Summary

VI. SUMMARY

A. POPULATION DYNAMICS

Population dynamics of the common sucking pests of tea plantation was studied for 3 years on two planting materials at two different elevations of Darjeeling hill slope.

1. The population trends of common thrips were more or less same both at mid (1200 m) and high (1650 m) elevations showing similar fluctuations on both the planting materials under study. However, the population density of thrips varied depending on elevation and planting material. Population continued to persist throughout the plucking season in all the 3-years of observation on the planting materials, china seed jat and T 78 both at mid and high elevations, but at varying intensity. The population started to build up during February – March in each season from the residual low population, which could survive the winter. The increasing trend in population continued and reached the first peak sometime by end of April or May. It was observed that growth of population was checked considerably when plucking started from March. However, the increasing trend continued and a sharp decline in population could be noticed only when monsoon started with heavy shower in June - July. The population count was always low if preceded by a heavy downpour. It started to increase again from mid or end of September and attained the second peak in October. The level of infestation during autumn was much lower than that of the spring and lowest during winter. All developmental stages of *M. setiventris* were observed throughout the year indicating overlapping of generations. Higher

level of population of common thrips was observed on china seed *jat* than the clone T 78 having some Assam character both at mid and high elevations. The population density was more at high elevation than that at mid elevation, indicating the preference of the thrips for china seed *jat* and a high altitude.

2. The combined effect of weather factors namely rainfall, maximum and minimum temperatures, morning and afternoon relative humidity and sunshine hours were found to contribute significantly to the variation of common thrips population. Rainfall had a negative influence on the thrips population in general, which was significant at mid elevation. But, both maximum and minimum temperatures had significant positive influence on common thrips population on both the planting materials at both the elevations. At mid elevation, the sunshine hours had a significant positive influence. In case of relative humidity, a negative trend of influence was observed except for the morning relative humidity on china seed *jat* at mid elevation, which was positive. But, the influence of relative humidity was not found statistically significant in any of the situations.

3. Other than the weather factors, it appeared that the growth habit of tea bushes with inter flush and long winter dormancy might have played a significant role in regulating thrips population, particularly during winter months.

4. Common thrips population continued even under pest control measures but at a much lower level. It was naturally controlled during summer months by

heavy rains and plucking, suggesting that no pest control measures were necessary during this period.

5. In case of greenfly, more or less a similar trend of population fluctuation was noticed both at mid and high elevations and on both the planting materials under study, which persisted throughout the year with varying intensity depending on elevation as well as planting material. But unlike thrips, the population of greenfly started to build up rather late from early June from the residual population, attaining its first peak by June end - July. The population declined between end August and early September, which started increasing again from end of September reaching its second peak In October. The level of greenfly population was lower during autumn surge than the first peak and was lowest during winter. A general trend of enhanced population of greenfly was noticed on tea clone T 78 than china seed *jat* at both mid and high elevation. The population of greenfly was found generally higher at mid elevation than high elevation.

6. The combined effects of weather factors were found to contribute significantly to the variation of the greenfly population. The individual weather factor namely, maximum temperature, minimum temperature, relative humidity in the morning and afternoon had positive and highly significant influence on the building up of greenfly population, but, sun shine hours had significantly negative influence on the greenfly population.

7. Greenfly is a pest of freshly growing tea shoots. Since in winter there is no active growth of shoots, this dormancy in tea might also be playing a

significant role in bringing down the greenfly population in winter. The residual population possibly survived on the few fresh shoots available on the tea bushes.

8. Under pest control measures, the greenfly population remained active at a much lower level than the untreated plots, particularly during peak period of infestation. Immediately after a pesticidal spray, the population got reduced considerably, but started to build up again. In total 5-6 rounds of spray were required to maintain the population below the economic injury level. During August and September the population was lowest even in untreated plots, and so insecticide spray was not at all necessary during this period. Weekly plucking of growing shoots and heavy rainfall might be responsible for keeping the population down.

9. The aphid infestation was very much sporadic and it's population never built up to attain the pest status at both the elevations on any of the planting materials studied. Only occasional colonies were observed on growing shoots when sampling was done. These colonies were noticed mainly during June to October and rarely in the early and end parts of the flushing / plucking season.

10. The combined effect of weather factors were found non-significant except in case of china seed *jat* at high elevation. However, rainfall appeared to have a significant positive influence on both the planting materials at mid elevation, but it was not significant at high elevation. Both maximum and minimum temperatures showed a positive significant influence in all the situations except for the influence of maximum temperature on T 78 at TRA CPS, which was

non significant. At mid elevation relative humidity in the morning and afternoon had significant positive influence on the aphid population of both the plating materials except that of morning humidity in case clone T 78 at mid elevation, which was not significant. Sunshine hours had a highly significant negative influence on aphid on both the planting materials.

11. In the pesticide treated plots, sporadic colonies of aphid could be noticed even during the rainy seasons. However, no insecticide was necessary from mid July to September end as aphid population was very low.

12. A comparison of the population of different sucking pests revealed that in spring the built up of thrips population was much earlier in all the four situations (elevation + planting materials) than the two other sucking pests, reaching the first peak during April-May. But greenfly reached its first peak slightly late *i. e.* in June –July, the time period, when thrips population started to decline. In autumn, mixed infestation of both the insects was noticed. The population of both the pests started increasing as soon as monsoon rains receded by end of September, reaching the peak infestation level in October. Aphid, in scattered colonies, was active mainly during rainy season when population of other two sap suckers remained at low level.

13. While thrips were generally confined to the unopened buds and the first leaf from top of a growing shoot, the greenfly was generally confined to the second and third leaves for better shelter. Hence, the coexistence of these two suckers during autumn flush was possibly without much of competition for food. When scattered aphid colonies started appearing both common thrips

and greenfly population had started declining.

14. No alternate host of common thrips was observed. Greenflies were found to attack *Camellia japonica, Ricinus communis,* and *Priotropis cytisoides* other than tea. Aphid occasionally attacked *Citrus medica.*

B. FEEDING IMPACT

1. Feeding by common thrips and greenfly improved flavour significantly which was confirmed by both organoleptic taste and biochemical analysis. Improvement in liquor character in infested tea was also confirmed by organoleptic taste as per Darjeeling tea standard. In case of overall quality, the tasters' scores were generally higher for tea made from infested shoots than that from uninfested shoots.

2. In biochemical analysis, a difference was observed in residual catechins in black tea made from thrips and greenfly infested and uninfested leaves. Major catechins were found to be higher in infested tea over uninfested one indicating the basis for genesis of greater flavour.

3. Caffeine was lower in case of tea made from thrips and greenfly infested shoots of both the planting materials, china seed *jat* and clone T 78.

4. Most of the Volatile Flavour Constituents (VFC) responsible for the flavour of made tea like linalool, its oxides and methyl salicylate were found to be higher

in case of tea made from thrips and greenfly infested shoots than their uninfested counterparts for both the planting materials. Moreover, the volatile, trans-2-hexanales which gives the grassy odour, not desirable for Darjeeling orthodox, was found higher in tea made from uninfested shoots than the infested one. So, infestation by these sucking pests, in general appeared to impart an enhanced flavour, much desired for Darjeeling orthodox tea.

C. NATURAL ENEMY

The natural enemies commonly recorded in the samples collected by D-Vac vacuum sampler from tea bushes of Darjeeling elevations during the productive season were: spider, preying mantid, lady bird beetle, green lacewing and brown lace wing. In addition, minute pirate bug and syrphid fly were also recorded by manual search. In general there was a higher incidence of population of these natural enemies in the tea plantations of mid elevation than that of high elevation at both bio-organically and conventionally managed gardens, except for brown lacewing, whose occurrence was higher in upper elevation. The spiders as a group had higher representation than the other groups of natural enemies in all the situations.

Highlights of the findings of the present investigation

1. Common thrips population is higher at upper elevation than the lower elevation and prefers china seed *jat* more than clone T 78 having some Assam characters, indicating that it prefers the more flavoury materials.

2. Greenfly population is more at lower elevation and on clone T 78 having some Assam-type-tea characters than at higher elevation and on China seed *jat.*

3. Aphid infestation on unprune tea in Darjeeling hills is sporadic and not generally attains the pest status.

4. The combined effect of weather factors namely rainfall, maximum and minimum temperatures, relative humidity at morning and afternoon and sunshine hours variably contribute to the fluctuation of population of these sucking pests. Generally individual weather factors like max. & min. temp. and sunshine show a significantly positive influence and rainfall a negative influence on thrips population. Max. and min. temp. also show a significantly positive and sunshine a significantly negative influence on greenfly population. By and large significant positive influence of max. & min. temperature, rainfall and relative humidity on aphid population is evident. However, the sunshine appears to influence aphid population negatively.

5. The population of common thrips, greenfly and aphid continues to persist under insecticide spray but at a much lower level.

6. During heavy rains of monsoon season population of these sucking pests reduces to the minimum and pest control measure does not seem necessary during this period.

7. Greenflies attack *Camellia japonica, Ricinus communi,* and *Priotropis cytisoides* in addition to tea in Darjeeling elevations. Aphid occasionally attacks *Citrus medica.*

8. Infestation of thrips and greenfly improves made tea quality in Darjeeling orthodox, hence the common belief of Darjeeling tea planters that the initial infestation by these pests improves quality is justified. But, whether this improvement in quality can compensate the crop loss or not by fetching higher price in the market remains a matter of further investigation.

9. The major groups of natural enemies active in tea estates of Darjeeling hills are spider, preying mantid, lady bird beetle, green lacewing and brown lacewing, minute pirate bug and syrphid fly. Out of which spiders are the most dominating group.