Chapter 5

POPULATION DYNAMICS OF SOME OF THE MAJOR/MINOR TEA PESTS
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5.1 INTRODUCTION

In nature, it is often observed that certain group of organisms continue to increase under a set of favourable environmental conditions, but in the face of sudden or violent changes in the environmental conditions due to some exogenous substances (like pesticides or other agrochemicals), or in the biological characteristics of the organisms, the population start declining. The individuals comprising the population may of course die naturally without facing the vagaries of weather/agrochemicals, but frequently such changes in population follow an orderly growth and decline, giving the impression of cyclic oscillations of population (Watt, 1962; 1968).

To evaluate the innate relationship between the population and its environment, it is most essential to fully appreciate the biological characteristics of the species. This requires a thorough knowledge of behaviour, habitat, life cycle of the species, and the interrelationship between the various systems that make the population a viable unit in time and space (Banerjee, 1986).

A population system is perhaps best be perceived as a dynamic entity, in which input is natality, and mortality is the output. Both these opposite, yet interdependent forces, under the influence of environment at biotic and physical levels tend to keep the population in a steady state, but deviations cause oscillations (Banerjee, 1986).

A study of the population size and seasonal fluctuation/oscillation of the pests are essential to monitor their growth and multiplication in the tea fields. Once found to occur above the threshold level assuming the status of major pest, they warrant attention and requires application of the plant protection chemicals.
Keeping the above in view, in the present study, the population size of the tea pests, their seasonal fluctuation/oscillation etc. were studied under the Barak valley conditions.

5.2 REVIEW OF LITERATURE

It is difficult to visualise a natural population outside the context of its numerical abundance, spatial distribution and natural decline, all of which are mutually dependent. Divergent opinions have been expressed about the mechanisms of population regulation, and the state at which population exists in nature. Nicholson (1957) believes that insect population stay in a state of equilibrium, depending on the climate and physical conditions. However, they do oscillate around this level. Though essentially agreeing with this concept, Richards (1961) advocated a cautious approach to avoid over simplification of the rather complex process of maintaining an equilibrium density. Solomon (1949), Andrewartha and Birch (1954) and Milne (1962) believe in varying degrees that population and environment must go hand in hand in developing a conceptual framework, though they hold divergent views on the scope, definition and limitation of various processes involved in the regulation of insect numbers. Clark et al. (1968) have introduced the concept of life system in population studies and have discussed at length its importance in the practical control of the pests. The life system is essentially an expression of the innate relationship between population and environment, both biotic and physical, in their totality. There is, however, little doubt that innumerable factors interact to influence the survival and growth of a population, albeit, disagreements about the factors that are of mere consequence than others in influencing the dynamics of population (Banerjee, 1986).
An extensive knowledge about the distribution and abundance of pests is required before the long term control measures is suggested (Banerjee, 1981). Considering the wide importance of population studies, Morris (1960) suggested that analytical studies should be extensive when they concern only the distribution of the species over a larger area, or prediction of damage and control measures. Intensive studies, on the other hand, should involve population studies within the same area over a long time range. Such studies have considerable fundamental importance in so far as the construction of life tables, energy budgets and productivity studies are concerned (Banerjee, 1979). Watt (1961, 1964) demonstrated that mathematical models can be utilised, aided by computers, to optimise the management procedures and strategies in biological and insecticidal control of pest species.

Till mid-nineteen sixties, no fixed yardstick was available to the tea industry to measure the loss in tea crop due to pests and diseases in terms of production, monetary units etc., though it was well known that pests and diseases cause considerable loss (6-14%) to tea crops in north east India. Information has also been lacking on the incidence pattern of the important pests and diseases of tea in the different soil and agro-climatic regions of north east India (Sen, 1964). This is, therefore, a necessary and inevitable prerequisite for making any recommendations with regard to pesticide requirements and their application in a region.

Having huge acres of land under the cultivation in North Eastern India, having sizeable acres of land under each garden having innumerable bushes, it is physically impossible to do bush by bush count and therefore a method of using a smaller representative area has become a necessity. While adopting statistical concepts, reliable sampling methods have been developed by the workers over the years which
not only give the sampler a definite plan to work but also gives some idea about the usefulness of a particular sampling type (Sen, 1966).

It is an established fact that pest and diseases cause loss in tea crops in North East India. In order to minimise the loss through the incidence of pests and disease, it becomes necessary to control them by adopting proper plant protection measures. But to take appropriate precautionary measures, an idea about the local incidence and seasonal distribution of pest and diseases in the recent past is essential. It is fairly well known that the incidence and intensity of attack varies widely from district to district and within district, it varies with the variation in climate, elevation and jats/clones of tea used (Sarkar, 1967). However, it is difficult to establish a direct cause and effect relationship between rainfall pattern and pest activity because the effects of environmental factors on pests are usually well confounded (Banerjee, 1972).

The seasonal variation of different pests on tea was studied by various workers. Das and Kakoty (1992) studied the seasonal variation of Aphid population in young and mature tea. Colonies of aphids (Toxoptera aurantii, Boyer) are found on tea flushes and are seen on young plants and bushes recovered from pruning. As a result of Aphid infestation, leaves curl up and shoot growth is stunted (Muraleedharan, 1991). Although the damage caused by them is less severe, they cause considerable damage to the young leaves by sucking the sap, which results in overall deterioration of the quality of made tea.

The tea leaf roller (Gracillaria theivora, Wlsm) is commonly seen in large numbers in the fields recovered from pruning. The young caterpillars mine into leaves while the older larvae roll the leaves from tip downwards and feed from inside (Muraleedharan, 1992).
Thrips is a major tea pest all over India. The damage is caused to tender leaves and stems by laceration and sucking the juice which oozes out from the damaged tissue. The initial symptom of attack is long, paired brownish spots on the rolled leaves of the bud. Later on, two or more sand papery lines of corky tissue appear on the ventral surface of leaves. Badly damaged leaves appear rough, deformed and may curl up. The damaged shoots remain stunted in growth with corky tissue on the bark (Gope, 1991).

Mites are serious pests in all the tea growing countries. They cause damage to the green tissues of leaves thereby reducing the photosynthetic efficiency of plants, resulting in yield reduction (Muraleedharan, 1992). The red spider mite (*O. coffeae*) causes extensive damage to the tea in most of the countries of South East Asia, India, Africa and Sri Lanka. Ma & Yuan (1976) reported several outbreak of this species in Fukien area of China.

The red spider mite was discovered in Assam in 1868, but by 1880, it became so widespread and assumed such a serious proportion that an expert was appointed to investigate into this problem (Watt and Mann, 1903). From 1881, it has increased in alarming proportion and has spread to almost all the districts of Assam wherever tea is grown and is now regarded as the most widely distributed and destructive pests of tea in north eastern India (Das, 1963) including Barak Valley.

It is well known that the damage caused by red spider mite is characterised by reddish brown spots which develop at the point of feeding, which ultimately turn the entire leaf into ruddy bronze; it is therefore possible to assess the relative extent of damage by these mites (Sarkar, 1977).
A population study involving distribution and incidence of some of the tea pests (like aphids, thrips and red spiders) on different tea cultivars (i.e., TV1, TV18, TV 25 and TV 26) was conducted in their respective habitat by Sannigrahi and Mukhopadhyay (1993). The pest incidence was also correlated with weather factors like maximum and minimum temperature, humidity and rainfall, whereby they observed significant correlation between pest population and weather factors.

The significance of termites in soils is related to their population and the role they have in decomposing and transforming the mineral and organic components of soils and plants (Drummond, 1888, Ratcliffe et al., 1952). However, the infestation caused by live wood eating and scavenging termites in most of the tea estates of Barak Valley has created a perilous situation for the tea plantations. In contrast to the wealth of quantitative information on the population of other soil animals (like earthworm, mites and collembola), in a wide variety of habitat, the little available information on termite is largely qualitative, i.e., population is roughly estimated on the basis of counting the termite mounds. The work of Kozlova (1951) in Central Asia, Sands (1965a) in West Africa were based on qualitative estimation of termite occurrence/abundance in their respective places.

Environment invariably influences growth and multiplication of all the insect species in general and severity of infestation caused by pests in particular. It constitutes various factors such as climate, soil, topography, diseases, natural enemies etc. Amongst all these, climate, which is the complex meteorological factor prevailing throughout the year exert great influence on the organisms. These factors are mainly rainfall, temperature, atmospheric humidity, soil moisture, sunshine hours and wind (Das 1957).
Environmental factors do not however, act in the same way on all insects; certain conditions may adversely affect some species, while these may encourage the growth and multiplication for others (Das, 1957).

5.3 MATERIALS AND METHODS

5.3.1 Population estimation of few major/minor tea pests

5.3.1.1 Aphids (*Toxoptera aurantii*, Boyer): The methods followed here is the modification of the method described by Das and Kakoty (1992).

Sample blocks comprising 100 bushes were selected in plots each containing separate plantations of a particular type of tea variety (i.e., TV 1, 18, 20, 22, 23, 24, 26, 27, 28 and 29). Infested twigs at three concentric circles (i.e., inner, middle and outer) of each bush were separately plucked and the population of aphids there in was counted. The observation was done at fortnightly interval and the mean of two observations in a month was taken to find out the average population for that particular month.

5.3.1.2 Leaf roller (*Gracillaria theivora*, Wlsm): The methods followed here was same as that followed in case of Aphids. Sample blocks comprising 100 bushes were selected in plots, each containing blocks of separate tea variety. Infested twigs at the three concentric circles (inner, middle and outer) of each bush were separately studied to estimate the population therein. The observation was done at fortnightly intervals and the mean of two observations in a month was taken to find out the average population for that particular month.
5.3.1.3 Thrips (*Scirtothrips dorsalis*, Hood): For estimation of the population of thrips, the following method was adopted.

A young twig (two leaf and a bud) was plucked and kept inside a plastic vial (5.5 cms x 8.8 cms) covered with lid. The collected specimens were brought to the laboratory and a piece of cotton wool, soaked in ethyl alcohol was placed inside the vial to make the thrips senseless for counting. For sampling, 50 bushes (*Ooman, 1982*) were selected at random during 1996-97. All the samples were carefully transplanted under cool conditions to laboratory and counted under binocular microscope. The densities were expressed as a number of individuals (including adult and larvae) per twig. Throughout the study (i.e., from February, '96-January, '97), the sampling of twigs was done in afternoon hours at fortnightly intervals. Care was taken against dislodging of insects while handling the plant parts (i.e., young twigs) for sampling. Mean of the two observations taken in a month was calculated to find out the pest population for a particular month.

5.3.1.4 Red spider mite (*Oligonychus coffeae*, Nietner): A sample survey was carried out to estimate the mean infestation caused by red spider mite. The objective of this survey was to estimate the following parameters periodically.

A Incidence of red spider mite infestation, and

B Estimation of the population of red spider mite present in the individual leaf.
A. The incidence of red spider mite was estimated by the systematic sampling method. In this method, one bush was selected at random from amongst the first five bushes of a row. If the 4th bush was selected, then subsequent bushes in the sample were 4+5=9th, 9+5=14th etc. and so on.

Systematic sampling has been found to be more efficient over simple random sampling and stratified random sampling. Systematic selection of the bushes along the row is convenient in the field conditions, moreover, it is relatively easy to organise and supervise, which in turn ensure greater accuracy (Sarkar, 1977).

In the method of estimation by systematic sampling method, the following scoring method as used by Sarkar (1977) was adopted:

- 0 = No infestation (Uninfested)
- 1 = Less than 25% of the leaves affected (Mild)
- 2 = 25 - 50% leaves affected (Mild-Moderate)
- 3 = 50 - 75% leaves affected (Moderate-Severe)
- 4 = 75 - 100% leaves affected (Severe).

B. In the next phase of counting the number of mites present in the leaves, five leaves, each from the infested bushes was plucked. These five leaves were plucked each from the east, west, north, south and one from the centre of the bush. Then, the number of red spiders present in individual bushes were numerically calculated. This observation was carried out in the Bagla experimental plot of TRA, Silcuri (Assam).
Incidence of red spider mites and their population estimation was done at fortnightly intervals. Mean of the two sets of data was calculated to find out the population for that particular month.

5.3.1.5 Termite: In an attempt to estimate the termite population in mounds, two separate methods have been used by the different workers as follows. I) The whole mound was sampled and the total population, or an estimated proportion was counted, and II) a sample was taken from the mound and the termites were counted in the sample. Whole mound sample was used by Holdaway et al. (1935), Gay and Greaves (1940), Maldague (1964), Bouillon and Mathot (1964) and Gay and Wetherly (1970). The second method was used by Hartwig (1956) and Sands (1965b).

All the works as mentioned above had taken the mound as a whole unit, and the whole/portion of termite populations were counted thereof. Since the population estimation in the present work is in the perspective of tea plantations, therefore, in this case, the entire tea bush was taken as an unit as a whole, and two separate methods were used for counting the termite population. These were, I) in stem (under the earthrun) and II) in the collar region (under the surface soil). For this purpose, five heavily infested bushes were selected at random and estimation of termite population for both stem and collar region were done from the same bush as per the methods given below.

I) For stem region: Aqueous solution of the fumigating agent, Methyl-iso-butyl ketone was made in the ratio of 1:10. This chemical solution was sprayed on the termite infested bushes with the help of a hand-sprayer. The chemical has got a
quick knock-down effect. The bush was then shaken vigorously for 2 to 3 minutes. As a result, the termites got detached from the bushes and fell at the collar region, where a big-sized card board encircling the collar region of the bush was placed. These termites were then collected and numerically counted. The total number of termites collected were put together to estimate the total population.

II) For collar region. For counting the population of termites in the collar region, the weeds around the collar region were removed and light forking was done to a depth of five centimetres. Aqueous solution of the same fumigating agent was subsequently sprayed on the forked soil, where termites start roaming due to disturbing the soil in the collar region. As a result of this spraying, the movement of the termites was stopped. The termites, along with the soil was then collected on a big sized card-board, and the soil was cleared by hand sorting. The termites that remained on the card board were then counted numerically.

5.3.2 Environmental influences on seasonal variation of the pests

Observations were made to find out whether the seasonal variation in infestation of the pests (aphid, leaf roller, thrips, red spider mite and termite) has any correlation with the environmental factors, i.e., maximum and minimum temperature, morning and afternoon humidity and rainfall.

5.4 RESULTS

5.4.1 Aphids

The aphid population in the three concentric circles (i.e., outer, middle and inner) of all the tea varieties mentioned were separately recorded. The mean was then
calculated to find out the average pest population per bush. The observation from January to December, '95 revealed that maximum aphid population was in the outer most circle, followed by middle and inner most circle. During the bud breaking period, (i.e., January/February), highest number of aphids were observed, and that too, in the outer circle (Fig. 5.1). This observation was in conformity with the findings of Anon, TRA, (1967), and Das and Kakoty, (1992).

The range of infestation of Aphids (Toxoptera aurantii, Boyer) has been compared along with various environmental parameters (Fig. 5.6). Among all the parameters, rainfall was found to influence the incidence/severity to aphid infestation. This is particularly true during early part of the season (i.e., January - April), whereby due to gradual increase in monthly precipitation, new shoots started flushing. These new shoots are the most favourable niche for aphids for sucking the juices and to start forming new colonies.

The aphid infestation started declining with the gradual increase in humidity. From September onwards till December, 1995, there was a steady increase in morning humidity (95% in September, 1994 to 98% in December, 1995) and during this period, there was a steady decline in the infestation caused by aphids.

5.4.2 Leaf roller

The leaf roller population in three concentric circles (outer, middle and inner) of different tea varieties revealed that maximum population of the pest was concentrated in the inner and middle circle. In the outermost circle, however, comparatively fewer number of the pest was observed to occur during the months of
Fig : 5.1 SEASONAL VARIATION IN APHID (*Toxoptera aurantii* Boyer) IN DIFFERENT MONTHS & IN ZONES OF THE TEA BUSHES

Fig : 5.2 SEASONAL VARIATION OF LEAF ROLLER (*Gracillaria theivora*) IN DIFFERENT MONTHS AND IN ZONES OF THE TEA BUSHES
observation. This observation suggests that young leaves in the inner and middle region of bush canopy are more prone to leaf roller infestation (Fig. 5.2).

Amongst all the environmental factors, rainfall was found to have an inverse relationship with the leaf roller infestation. From August, 1995 onwards till December, 1995 with the gradual reduction in precipitation there was a gradual increase in leaf roller infestation (Fig. 5.7).

5.4.3 Thrips

Thrips population was observed almost throughout the year with a variation in their seasonal abundance. During the bud breaking seasons (i.e., February and March, '96) maximum population was observed (per 50 twigs 66 thrips in February, '96 and 60 in March, '96) while in April, there was little reduction (i.e., 42/50 twigs) followed by a rise in May (56/50 twigs) and June (50/50 twigs). From the month of July onwards, with the onset of heavy rain, thrips population in the studied areas started declining, giving an impression that the pest species was perhaps washed down due to heavy shower. From November till January, the population of thrips took an ascending trend, suggesting that cold weather favours their growth and multiplication (Fig. 5.3).

Rainfall was observed to have an inverse relation with the incidence of thrips in tea fields. This was most prominent during the periods from May to October. From November onwards with the reduced monthly precipitation, the pest population had an increasing trend (Fig. 5.8). In the present observation it has been found that thrips in general, occur more during the months of reduced ambient temperature (i.e., January to March).
5.4.4 Red spider mite

A. Among the 67 tea estates of Barak Valley in which the survey to assess the severity/damage due to red spider infestation was carried out, it was observed that the infestation persisted almost throughout the year with a wide range of variation. During the peak period of incidence, it had been observed that the degree of infestation was mild in 10% of the tea estates, all under separate sub areas of the growing regions of Barak Valley, while mild to moderate infestation was found in 22% of the tea estates. Moderate infestation was also observed in the sizeable number (21%) of tea estates. Moderate to severe, as well as severe infestation was found to occur in comparatively fewer number of tea estates (6% each) (Fig. 5.4).

However, the degree of infestation was observed to be highly variable from season to season in general and from year to year in particular. No generalisation can be made as far as the severity of infestation in the valley is concerned. The cultivation practices including the management of pest problems also contribute to a great extent on the variation in occurrence of the pest population concerned.

B. The seasonal variation in population of red spider mite was observed from January to December. The observation revealed that from January onwards till June, the population of red spiders gradually increased. While from July onwards, the population started declining and this trend continued till December (Fig. 5.5).

Temperature was found to be having a direct relationship with the infestation caused by the red spider mite, where an increase in population was observed with the increase of the ambient temperature. While rainfall was found to be having an inverse relationship. The infestation of the pest increased to its maximum during June,
Fig 5.4 DIFFERENT DEGREES OF INFESTATION CAUSED BY RED SPIDER MITE IN TEA ESTATES OF BARAK VALLEY

Fig 5.5 SEASONAL VARIATION OF RED SPIDER MITE (Oligonychus coffeae Nietner) POPULATION
Fig. 5.6 SEASONAL VARIATION IN THE POPULATION OF APHIDS (Toxoptera aurantii, Boyer) IN RELATION TO METEOROLOGICAL FACTORS
Fig : 5.7 SEASONAL VARIATION IN THE POPULATION OF LEAF ROLLER (Gracillaria theivora, Wlsm) IN RELATION TO METEROLOGICAL FACTORS
Fig: 5.8 SEASONAL VARIATION IN THE POPULATION OF THRIPS (Scirtothrips dorsalis, Hood) IN RELATION TO METEOROLOGICAL FACTORS
Fig. 5.9 SEASONAL VARIATION IN THE POPULATION OF RED SPIDER MITE 
(*Oligonychus coffeae, Nietner*) IN RELATION TO METEOROLOGICAL FACTORS
followed by a steady decline. Low infestation prevailed till December/January, which seems to be because of low temperature during that period (Fig. 5.9). However, the infestation again increased from February onwards.

5.4.5 Termite

In the population estimation study, it was observed that the termite population, although varied, but was present all throughout the year in stem and in the collar region of the bushes in general. However, higher population (i.e., 78 numbers per bush) was observed in the stem as compared to the collar region (i.e., 36 numbers per bush) during the peak period of infestation (i.e., November). In both the stem and in collar regions, the termite population was observed to have increased from September till February, with highest population observed during November. The population was observed to have declined from March onwards, till July (Fig. 5.10 & 5.11).

It was observed that an inverse correlation exists between population of termite with the soil moisture content. In the south/south-west facing slopes (i.e., hot slope) in particular during monsoon, with higher soil moisture, the termite population declined. The condition was reverse during the soil moisture deficit periods. (Fig. 5.10). This particular relationship was also observed in the north/north-east facing slope (cold slope) but to a lesser extent. (Fig. 5.11). This suggests that moisture stress in soil helps to increase the termite population, activity and infestation. These findings also suggest that irrigation during the above mentioned stress period should help to reduce the termite population/activity and at the same time should help to improve the control measures taken with the termiticides, by increasing their percolation efficiency.
Fig 5.10 LIVE-WOOD EATING TERMITE POPULATION IN RELATION TO MOISTURE STATUS IN SOUTH/SOUTH-WEST FACING (Hot Slopes) AREAS
Fig 5.11 LIVE-WOOD EATING TERMITE POPULATION IN RELATION TO MOISTURE STATUS IN NORTH/NORTH-EAST FACING (Cold Slope) AREAS
5.5 DISCUSSION

The pest population study in Barak Valley revealed that some of the pests exist much above the critical threshold level and their population per unit area very often has been observed to cause serious damage, thus creating an alarming situation. To this group, belongs the live wood eating and scavenging termite, the red spider mite and the thrips. On the other hand, there are some more pests, which are less abundant per unit area and obviously cause damage to a lesser extent. This group include the aphids, leaf roller, Helopeltis, stem borer, Green weevil and the like. Of both the categories, the seasonal population fluctuation of aphids, and leaf rollers, thrips, red spider mite and termite have been studied elaborately.

Aphids and leaf roller population was observed throughout the year in three concentric circles (i.e., inner, middle and outer) of the bush canopy. Highest aphid population was observed to be in the outermost circle, indicating that the newer shoots, whose tip very often occupies the outer circumference, harbour larger number of aphid colonies. This is in conformity with the observation of Das and Kakoty (1992). The leaf roller was, however, more numerous in the inner and middle circles, as compared to outer circles indicating that the pest had a preference to those areas.

Thrips incidence was observed almost throughout the year. However, during the period of bud breaking (i.e., January/February) they were seen in sizeable number. Gope (1991) reported that this pest causes major damage during early part of the season. In the study area, however, the pest population was observed to have started declining from June/July onwards, due to heavy precipitation caused by monsoon.
In the present study red spider mite population was recorded almost throughout the year. However, its peak period of population increase was between May to July and the second outbreak, (slightly less than the first) was observed during August/September. Due to heavy shower during June/July the population of red spider mite apparently seems to have declined, but in fact, it was observed that mites are washed down to the lower zones of the bush. Therefore, with the decrease in precipitation in subsequent months, their population again increases in the upper canopy of the bushes. Banerjee (1972) observed this particular ethological aspect of red spider mite and reported that reduction in the population of red spider mite per unit area may be true within a limit, but it must not be overlooked that a potential source of infestation continues to persist in the lower zone of the bushes. This is particularly true in the case of unpruned teas and in skiffed bushes under longer pruning cycle. The abundant foliage in the middle and in lower zone of the bushes can support a large mite population, perhaps more than what is washed down from the upper canopy. Rain does not appear to have as severe physical impact on the foliage in these zones as it has on the upper one, consequently, the mites that inhabit these zones avoid the direct impact of rain. This aspect of mite ethosis is particularly interesting because it is known that red spiders perform active movements all over the bush frame. It is therefore, possible that some mites avoid the rain by simply moving in to the middle and lower zones of the bushes.

The average red spider mite population/leaf throughout the year was between the range of 02 to 58. In most of the months, the average pest population per leaf was recorded well above the critical threshold value of 2-3 mites/leaf as
described by Banerjee, (1971). Highest population of red spider mite (i.e., 58/leaf) was observed during June. Mite numbers normally increase in summer when the ambient temperature is high and the population is reduced during monsoon; a second but relatively small increase may occur during the dry periods. The above mentioned observations of Banerjee (1975) is in conformity with the present study, where population of red spider mite was observed to have increased from February to June/July, thereafter declined and again slightly increased during September, after which the population took a declining trend. A general decline in pest activity from October onwards can be linked with the onset of dormancy of tea in North-east India (Baruah, 1969), though mites continue to persist in unpruned and skiffed teas in varying numbers.

The population of termite is mainly influenced by rainfall, that obviously reflects on the moisture content of the soil. Termites are found to be more abundant and active when the soil moisture remains at its low ebb (i.e., September to March). This was confirmed by studying seasonal variation in termite population in the stem and collar region of the plants and the soil moisture status. (Fig. 5.10 and 5.11). Therefore, in the water deficit/drought periods, irrigation is a must as this would help to reduce the termite population. Banerjee (1972) however, reported that it is difficult to establish a direct cause and effect relationship between rainfall pattern and pest activity, although the effects of environmental factors on pests are usually well confounded. Difference in moisture content in north facing and south facing slopes was also found to have direct relationship with the numerical abundance of termites. It has been observed
that in south/south-west facing slopes (hot slopes), termite population was higher as compared to the north/north-east facing slopes (cold slopes). Sivapalan (1975), Das et al. (1982) also reported similar observations on the increased termite build up on hot slopes in general and unshaded hot slopes in particular.
5.6 BIBLIOGRAPHY


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