	66
Astigmata	Acaridae	*Tyrophagus* sp.	–	–	–	–	4	–	4
		Undetermined sp.	–	–	–	–	5	4	9

SUBORDER	FAMILY	SPECIES	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	TOTAL
Astigmata	Anoetidae	Undetermined sp.	–	–	2	–	–	–	2
	Pyroglyphidae	Undetermined sp.	–	–	–	–	–	–	–
	Unidentified Astigmata	Undetermined sp.	2	2	–	–	–	–	4
Prostigmata	Trombiculidae	Undetermined sp.	–	–	–	–	–	–	–
	Cunaxidae	*Dactyloscirus* sp.	–	–	2	–	–	–	2
		Undetermined sp.	–	3	–	1	–	–	4
	Tydeidae	*Pronematus* sp.	1	–	–	–	–	–	1
		Undetermined sp.	3	–	–	–	–	–	3
	Erythraeidae	Undetermined sp.	–	–	–	1	–	–	1
	Stigmaeidae	Undetermined sp.	–	–	2	–	–	–	2
	Scutacaridae	Undetermined sp.	–	2	–	–	–	–	2
	Pygmephoridae	Undetermined sp.	–	–	–	–	–	–	–
	Rhaphignathidae	Undetermined sp.	–	–	2	–	–	–	2
	Cheyetidae	Undetermined sp.	–	2	3	–	–	1	6
	Undetermined Prostigmata	Undetermined sp.	6	1	3	–	–	–	10
Mesostigmata	Uropodidae	*Fuscuropoda* sp.	–	–	–	3	–	3	6
		Undetermined sp.	–	12	7	9	10	5	43
	Phytoseiidae	*Amblyseius* sp.	7	1	–	–	–	–	8
		Undetermined sp.	10	2	–	–	–	–	12
	Ascidae	*Asca* sp.	–	–	–	–	–	–	–
		Lasioseius sp.	–	–	–	–	–	–	–
		Antennoseius sp.	–	–	–	–	–	–	–
		Gamasellodes sp.	–	–	–	–	–	–	–

SUBORDER	FAMILY	SPECIES	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	TOTAL
Mesostigmata	Ascidae	*Proctolaelaps* sp.	–	–	–	–	–	–	–
		Undetermined sp.	4	6	–	–	4	2	16
	Sejidae	Undetermined sp.	–	–	–	–	–	–	–
	Veigaiidae	Undetermined sp.	–	–	–	–	–	–	–
	Neoparasitidae	*Gamasiphis* sp.	–	–	–	–	1	–	1
		Undetermined sp.	–	–	–	–	–	–	–
		Cosmolaelaps sp.	–	–	–	3	–	–	3
	Laelapidae	*Ololoelaps* sp.	–	–	–	1	–	–	1
		Hypoaspis sp.	–	–	–	–	–	–	–
	Eviphidae	*Alliphis* sp.	–	–	–	2	–	–	2
	Rhodacaridae	*Rhodacarus* sp.	–	–	–	2	14	1	17
		Undetermined sp.	–	–	–	–	–	–	–
	Parasitidae	*Pergamasellus* sp.	–	–	–	–	–	–	–
		Undetermined sp.	–	2	2	–	–	1	5
	Macrochelidae	Undetermined sp.	–	–	–	–	–	–	–
	Podocinidae	*Podocinum* sp.	–	–	–	–	–	–	–
		Undetermined sp.	–	–	–	–	–	–	–
	Epicrosejidae	Undetermined sp.	–	–	–	–	–	–	–
	Undetermined Mesostigmata	Undetermined sp.	1	2	–	1	4	4	12
	Immature Mesostigmata	Undetermined sp.	6	1	8	1	–	1	17
	TOTAL		**65**	**86**	**77**	**88**	**88**	**80**	**484**

Uropodidae was represented by *Fuscuropoda* sp., the rest remaining unidentified. Phytoseiidae was represented by *Amblyseius* sp. and the rest could not be further identified. Ascidae was represented by *Lasioseius* sp., *Gamasellodes* sp. and *Proctolaelaps* sp.; Neoparasitidae was represented by *Gamasiphis* sp.; Laelapidae was represented by *Ololaelaps* sp., *Hypoa*sp.*is* sp.; Rhodocaridae was represented by *Rhodocarus* sp. ; Eviphidae was represented by *Alliphis* sp. Among all the Mesostigmata mites Ascidae occupied the top position followed by Laelapidae in the second position and Phytoseiidae and Uropodidae in the third and fourth position respectively on the basis of their numerical abundance. A large number of Mesostigmata mites could not be identified.

The details of species of mites and their number in Site-II observed during the period of study are shown in Table 9.

SITE III (ORCHARD) :

The Cryptostigmatid fauna obtained from this site was represented by 16 families *viz.* Pthiracaridae represented by *Hoplophorella* sp.; Haplochthoniidae represented by *Haplochthonius* sp.; Epilohmanniidae represented by *Epilohmannia* sp.; Lohmanniidae represented by *Haplacarus* sp. and *Vepracarus* sp.; Nothridae represented by *Nothrus* sp.; Trhypochthoniidae represented by *Archegozetes* sp.; Basilobelbidae represented by *Basilobelba* sp.; Tectocepheidae represented by *Tectocepheus* sp.; Oppiidae represented by *Oppia* sp.; Haplozetidae represented by *Peloribates* sp., *Pilobatella* sp. and *Xylobates* sp.; Galumnidae represented by *Galumna* sp. and Oribatellidae represented by *Lamellobates* sp. and *Scheloribates* sp. Of all the Cryptostigmata mites obtained a major portion was occupied by immature forms. Of the identified species *Galumna* sp. occupied the topmost position followed by *Scheloribates* sp. in the second position and *Oppia* sp. in the third position on the basis of their numerical abundance.

Astigmata was represented by Acaridae family, of which only *Tyrophagus* sp. could be identified (and the rest could not be identified beyond their family position) and Pyroglyphidae family. Acaridae occupied the dominant position among Astigmata mites.

Among Prostigmata families like Cunaxidae, Tydeidae, Erythraeidae, Scutacaridae, Rhaphignathidae and Cheyletidae were present. In Cunaxidae family only *Dactyloscirus* sp. could be identified. Cheyletidae occupied the top position and was followed by Cunaxidae in the second position on the basis of their numbers.

Mesostigmata mites were represented by 10 families *viz.* Uropodidae, Phytoseiidae, Ascidae, Veigaiidae, Neoparasitidae, Laelapidae, Rhodacaridae, Macrocheyledae, Podocinidae and

Table 9. : Showing species of soil Mites and their monthwise number of population in lowland (September, 2001 to February, 2002).

SUBORDER	FAMILY	SPECIES	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	TOTAL
Cryptostigmata	Pthiracaridae	*Hoplophorella* sp.	–	–	–	1	–	–	1
	Haplochthoniidae	*Haplochthonius* sp.	–	4	2	–	–	–	6
	Lohmaniidae	*Haplacarus* sp.	–	–	–	–	–	–	–
		Vepracarus sp.	–	–	–	–	–	–	–
	Epilohmanniidae	*Epilohmannia* sp.	–	–	–	–	2	–	2
	Nothridae	*Nothrus* sp.	–	2	–	–	–	–	2
	Trhypochthoniidae	*Archegozetes* sp.	3	–	–	–	–	–	3
	Nanhermanniidae	*Cyrthermannia* sp.	–	–	–	–	–	–	–
	Cepheidae	*Cepheus* sp.	–	–	–	–	–	–	–
	Basilobelbidae	*Basilobelba* sp.	–	–	–	–	–	–	–
	Tectocepheidae	*Tectocepheus* sp.	–	–	–	–	–	–	–
	Oppiidae	*Oppia* sp.	–	–	–	1	2	8	11
	Chaunoproctidae	*Chaunoproctus* sp.	–	–	–	–	1	1	2
	Haplozetidae	*Peloribates* sp.	–	–	–	–	–	–	–
		Pilobatella sp.	–	–	–	–	–	–	–
		Rostrozetes sp.	–	–	–	–	–	–	–
		Xylobates sp.	–	–	–	–	–	2	2
	Galumnidae	*Galumna* sp.	–	–	–	2	–	3	5
	Oribatetellidae	*Lamellobates* sp.	–	–	–	–	–	–	–
		Paralamellobates sp.	–	–	–	–	–	–	–
		Scheloribates sp.	2	4	3	4	6	20	39
	Immature Cryptostigmata	*Unidentified* sp.	7	9	10	7	8	5	46
Astigmata	Acaridae	*Tyrophagus* sp.	4	3	–	–	2	13	22
		Undetermined sp.	–	4	–	–	–	–	4

SUBORDER	FAMILY	SPECIES	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	TOTAL
Astigmata	Anoetidae	Undetermined sp.	–	–	2	–	–	–	2
	Pyroglyphidae	Undetermined sp.	–	–	–	–	–	–	–
	Unidentified Astigmata	Undetermined sp.	–	–	–	–	–	–	–
Prostigmata	Trombiculidae	Undetermined sp.	1	–	–	–	–	–	1
	Cunaxidae	*Dactyloscirus* sp.	–	–	2	–	–	–	2
		Undetermined sp.	–	–	–	–	–	–	–
	Tydeidae	*Pronematus* sp.	4	–	–	–	1	–	5
		Undetermined sp.	6	–	–	–	–	–	6
	Erythraeidae	Undetermined sp.	–	–	–	–	–	–	–
	Stigmaeidae	Undetermined sp.	–	–	2	–	2	–	4
	Scutacaridae	Undetermined sp.	–	–	–	–	–	4	4
	Pygmephoridae	Undetermined sp.	–	–	–	–	–	–	–
	Rhaphignathidae	Undetermined sp.	–	–	–	–	–	2	2
	Cheyetidae	Undetermined sp.	3	6	–	–	–	–	9
	Eupodidae	*Eupodes* sp.	–	–	–	–	–	–	–
	Undetermined Prostigmata	Undetermined sp.	–	–	–	–	–	–	–
Mesostigmata	Uropodidae	*Fuscuropoda* sp.	–	–	–	–	–	–	–
		Undetermined sp.	–	–	–	–	–	5	5
	Phytoseiidae	*Amblyseius* sp.	9	–	3	–	4	–	16
		Undetermined sp.	1	–	–	–	–	–	1
	Ascidae	*Asca* sp.	–	–	–	–	–	–	–
		Lasioseius sp.	–	–	–	–	–	2	2
		Antennoseius sp.	–	–	–	–	–	–	–
		Gamasellodes sp.	–	2	–	–	–	6	8

SUBORDER	FAMILY	SPECIES	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	TOTAL
Mesostigmata	Ascidae	*Proctolaelaps* sp.	1	–	–	–	–	–	1
		Undetermined sp.	–	–	6	–	–	5	11
	Sejidae	Undetermined sp.	–	–	–	–	–	–	–
	Veigaiidae	Undetermined sp.	–	–	–	–	–	–	–
	Neoparasitidae	*Gamasiphis* sp.	–	–	–	–	1	–	1
		Undetermined sp.	–	–	–	–	–	–	–
	Laelapidae	*Ololoelaps* sp.	–	–	–	–	1	–	1
		Hypoaspis sp.	–	–	–	–	3	–	3
	Eviphidae	*Alliphis* sp.	–	–	–	2	–	8	10
	Rhodacaridae	*Rhodacarus* sp.	–	–	–	–	–	2	2
		Undetermined sp.	–	–	–	–	–	–	–
	Parasitidae	*Pergamasellus* sp.	–	–	–	–	–	–	–
		Undetermined sp.	–	–	–	–	–	–	–
	Macrochelidae	Undetermined sp.	–	–	–	–	–	–	–
	Podocinidae	*Podocinum* sp.	–	–	–	–	–	–	–
		Undetermined sp.	–	–	–	–	–	–	–
	Epicrosejidae	Undetermined sp.	–	–	–	–	–	–	–
	Undetermined Mesostigmata	Undetermined sp.	–	7	7	–	–	6	20
	Immature Mesostigmata	Undetermined sp.	15	–	–	2	–	2	19
	TOTAL		**56**	**41**	**37**	**19**	**33**	**94**	**280**

Epicrosejiidae. Uropodidae was represented by *Fuscuropoda* sp. (rest undetermined); Phytoseiidae by *Amblyseius* sp. (rest undetermined); Ascidae was represented by *Asca* sp.; *Lasioseius* sp., *Gamasellodes* sp.; Neoparasitidae was represented by *Gamasephis* sp.; Laelapidae by *Ololaelaps* sp.and *Hypoa*sp.*is* sp.; Rhodacaridae was represented by *Rhodacarus* sp.; Podocinidae by *Podocinum* sp.; Epicrosejidae was represented. Many of the specimens were immature and thus could not be identified. Of all the Mesostigmata mites Phytoseiidae occupied the dominant position being most numerous and was followed by Ascidae and Rhodocaridae, both in the second position because of their equal numerical abundance. Besides the immature ones, a large number of mites could not be identified since they are very rare in India and many of them have not been identified by the experts till date.

The species of mites and their number obtained in Site-III during the study period are shown in Table 10.

(C) Seasonal Fluctuation

SITE I (UPLAND) :

The population of mites exhibited quantitative and qualitative variation with change of seasons. The fluctuation was not strictly regular. In this site, the maximum population reached in December and the minimum in September. It was observed, that a tendency to increase in number, started from December when a peak of mite population was reached (Fig. 3)

SITE II (LOWLAND) :

In this plot the fluctuation of mite population with change of seasons was not regular. The population reached the maximum in February and the minimum was observed in December. The tendency to decrease in number of mites started from Septmebr till it reached a minimum in December. From December onwards there was a gradual rise in population (Fig. 3).

SITE III (ORCHARD) :

In this plot also the population of mites exhibited quantitative and qualitative variation with change of seasons. The population reached a peak in February and was minimum in September. In this case the fluctuation in population was almost regular. There was a gradual rise in population from September and it reached maximum in February (Fig. 3).

Table 10. : Showing species of soil Mites and their monthwise number of population in orchard (September, 2001 to February, 2002).

SUBORDER	FAMILY	SPECIES	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	TOTAL
Cryptostigmata	Pthiracaridae	*Hoplophorella* sp.	1	–	–	–	–	6	7
	Haplochthoniidae	*Haplochthonius* sp.	–	9	–	–	–	–	9
	Lohmaniidae	*Haplacarus* sp.	–	–	–	1	–	–	1
		Vepracarus sp.	–	7	–	–	–	–	7
	Epilohmanniidae	*Epilohmannia* sp.	–	6	–	2	8	–	16
	Nothridae	*Nothrus* sp.	–	–	–	–	3	–	3
	Trhypochthoniidae	*Archegozetes* sp.	9	7	–	–	–	–	16
	Nanhermanniidae	*Cyrthermannia* sp.	–	–	–	–	–	–	–
	Cepheidae	*Cepheus* sp.	–	–	–	–	–	–	–
	Basilobelbidae	*Basilobelba* sp.	–	1	–	–	–	–	1
	Tectocepheidae	*Tectocepheus* sp.	–	–	3	2	–	4	9
	Oppiidae	*Oppia* sp.	–	–	–	3	9	15	27
	Chaunoproctidae	*Chaunoproctus* sp.	–	–	–	–	–	–	–
	Haplozetidae	*Peloribates* sp.	–	–	3	–	4	–	7
		Pilobatella sp.	1	–	–	–	–	–	1
		Rostrozetes sp.	–	–	–	–	–	–	–
		Xylobates sp.	–	7	5	30	6	41	89
	Galumnidae	*Galumna* sp.	–	–	6	3	7	–	16
	Oribatetellidae	*Lamellobates* sp.	–	3	1	2	–	3	9
		Paralamellobates sp.	–	–	–	–	–	–	–
		Scheloribates sp.	5	–	17	10	29	22	83
	Immature Cryptostigmata	Unidentified sp.	–	–	14	4	4	8	30
Astigmata	Acaridae	*Tyrophagus* sp.	–	–	3	–	–	–	3
		Undetermined sp.	–	–	–	4	–	–	4

SUBORDER	FAMILY	SPECIES	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	TOTAL
Astigmata	Anoetidae	Undetermined sp.	–	–	–	–	–	–	–
	Pyroglyphidae	Undetermined sp.	–	2	–	–	–	–	2
	Unidentified Astigmata	Undetermined sp.	–	–	–	–	–	–	–
Prostigmata	Trombiculidae	Undetermined sp.	–	–	–	–	–	–	–
	Cunaxidae	*Dactyloscirus* sp.	2	–	–	–	–	–	2
		Undetermined sp.	–	–	3	4	–	–	7
	Tydeidae	*Pronematus* sp.	–	–	–	–	–	–	–
		Undetermined sp.	–	–	–	–	–	3	3
	Erythraeidae	Undetermined sp.	–	–	–	2	–	–	2
	Stigmaeidae	Undetermined sp.	–	–	–	–	–	–	–
	Scutacaridae	Undetermined sp.	–	–	–	–	–	2	2
	Pygmephoridae	Undetermined sp.	–	–	1	–	–	–	1
	Rhaphignathidae	Undetermined sp.	–	–	–	–	–	–	–
	Cheyetidae	Undetermined sp.	3	–	1	2	–	–	6
	Eupodidae	*Eupodes* sp.	–	6	2	–	–	–	8
	Undetermined Prostigmata	Undetermined sp.							
Mesostigmata	Uropodidae	*Fuscuropoda* sp.	–	–	–	–	–	–	–
		Undetermined sp.	–	–	–	–	–	–	–
	Phytoseiidae	*Amblyseius* sp.	13	–	–	–	–	–	13
		Undetermined sp.	3	–	–	–	–	–	3
	Ascidae	*Asca* sp.	–	–	–	–	–	3	3
		Lasioseius sp.	1	–	–	–	–	–	1
		Antennoseius sp.	–	–	–	–	–	–	–
		Gamasellodes sp.	4	–	5	–	–	–	9

SUBORDER	FAMILY	SPECIES	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	TOTAL
Mesostigmata	Ascidae	*Proctolaelaps* sp.	–	–	–	–	–	–	–
		Undetermined sp.	1	–	–	–	–	–	1
	Sejidae	Undetermined sp.	–	–	–	–	–	–	–
	Veigaiidae	Undetermined sp.	–	4	–	–	–	–	4
	Neoparasitidae	*Gamasiphis* sp.	–	–	–	–	2	–	2
		Undetermined sp.	–	–	–	–	–	–	–
	Laelapidae	*Ololoelaps* sp.	–	–	–	2	–	–	2
		Hypoaspis sp.	–	–	–	2	2	–	4
	Eviphidae	*Alliphis* sp.	–	–	–	–	–	–	–
	Rhodacaridae	*Rhodacarus* sp.	–	–	–	4	7	–	11
		Undetermined sp.	–	–	–	–	–	–	–
	Parasitidae	*Pergamasellus* sp.	–	–	–	–	–	–	–
		Undetermined sp.	–	–	–	–	–	–	–
	Macrochelidae	Undetermined sp.	3	–	–	–	7	3	13
	Podocinidae	*Podocinum* sp.	–	5	–	–	–	–	5
		Undetermined sp.	–	–	–	–	–	–	–
	Epicrosejidae	Undetermined sp.	2	–	–	–	2	–	4
	Undetermined Mesostigmata	Undetermined sp.	2	7	5	4	3	–	21
	Immature Mesostigmata	Undetermined sp.	4	–	–	–	3	6	13
	TOTAL		**54**	**64**	**69**	**81**	**96**	**116**	**480**

Fig. 2. : Photograph showing sampling site I (Upland).

Fig. 3. : Photograph showing sampling site II (Lowland).

Fig. 4. : Photograph showing sampling site III (Orchard)

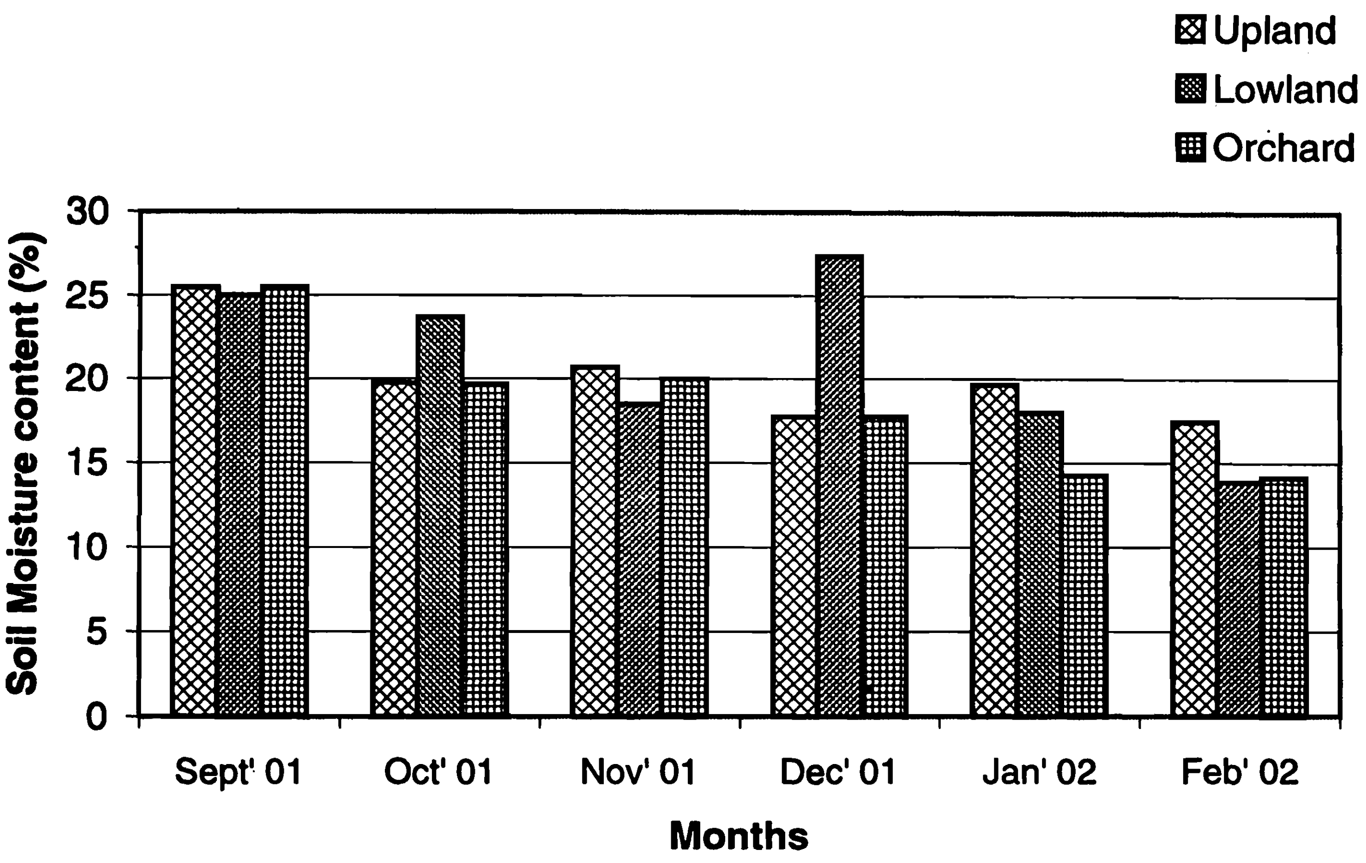

Fig. 5. Showing soil moisture content range in six months in all three sampling sites (Sept'01 to Feb'02).

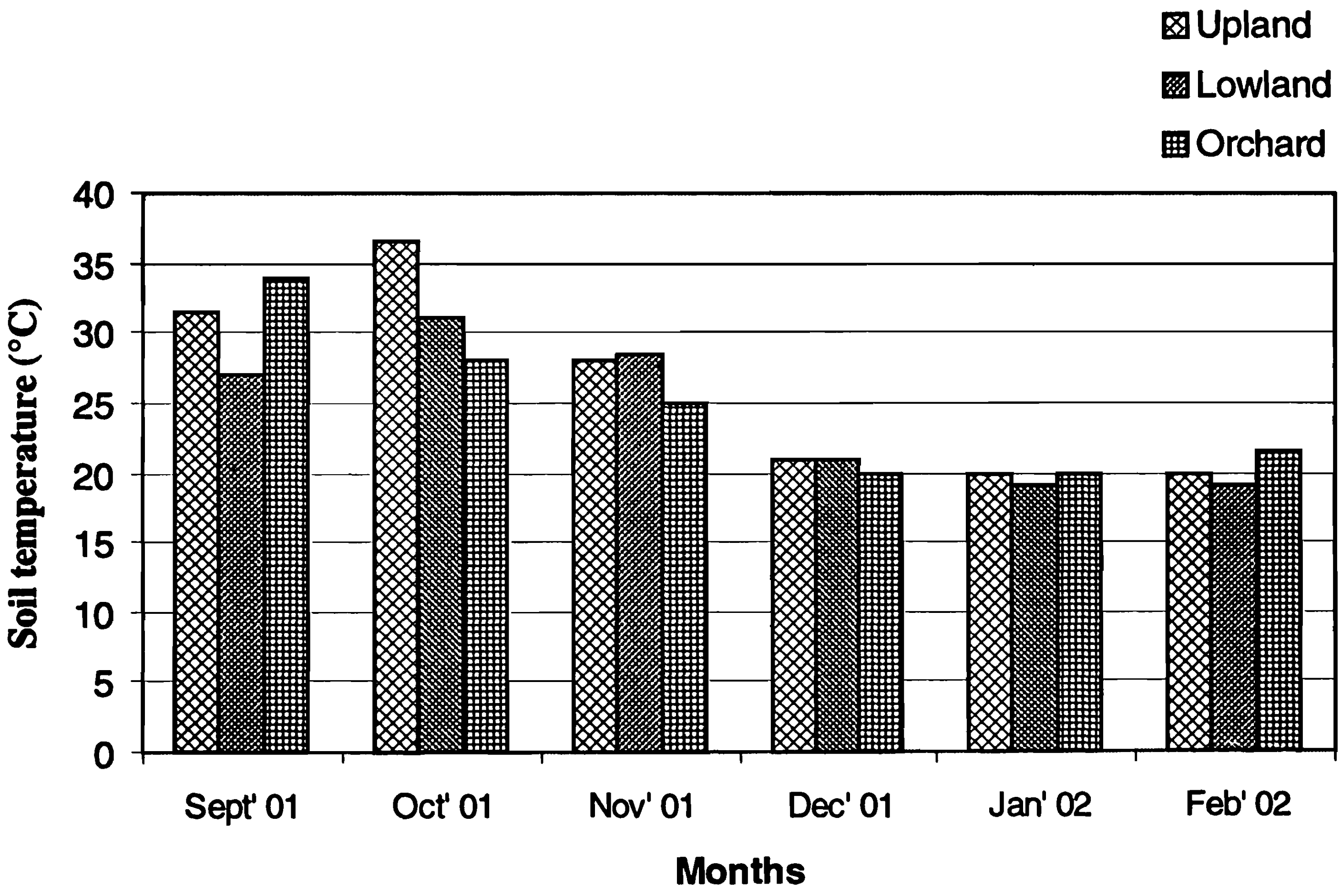

Fig. 6. Showing soil temperature range in six months in all three sampling sites (Sept'01 to Feb'02).

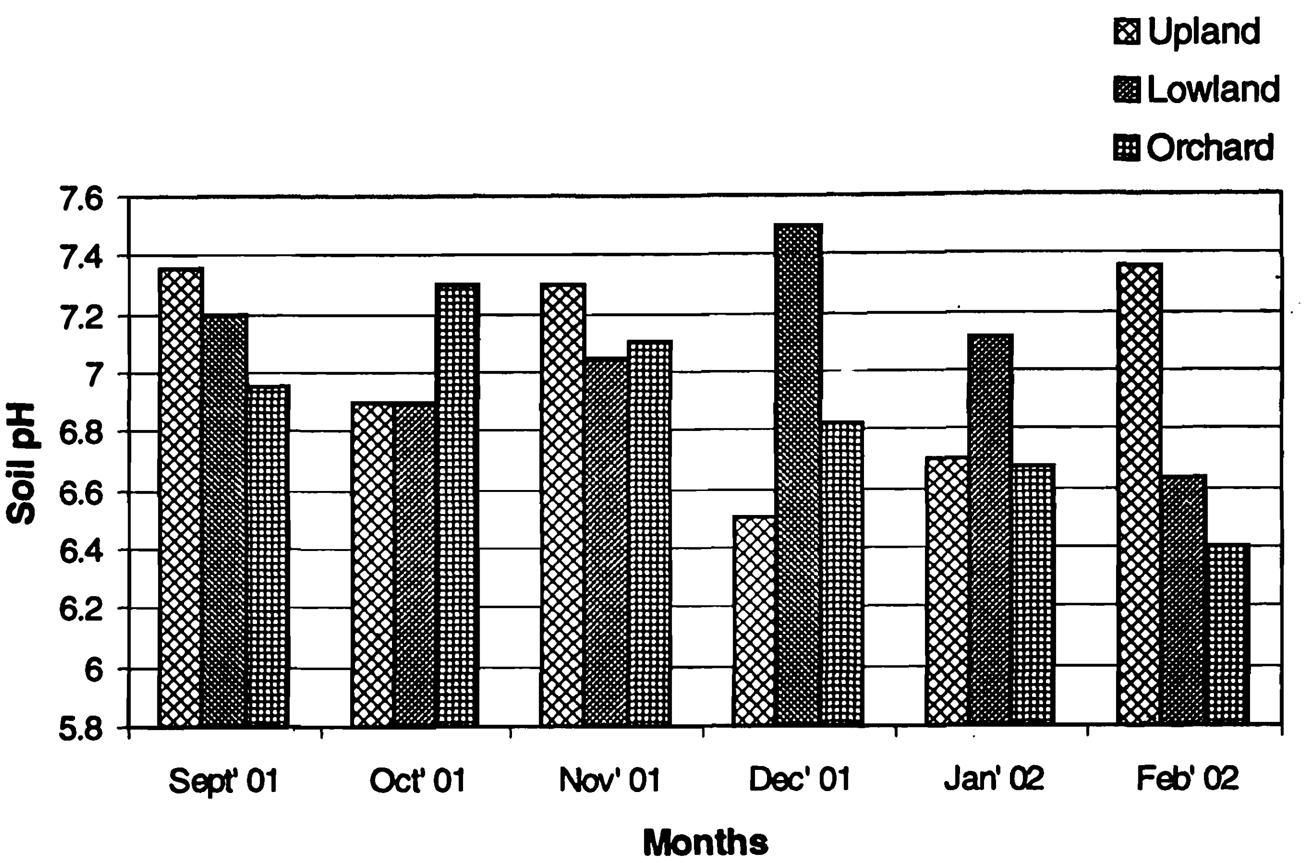

Fig. 7. Showing soil pH range in six months in all three sampling sites (Sept'01 to Feb'02).

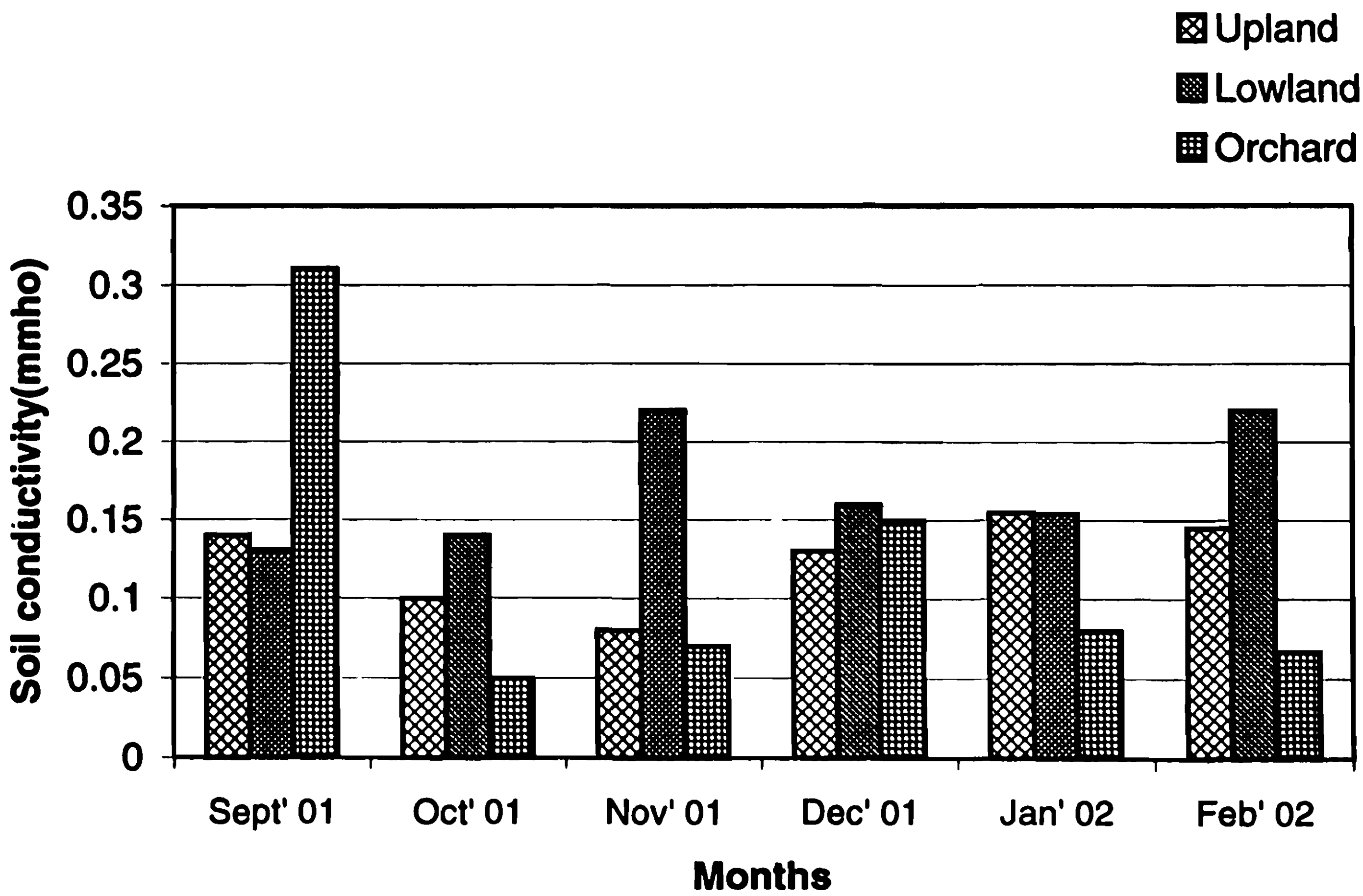

Fig. 8. Showing soil conductivity range in six months in all three sampling sites (Sept'01 to Feb'02).

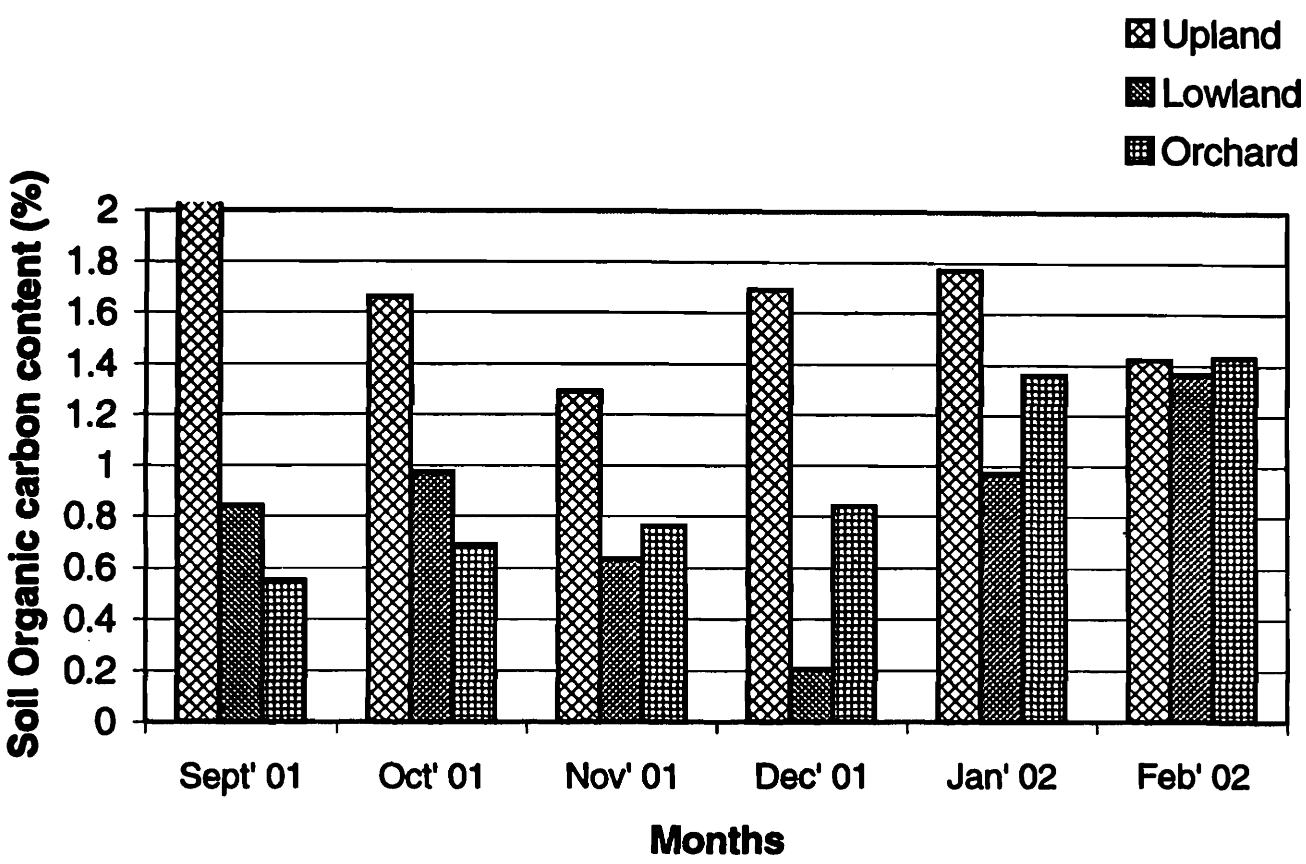

Fig. 9. Showing soil organic carbon content range in six months in all three sampling sites (Sept'01 to Feb'02).

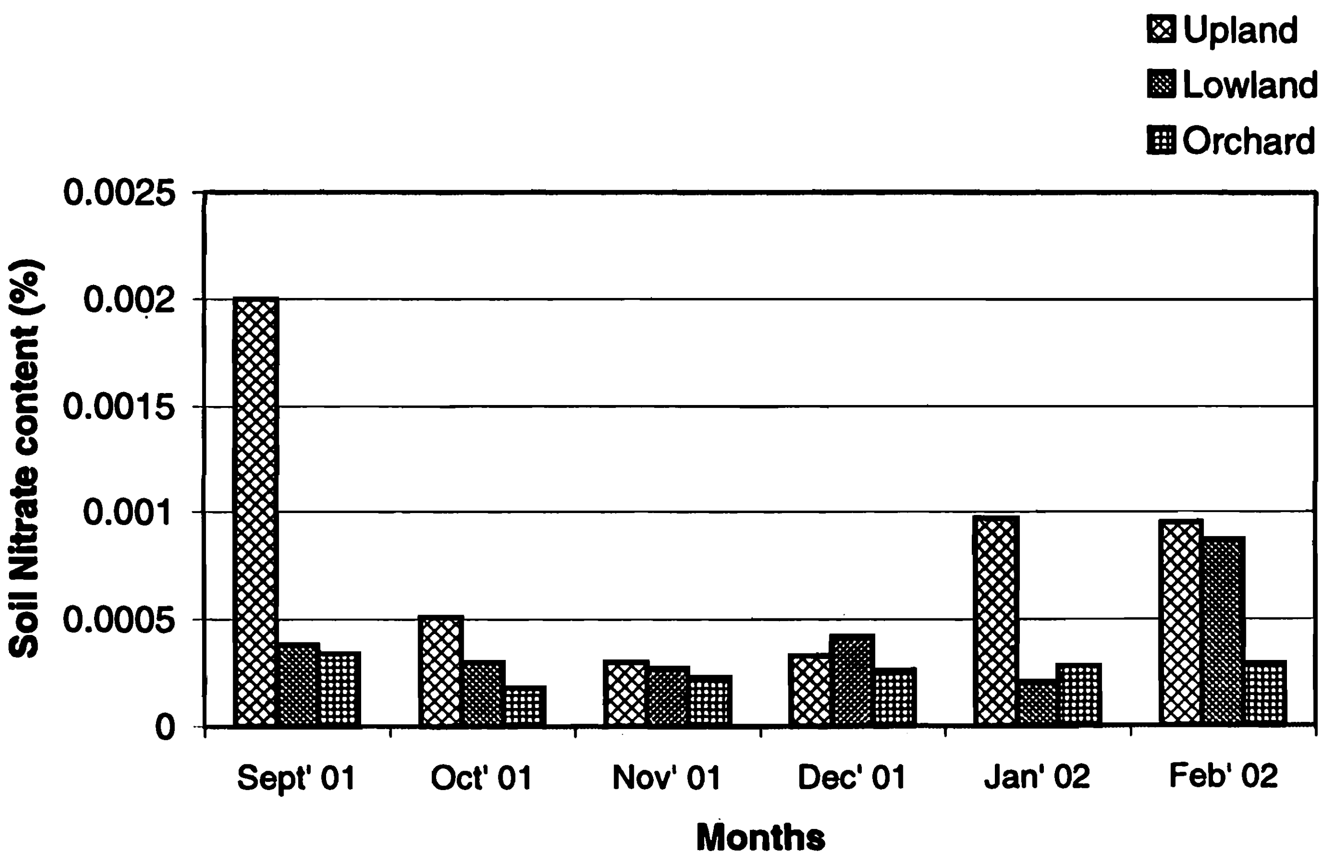

Fig. 10. Showing soil nitrate content range in six months in all three sampling sites (Sept'01 to Feb'02).

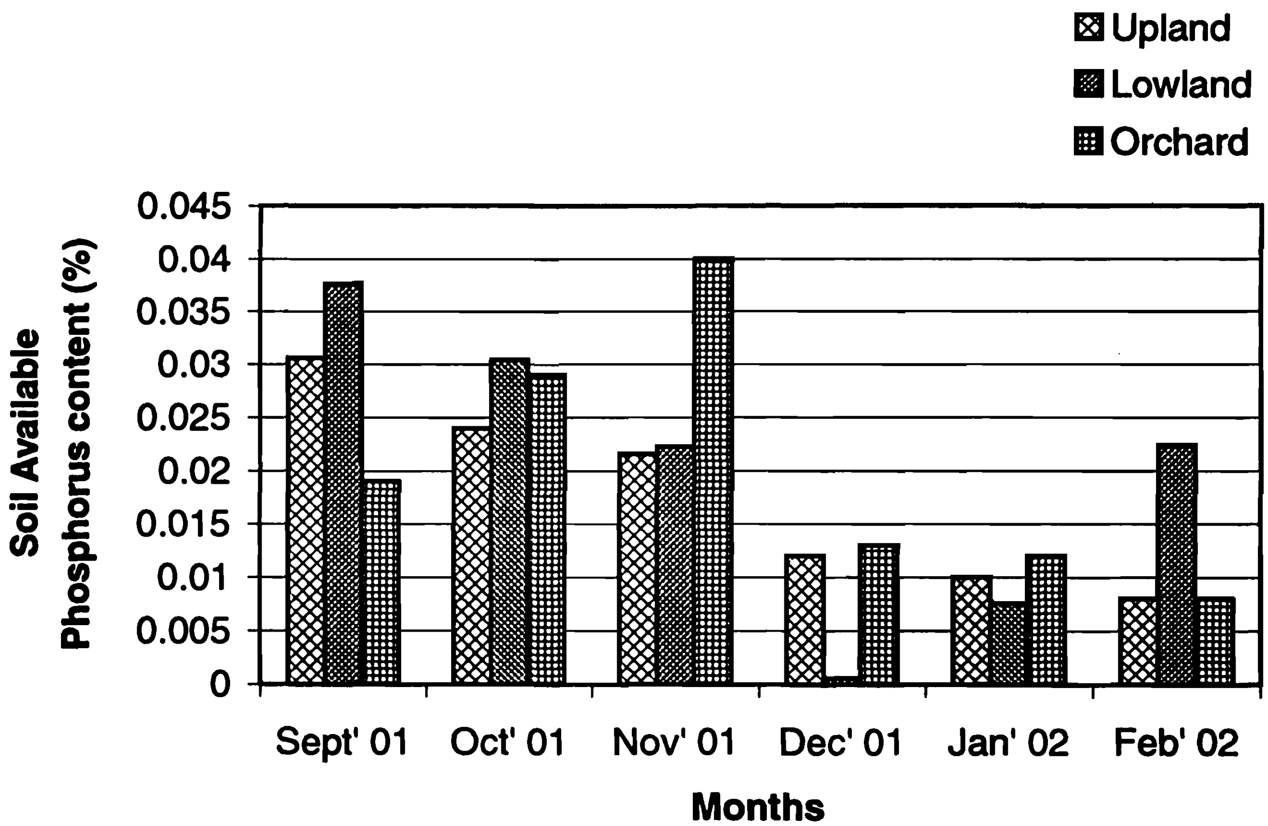

Fig. 11. Showing soil available phosphorus content range in six months in all three sampling sites (Sept'01 to Feb'02).

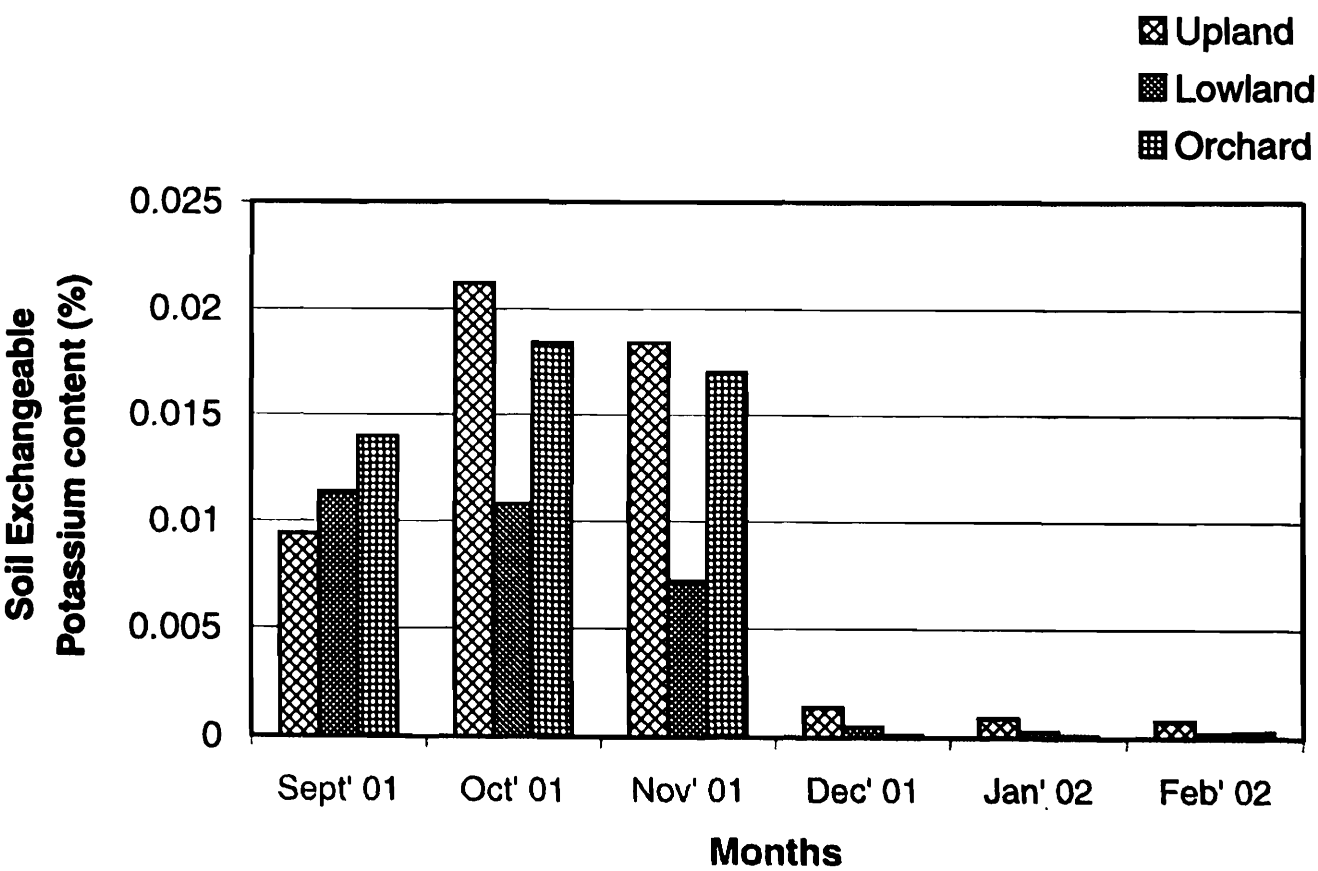

Fig. 12. Showing soil exchangable potassium content range in six months in all three sampling sites (Sept'01 to Feb'02).

STATISTICAL ANALYSIS

The data involving different edaphic factors and population of mites were subjected to statistical analysis separately for each site in order to find out correlation between them.

The correlation coefficient values between the total number of mites and the soil factors and in between the soil factors for each site were determined. The results of all these analysis are summarized in Tables 11–13.

Tables 11–13 showed relationships between mite population and soil factors at different sampling sites, which indicated negative relationships of mite population in all the three sites with soil moisture, temperature, pH and exchangeable potassium having significant values in case of moisture in sites I and III, temperature in site III, pH in sites II & III and exchangeable potassium in site III only. Soil conductivity showed nonsignificant negative correlation in sites I & III and in site II it was positive but nonsignificant. Available phosphorus was found to show nonsignificant negative correlation in sites I & III and nonsignificant positive correlation in site II. The values of correlation coefficient between organic carbon and nitrate and mite population showed positive relationship which was significant in all the sites for organic carbon and only in site II it was significant for nitrate.

Table 11. : Correlation between different parameters and also between different parameters vs. population of mites in Site-I.

MITE POPULATION	1.000								
SOIL MOISTURE	–0.853*	1.000							
SOIL TEMPERATURE	–0.333	0.571	1.000						
SOIL pH	–0.770	0.462	0.281	1.000					
CONDUCTIVITY	–0.090	–0.038	–0.591	–0.183	1.000				
ORGANIC CARBON	0.968**	–0.776	–0.355	–0.826*	0.104	1.000			
NITRATE	0.422	–0.561	–0.567	–0.108	0.541	0.529	1.000		
AVAILABLE PHOSPHORUS	–0.657	0.856*	0.886*	0.407	–0.453	–0.665	–0.761	1.000	
EXCHANGABLE POTASSIUM	–0.128	0.350	0.888*	0.293	–0.871*	–0.230	–0.512	0.729	1.000
	MITE POPULATION	SOIL MOISTURE	SOIL TEMPERATURE	SOIL pH	CONDUCTIVITY	ORGANIC CARBON	NITRATE	AVAILABLE PHOSPHORUS	EXCHANGABLE POTASSIUM

Table 12. : Correlation between different parameters and also between different parameters vs. population of mites in Site-II.

MITE POPULATION	1.000								
SOIL MOISTURE	–0.649	1.000							
SOIL TEMPERATURE	–0.209	0.384	1.000						
SOIL pH	–0.816*	0.789	–0.023	1.000					
CONDUCTIVITY	0.426	–0.731	–0.237	–0.484	1.000				
ORGANIC CARBON	0.828*	–0.735	–0.134	–0.911*	0.208	1.000			
NITRATE	0.832*	–0.438	–0.446	–0.540	0.500	0.477	1.000		
AVAILABLE PHOSPHORUS	0.457	0.065	0.701	–0.393	–0.170	0.392	0.097	1.000	
EXCHANGABLE POTASSIUM	–0.052	0.405	0.928**	–0.026	–0.413	0.005	–0.377	0.861*	1.000
	MITE POPULATION	SOIL MOISTURE	SOIL TEMPERATURE	SOIL pH	CONDUCTIVITY	ORGANIC CARBON	NITRATE	AVAILABLE PHOSPHORUS	EXCHANGABLE POTASSIUM

Table 13. : Correlation between different parameters and also between different parameters vs. population of mites in Site-III.

MITE POPULATION	1.000								
SOIL MOISTURE	–0.915*	1.000							
SOIL TEMPERATURE	–0.833*	–0.913*	1.000						
SOIL pH	–0.871*	0.644	0.559	1.000					
CONDUCTIVITY	–0.486	0.738	0.638	0.032	1.000				
ORGANIC CARBON	0.933**	–0.917*	–0.749	–0.837*	–0.515	1.000			
NITRATE	0.143	0.174	0.186	–0.610	0.737	0.173	1.000		
AVAILABLE PHOSPHORUS	–0.684	0.485	0.404	0.825*	–0.179	–0.628	–0.579	1.000	
EXCHANGABLE POTASSIUM	–0.859*	0.733	0.769	0.876*	0.100	–0.775	–0.412	0.870*	1.000
	MITE POPULATION	SOIL MOISTURE	SOIL TEMPERATURE	SOIL pH	CONDUCTIVITY	ORGANIC CARBON	NITRATE	AVAILABLE PHOSPHORUS	EXCHANGABLE POTASSIUM

Analysis of site wise intersoil-factors relationships (Tables 11–13) indicated that moisture had a positive relationship with temperature, pH, available phosphorus and exchangeable potassium in sites I & II but it was definite in case of available phosphorus in site I. In site III moisture showed definite negative relationships with temperature and organic carbon. Temperature indicated definite positive correlation with available phosphorus and exchangeable potassium in site I, in site II it was significantly positive with exchangeable potassium only and in site III these two parameters indicated positive but nonsignificant relationship. pH showed strong positive relation with organic carbon in all the three sites. In site III this factor also showed definite positive correlation with available phosphorus and exchangeable potassium. The relationship between conductivity and other factors indicated nonsignificant negative and positive correlations except exchangeable potassium, which indicated strong positive relationship with conductivity in site I. No significant relationship was observed between organic carbon and nitrate, available phosphorus and exchangeable potassium. The relationships between most of the factors and nitrate indicated nonsignificant negative or positive correlation in the three sites. Available phosphorus showed positive relationship with exchangeable potassium in the three sites but the values were significant in sites II & III.

DISCUSSION

In this investigation the studies on soil mites was made in an upland, a lowland and an orchard in the district of South 24 Parganas from where soil samples were collected at monthly interval over a period of 6 months (from September '01 to February '02). The plots under investigation were subjected to relatively moderate humidity, fairly moderate temperature and moderate amount of rainfall. The soil of upland under vegetable cultivation is more or less loam in texture, that of lowland under paddy cultivation is clay in texture and the orchard soil under banana and guava cultivation is sandy-loam in texture. Since all the sites were well vegetated, they supported a moderate population of soil mites.

The Cryptostigmatid fauna obtained from the 3 sampling sites taken together belong to 22 families, of which 8 families were found to occur in all the 3 sites. The analysis of population of the 8 common families showed that the genus *Scheloribates* occupied the topmost position in numerical abundance of the total population. The other 7 genera of the other 7 common families were *Oppia, Haplochthonius, Nothrus, Galumna, Epilohmannia, Xylobates and Archegozetes.* In the upland, *Scheloribates* was followed by *Galumna* and *Haplochthonius* in the second and third position respectively. In the lowland, *Scheloribates* occupied the top position followed by *Oppia* in the second and *Galumna* in the third position while in the orchard, *Xylobates* occupied the dominant position followed by *Scheloribates* which in turn was followed by *Oppia.* The genus *Scheloribates* was represented by two species–*S. thermophilus and S. praeincisus.* The occurrence of the genus *Scheloribates* as a dominant form in different sampling sites of Gangetic West Bengal was previously reported by the workers like Choudhuri and Banerjee (1977), Banerjee and Roy (1981), Ghatak and Ray (1981), Sanyal (1981 a) and Sanyal and Bhaduri (1982).

Among Astigmata, Acaridae family was found in all three sites. Among Prostigmata, Cheyletidae and Cunaxidae were dominant in the upland and orchard and Cheyletidae and Tydeidae were dominant in lowland. Among Mesostigmata, Uropodidae, Ascidae, Phytoseiidae and Rhodacaridae were the dominant families. The total population of mites was comparatively lower in the lowland than in any other sites (Table 9)

The population of soil mites exhibited quantitative and qualitative variations with change of season (Fig. 13). The fluctuation was not strictly regular in any of the three sites.

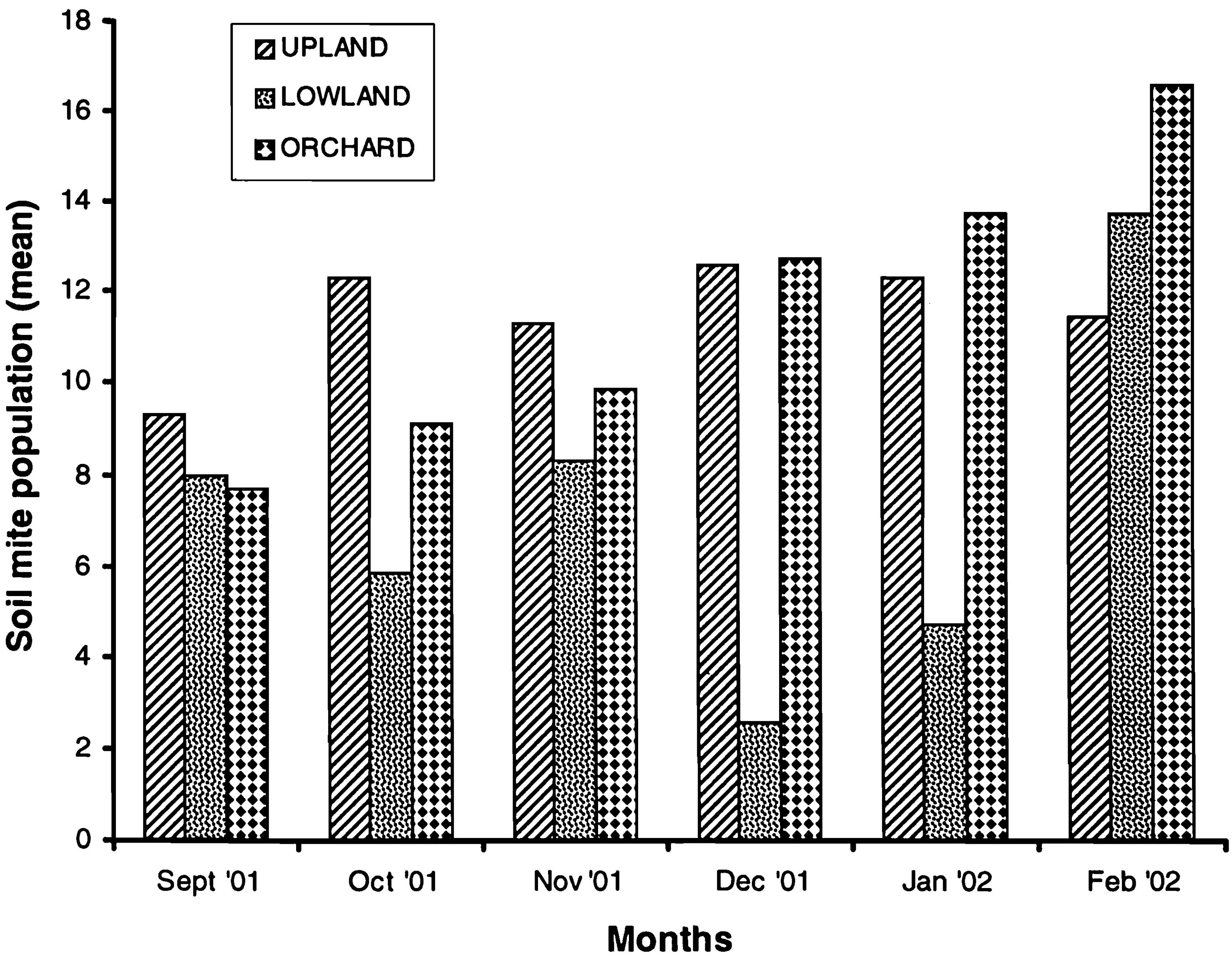

Fig. 13. Showing monthly variations in soil mite population in all three sites in six months. (September '01 to February '02).

In the upland the maximum population reached in December and minimum in September (Fig. 10). It was observed, that a tendency to increase in number, started from December when a peak of mite population was reached. The occurrence of minimum population during September may be due to the fact that the application of agricultural practices (ploughing and irrigation) and water logging due to heavy shower caused disturbances in soil texture. The occurrence of minimum population in September in orchard was also due to the same reasons. In the case of orchard, temperature of soil revealed a strong negative correlation with the mite population. In the case of lowland, the maximum population reached in February as in the case of orchard, when the lowland plot was left undisturbed. It was observed, that a tendency to decrease in number of mites in lowland started from September and in December the number of mites was least. From December again there was a gradual increase in number, which reached the peak of mite population in February. The minimum population in December may be due to the fact that sudden heavy rainfall caused water logging of pore spaces and subsequent poor aeration leading to a probable increase in mortality or migration of mites elsewhere. High population in winter months was reported by Sengupta and Sanyal (1991), Hatter *et al.,* (1992) and Sanyal and Sarkar (1993). Monsoon minima of mites were observed by Sarkar (1990) in some sampling plots of Tripura. Recently Sanyal *et al.,* and Chattopadhyay and Hazra (2000) showed post monsoon maxima in uncultivated fields of West Bengal.

The moisture content of soil all 3 sites showed a relatively moderate range of variation. In the lowland, in December the population fell drastically due to a sudden heavy shower for a couple of days leading to increased mortality or migration of mites elsewhere. For the rest of the 5 months of sampling (i.e. except December) soil moisture did not seem to have any significant correlation with mite population. However, the study revealed that a general rise in soil moisture content led to a fall in mite population of this plot. In the case of upland and orchard, soil moisture showed a rather significant negative correlation with mite population. The capacity to withstand the condition of drought or desiccation as well as higher moisture level may vary from species to species, which might be considered as a probable reason for population fluctuation. In this study, the monsoon month of September witnessed a lean population when the moisture level was appreciably high while winter samples supported a higher population when the moisture content was moderate. It can therefore be assumed that soil moisture, which is dependant on rainfall, percolation, evaporation etc., may exert significant effect on mite population atleast in these two cases. Workers like Hammer (1953), Dhillon and Gibson (1962), Choudhuri and Pande (1982), Sarkar (1991) and Sanyal and Sarkar (1993) observed negative correlation of soil moisture with mite population.

In the present investigation the pH of the soil samples did not exhibit a very wide range of variation, it was as low as 6.4 in orchard and as high as 7.5 in lowland. This range of pH is believed to be well within the tolerance range of most of the species as reported by Choudhuri and Banerjee (1977) and Sanyal (1994). Statistical analysis revealed that pH in the case of upland had very little to do with the fluctuation of the population of the soil mites though in general it is seen that lower pH leads to an increase in the population and this case was also not an exception to this general idea. In the case of lowland and orchard statistical analysis revealed a significant negative correlation of pH with soil mite population. This is further evident from the occurrence of a lean population in the samples with higher pH. Sanyal (1994) in his review also reported significant negative correlation of pH with Oribatid population and suggested that higher pH may have inhibitory role on population increase.

Conductivity had very little to do with the fluctuation of soil mites in all three sampling sites. It was observed that a high level of conductivity decreased the population of mites in upland and orchard but the case was just the opposite in lowland where a high level of conductivity increased the mite population.

In all the 3 sampling sites organic carbon content of soil showed relatively wide range of variation and exhibited a very strong positive correlation with population. Organic carbon being the most important constituent of soil organic matter, any increase in the percentage of organic carbon obviously leads to a greater organic matter content. Therefore it can be concluded that soil organic matter exerts direct and indirect influence on mite population through its effect on vegetation and various soil conditions such as soil temperature, moisture holding capacity, soil reaction and microbial population, etc. Again the feeding habit of mites also suggests their dependence on the availability of the organic matter. Therefore, it appears that organic matter as a source of potential food may exert direct or indirect influence on soil mite population.

Nitrate though acts as an attractant for the arthropods showed no significant correlation with mite population in this investigation of 3 sampling sites. A weak positive correlation existed between the mite population and nitrate content in all the 3 sampling sites. Available phosphorus showed no significant correlation with mite population whereas exchangable potassium exhibited a significant negative correlation with mite population in the case of orchard soil.

Thus, it can be said that a general rise in organic carbon content and nitrate content led to a rise in mite population in all 3 sampling sites and a general rise in soil moisture, soil temperature, pH, potassium led to a fall in mite population in all 3 sampling sites. The factors like conductivity and phosphorus were variously correlated to mite population of the 3 sites showing weak negative correlation with mite population in 2 of the 3 study sites.

Finally, it can be concluded that the mites which were dominant in each of the 3 sampling sites can be effectively used as bio-indicators of soil quality. These dominant mites are tolerant species as they can effectively withstand a wide variety of soil conditions unlike those species which are found less in number due to their death or migration elsewhere under adverse soil conditions or environmental stress conditions. Here it may be mentioned that during sampling a large number of Mesostigmata mites have been found which are very rare in India and have not been identified till date since almost no work has been done on these mites.

SUMMARY

The paper contains results of a study on "Bio-monitoring of soil quality in agroecosystem with mites as indicator" The study was carried out in an upland where cabbage, tomato, chilly and brinjal were cultivated, in a lowland under paddy and pumpkin cultivation and in an orchard of guava and banana trees at Narendrapur, in South 24 Parganas district, West Bengal. From each plot a total of 42 samples were drawn at monthly interval over a period of 6 months (September '01 to February '02).

Soil factors studied were soil moisture, soil temperature, soil pH, conductivity, organic carbon content, nitrate, available phosphorus and exchangeable potassium. These parameters varied seasonally and also sampling site wise variation was observed.

The Cryptostigmatid fauna obtained from the 3 sampling sites taken together belong to 22 families, of which 8 families were found to occur in all the three sites. In order of dominance *Scheloribates* came first being followed by *Galumna* and *Haplochthonius* in the upland and by *Oppia* and *Galumna* in the lowland. In the orchard *Xylobates* was the dominant form followed by *Scheloribates* and *Oppia.* Among Astigmata, Acaridae family was found in all the 3 sites. Among Prostigmata, Cheyletidae and Cunaxidae were dominant in upland and orchard and Cheyletidae and Tydeidae were dominant in lowland. Among Mesostigmata, Uropodidae, Ascidae, Phytoseiidae and Rhodacaridae were the dominant families. The total population of mites was comparatively lower in the lowland than in any other sites.

The mites in upland exhibited maximum population in December and in lowland and orchard the maximum population was exhibited in February. In upland and orchard the population was at the minimum level sometimes in December. In the winter months (December and February) both the soil moisture and the soil temperature were moderate and organic carbon content was fairly high and supported a larger population in all 3 sites.

Of all the soil factors studied in all the 3 sites organic carbon content was the only factor which showed a very significant positive correlation with soil mite population in all 3 sites.

The relation of moisture with population though negative in all 3 sites was weak in lowland but significant in upland and orchard. pH had a negative correlation with population in all 3 sites but it was weak in upland and significant in the other two sites. Conductivity had a weak correlation with population in all 3 sites–positive weak correlation in case of lowland and negative correlation in the remaining 2 cases. The relation of nitrate, phosphate and potassium with population are decided mostly by local conditions (*viz.* rainfall, fertilizer application and other agricultural practices).

This study further revealed, in the light of earlier studies, that cumulative influence of different soil factors on population were most important than influence of a particular factor. The slight differences observed in faunal makeup as well as in seasonal variation might be due to prevalence of local microclimatic conditions and agricultural practices.

Thus, from this study it may be assumed that since mite population fluctuates with changes in soil factors and thus with soil quality, the population load of mites and species diversity may be considered as indicators of soil quality.

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