

THE RED SPIDER MITE AND THE SCARLET MITE OF TEA AND THEIR CONTROL

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Outbreaks of Red Spider Mite and Scarlet Mite followed a similar pattern and were found to be associated with seasonal changes, with peak populations occurring during the inter-monsoonal dry periods. In the case of the Red Spider Mite, there was a significant correlation between mite numbers and the previous month's rainfall, indicating that the optimum time for applying chemical control measures was one month after the commencement of the dry season. An experiment on loss of crop caused by mites showed that mite control is economically worthwhile on tea estates.

Of 16 acaricides evaluated for mite control, the best control of Red Spider Mite and Scarlet Mite was given by dicofol (Kelthane) and oxythioquinox (Morestan). The minimum doses of these acaricides required for economic control and their persistence have also been determined. Dinobuton (Acres) and tricyclohexyltin hydroxide (Plictran) are two new acaricides that gave excellent control of both species of mites, and need further testing.

Four species of mites are regarded as pests of tea in Ceylon. These are the Red Spider Mite (*Oligonychus coffeae* Nietner), the Scarlet Mite (*Brevipalpus californicus* Banks), the Yellow Mite (*Hemitarsonemus latus* Banks) and the Purple Mite (*Calacarus carinatus* Green). Of these, the most widely distributed are the Red Spider Mite and the Scarlet Mite. The main object of the investigations reported here was to determine the most suitable acaricides for controlling these two species of mites. Further, to determine the optimum time for applying chemical control measures, the incidence of mite outbreaks was also studied on six estates, with special reference to the relationship between mite outbreaks and rainfall. An experiment was also conducted to estimate the loss of crop caused by mites.

The Red Spider Mite and the Scarlet Mite are dry weather pests, as outbreaks usually occur during the intermonsoonal dry periods. Annually about 50,000 acres of tea are estimated to be attacked by mites, but only about 20,000 acres receive proper chemical control measures. The reason for this may be that mite damage is insidious and therefore not recognized during its early stages, but it is important to note that recurrent mite attacks will not only bring about a loss of crop, but also cause general debilitation through maintenance-leaf fall.

The reasons for the occurrence of outbreaks during the dry season were recently investigated by Fernando (1967) and Danthanarayana (1967), especially in regard to the Red Spider Mite. They found that fluctuations in mite numbers are associated with certain biochemical changes that take place within the leaf.

Red spider and scarlet mite outbreaks can also arise as side effects of pesticide applications. DDT applications against caterpillar pests and cabaryl (Sevin) spraying against scale insects can bring about increases of mite populations (Cranham 1964; 1965; 1966a). It is also known that copper-based fungicide applications against Blister Blight (*Exobasidium vexans*) stimulate the build-up of mite outbreaks (Venkata Ram 1963; Cranham 1966a and b).

Since red spider mite and scarlet mite outbreaks occur concurrently, it is important that chemicals used for control must be effective against both species. In the past, various forms of sulphur were used to control the two mite species, but as sulphur applications taint the tea made from sprayed leaf, at least three rounds of harvested leaf had to be discarded after spraying. Sulphur was replaced later by chlorobenzilate (Akar), followed by dicofol (Kelthane) and tetradifon (Tedion) (Baptist & Ranaweera 1955; Cranham 1966b). Sulphur and chlorobenzilate were found to be less persistent than dicofol and tetradifon, and usually two applications are necessary at an interval of about two weeks for effective control (Cranham *et al* 1962; Cranham 1966b). In the investigations reported here, dicofol and tetradifon were re-evaluated in order to determine the minimum doses required for control and some new acaricides were also evaluated.

EXPERIMENTAL

Incidence of mite outbreaks and crop loss

Materials and methods

An experiment (E21) was conducted at Downside Estate, Welimada to evaluate the effects of fertilizer applications, shade, climatic effects and chemical control on red spider mite and scarlet mite numbers. This experiment was of a split-plot design with six replicates. Each block had eight plots, each 1/30 acre in extent and four plots in each block were sprayed with dicofol (Kelthane) to keep the tea practically free from mites. Two densities of shade (no shade and light shade) provided by *Grevillea robusta* and Dadap (*Erythrina lithosperma*), and four levels of fertilizer (0, 60, 120 and 180 lb nitrogen per acre) were also incorporated. Yield records were regularly maintained and mite samplings were carried out at monthly intervals according to the method described below.

Results

Changes in mite numbers were not found to be related to levels of fertilizer applications. It was evident that the shaded plots had higher mite populations than the unshaded, but this aspect of the problem will be published in detail elsewhere. Analysis of data on mite numbers and weather factors showed that red spider mite numbers are negatively correlated to the previous month's rainfall ($r = -0.353$; $P < 0.001$). The regression of the numbers of the Red Spider Mite on the previous month's rainfall accounted for 12.5% of the variability in numbers. Since correlations of the mite numbers with the current month's rainfall and also with the rainfall two months prior to sampling were not significant, prophylactic control measures are indicated at the end of the first month after the dry season starts. Figures 1 and 2 show that the pattern of scarlet mite build-up is similar to that of the Red Spider Mite and closely follows the rainfall figures; a significant relationship between scarlet mite numbers and rainfall was, however, not evident in the statistical analysis.

In this experiment the control of a moderate attack by red spider and scarlet mites gave an yield increase of 180 lb made tea per acre during a four-year pruning cycle (Table 1). This constituted yield increases of 0.56%, 4.99% and 4.69% during the first, second and third years respectively; during the last half year, there was a decline in yield by 1.77%. The increases in yield during the second and third years were very highly significant ($P < 0.001$). The economics of controlling mites based on this experiment showed that profits from mite control are about eight times the investments on acaricides and labour. It was clear, therefore, that the control of Red Spider Mite and Scarlet Mite is economically worthwhile; this is more so when one considers the fact that mites are dry weather pests and the flavour and quality of made tea also increase during the dry season, resulting in higher prices for the manufactured product.

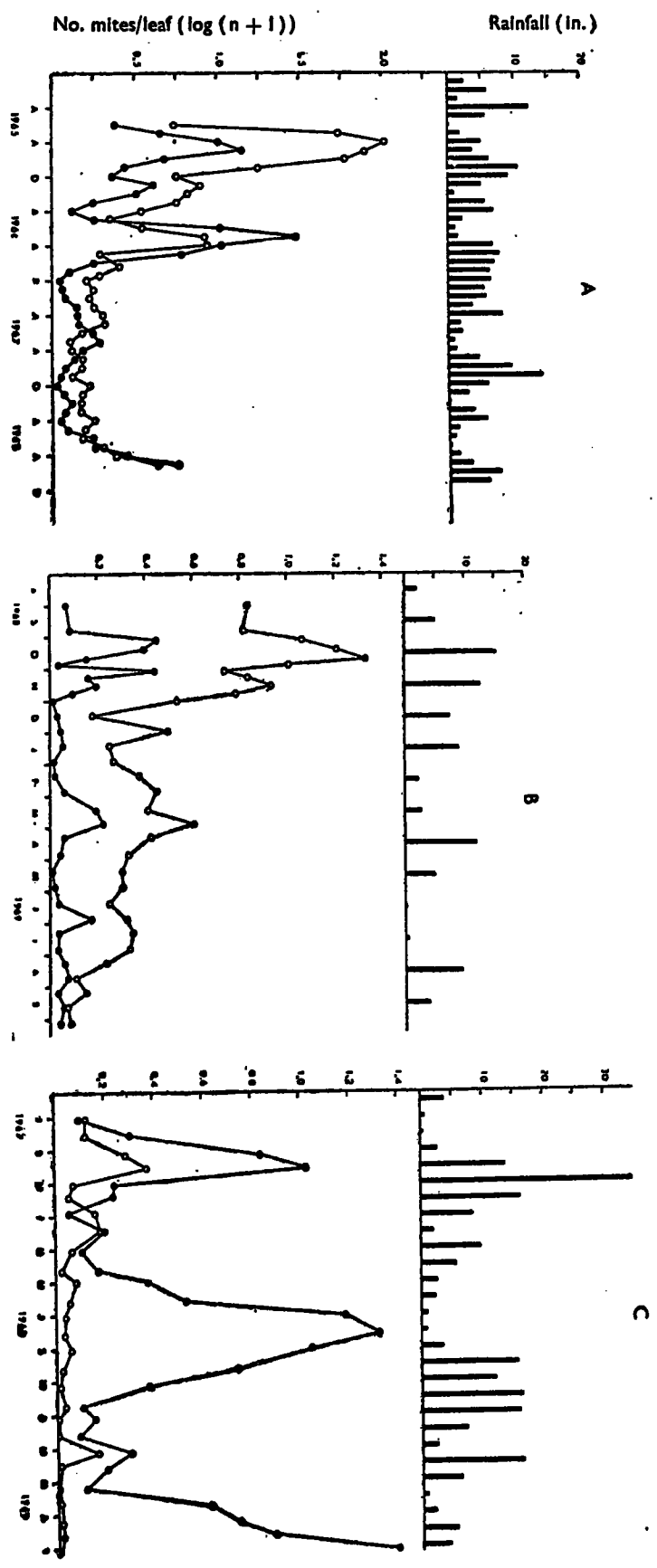


FIGURE 1—Fluctuations in red spider mite (●) and scarlet mite (○) numbers in untreated plots at three estates
 A — Downside B — Gornotawa C — Liddesdale

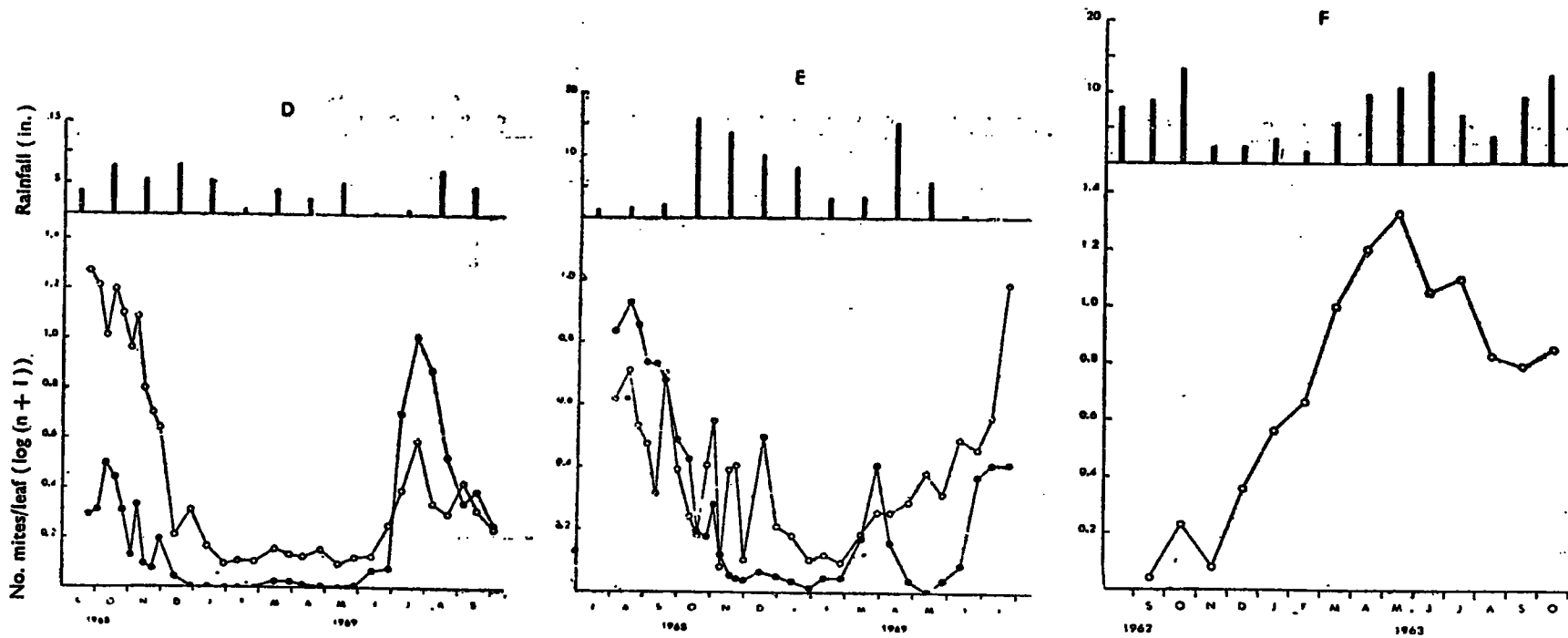


FIGURE 2—Fluctuations in red spider mite (●) and scarlet mite (○) numbers in untreated plots at three estates

D — Welimada E — Glenanore F — St Coombs

TABLE 1 — Mean yield increases in plots sprayed with dicofol (Kelthane) at Downside Estate, Welimada, during a four-year pruning cycle

	Yield increase	
	Per cent	lb made/acre
First year (1965)	0.56	10 NS
Second year (1966)	4.99	111***
Third year (1967)	4.69	71***
Fourth year (1969)	- 1.72	10 NS

*** Significantly different from untreated control ($P < 0.001$)

Experiments on mite control

Materials and methods

Five field experiments were carried out in 1967 and 1968 in Uva, where mite outbreaks are an annual feature during the months, June to September. All experiments were of the randomized block design with four replicates per treatment. The plot size was 1/20 acre. The following 16 acaricides were evaluated :—

Amidithion (Thiocron 30% EC; ex Ciba, Switzerland)
 Binapacryl (Acricid 50% WP; ex Hoechst, Germany)
 Carbophenothion (Triithion 20% EC; ex Stauffer, USA)
 Chlorphenamidine (Galecron 50% EC; ex Ciba, Switzerland)
 Dichlorvos (Nogos 100% EC; ex Ciba, Switzerland)
 Demeton-methyl (Metasystox R 20% EC; ex Bayer, Germany)
 Dicofol (Kelthane 42% EC; ex Rohm & Hass, USA)
 Dimethoate (Rogor-40, 30% EC; ex Fisons, England)
 Dinobuton (Acres 30% EC; ex Murphy, England)
 Ethion (Ethion 48% EC; ex FMC Corporation, USA)
 Oxythioquinox (Morestan 25% WP; ex Bayer, Germany)
 Phosphamidon (Dimecron 50% EC; ex Ciba, Switzerland)
 Prothoate (Fac 20% EC; ex Montecatini, Italy)
 Sulphur (Thiovit 80% WP; ex Sandoz, Switzerland)
 Tetradifon (Tedion V-18, 8% EC; ex Duphar, Holland)
 Tricyclohexyltin hydroxide (Plictran 50% WP; ex Dow Chemical, USA).

In addition to the above, chlorphenamidine in combination with dichlorvos was included in one experiment, on a suggestion made by the manufacturers. The rates at which the acaricides were used are given in Tables 2-6, in pounds active ingredient (ai) per acre. Application of the acaricides was carried out with hand-operated knapsack sprayers having nozzles with disc size 1.6 mm; the spray volume was 60 gallons of water to the acre. Untreated control plots were also included in each experiment.

One pre-treatment assessment and weekly post-treatment assessments were made of the mite population (active stages, adults and nymphs) and the mite egg population. The results of the weekly samplings are given in detail elsewhere (Danthanarayana 1968; 1969; 1970). Sampling was carried out by taking two lots of 500 mature leaves at random from each plot and a sub-sample of 50 leaves was then taken from each of these lots. Thus, in all 100 leaves were taken from each plot.

The mites and eggs on the two batches of 50 leaves were brushed onto two freshly varnished cardboard discs in the field itself, using a battery operated version of the Henderson and McBurnie (1943) mite brushing machine. The mites and eggs that settled on varnished discs were then counted under the microscope in the laboratory. The data were subjected to analyses of variance or covariance, after appropriate transformations.

Results

Experiment E47 — Welimada Group (Dambawinne Division)

In this experiment three levels of dicofol (Kelthane) were compared with four levels of tetradifon (Tedion) and the untreated control. The treatments and the results are presented in Table 2. Both acaricides gave significant reductions in the numbers of red spider and scarlet mite active stages, but the best results, especially with regard to Scarlet Mite, were given by dicofol. In reducing the egg populations of the two mites, dicofol gave more consistent and superior results. The results also showed that tetradifon was more effective at the lower dosages tested. The results indicate that for controlling the two species of mites, these two acaricides can be used at dosages lower than previously recommended (Cranham 1966b).

Experiment E48 — Welimada Group (Dambawinne Division)

In this experiment 10 acaricides were evaluated for mite control. The treatments and the results are presented in Table 3. The results showed that oxythioquinox (Morestan), ethion, carbophenothion (Trithion), amidithion (Thiocron), and demeton-methyl (Metasystox R) gave the best control of both the eggs and the active stages of the Red Spider Mite. When the results of scarlet mite control are considered, binapacryl (Acracid), dimethoate and oxythioquinox gave the best results in reducing the numbers of active stages as well as eggs. This experiment showed that of the acaricides evaluated, only oxythioquinox was highly effective in controlling outbreaks of both Red Spider Mite and Scarlet Mite.

Experiment E67 — Glenanore Estate, Haputale

This experiment was primarily designed to determine the minimum required dose of oxythioquinox (Morestan) which has shown good results in the previous experiment. Also low levels of dicofol (Kelthane), tetradifon (Tedion) and combinations of dicofol and tetradifon were evaluated. The opportunity was also taken to test two new acaricides, dinobuton (Acres) and tricyclohexyltin hydroxide (Plictran). Considering the results of 13 weekly samples (Table 4) of Red Spider Mite first, it is clear that all three levels of oxythioquinox, the higher dose of dicofol, and Plictran gave the most significant and consistent control. Mixtures of dicofol and tetradifon also performed well, but it seems that dicofol was the active component. In controlling the Scarlet Mite, the three levels of oxythioquinox, the higher dose of dicofol, dinobuton and Plictran gave the best results. In the case of oxythioquinox, the minimum dose for best results in controlling both species of mites, is in the region of 0.22 lb active ingredient per acre, which is roughly equivalent to 14 oz of Morestan (25% WP), but the lower dose of 0.11 lb active ingredient per acre also gave results as good as the higher dose. It is clear that the rate of application of dicofol cannot be reduced below 0.26 lb per acre (10 fl. oz Kelthane, 42% MF). Once again tetradifon was found to give inferior results.

TABLE 2 — Control of the active stages and eggs of Red Spider Mite and Scarlet Mite of tea with dicofol (Kelthane) and tetradifon (Tedion) at Welimada Group (Experiment EAT)

Treatment	Rate (lb ai/acre)	Mean No. per 100 leaves			
		Red Spider Mite		Scarlet Mite	
		Active stages (log n)	Eggs (log n)	Active stages log (n+1)	Eggs (log n)
Dicofol	0.26	1.37	2.39	0.57	0.48
Dicofol	0.39	1.46	2.39	0.60	0.48
Dicofol	0.52	1.23	2.29	0.40	0.62
Tetradifon	0.05	1.40	2.65	0.95	0.92
Tetradifon	0.075	1.64	2.84	0.90	0.82
Tetradifon	0.10	1.54	2.72	0.93	0.90
Tetradifon	0.15	1.36	2.89	1.10	1.07
Untreated control	—	2.56	3.04	1.20	1.22
LSD ($P < 0.05$)		—	0.25	0.19	0.20
LSD ($P < 0.01$)		—	0.33	0.25	0.27
LSD ($P < 0.001$)		0.60	0.44	0.32	0.34

TABLE 3 — Control of the active stages and eggs of Red Spider Mite and Scarlet Mite with various acaricides at Welimada Group (Experiment E48)

Treatment	Rate (lb ai/acre)	Mean No. per 100 leaves			
		Red Spider Mite		Scarlet Mite	
		Active stages (log n)	Eggs (log n)	Active stages log (n+1)	Eggs log (n+1)
Chlorphenamide	0.6	1.17	2.11	0.96	1.08
Chlorphenamide+ dichlorvos	0.3 + 0.3	1.75	3.39	1.10	1.14
Dimethoate	0.3	1.55	2.26	1.02	1.00
Demeton-methyl	0.6	1.06	2.04	1.29	1.44
Amididithion	0.6	1.16	2.00	1.12	1.18
Ethion	0.6	0.86	2.05	1.23	1.37
Carbophenothion	0.6	1.04	1.97	1.08	1.11
Phosphamidon	0.3	1.82	2.49	1.20	1.26
Oxythioquinox	0.3	0.97	2.03	0.76	0.88
Binapacryl	0.6	1.72	2.49	0.85	0.72
Sulphur	4.0	1.30	2.12	1.22	1.24
Untreated control	—	2.25	2.72	1.34	1.44
LSD ($P < 0.05$)		0.39	0.27	0.20	0.20
LSD ($P < 0.01$)		0.52	0.34	0.27	0.36
LSD ($P < 0.001$)		0.66	0.68	—	0.57

TABLE 4 — *Control of the active stages and eggs of Red Spider Mite and Scarlet Mite with various acaricides at Glenanore Estate, Haputale (Experiment E67)*

Treatment	Rate (lb ai/acre)	Mean No. per 100 leaves (corrected for covariance)			
		Red Spider Mite		Scarlet Mite	
		Active stages log (n+1)	Eggs log (n+1)	Active stages log (n+1)	Eggs log (n+1)
Oxythioquinox	0.11	5.07	6.36	5.30	6.09
Oxythioquinox	0.22	5.04	6.69	4.33	4.98
Oxythioquinox	0.33	5.18	6.12	5.32	5.79
Dicofol	0.13	6.20	7.43	5.18	5.31
Dicofol	0.26	5.70	6.70	4.81	5.22
Tetradifon	0.05	5.82	7.20	5.94	6.43
Tetradifon	0.025	5.81	7.49	6.34	6.57
Dicofol + tetradifon	0.13 + 0.025	6.07	7.14	5.45	5.64
Dicofol + tetradifon	0.07 + 0.013	5.96	7.14	6.19	6.51
Dinobuton	0.6	5.68	6.99	4.89	5.13
Plictran	0.2	5.03	6.13	4.12	4.97
Untreated control	—	6.69	7.57	6.85	7.06
LSD ($P < 0.05$)		0.61	0.61	0.81	0.75

Experiment E68 — Welimada Group (Ambagasdowa Division)

The purpose of this experiment was to evaluate different levels of oxythioquinox (Morestan) and dicofol, (Kelthane) in order to determine the minimum doses required. Dinobuton (Acres) and prothoate (Fac) were also included. The results of 11 weekly samples presented in Table 5, show that all treatments other than prothoate (Fac) and the lower dose of dicofol gave good results. In the case of Scarlet Mite, dicofol (Kelthane) gave the best results at both dosages, and was superior to oxythioquinox (Morestan) which gave good results at the two higher rates. It is evident that dicofol shows better ovicidal action than oxythioquinox. Dinobuton (Acres) gave consistently good control which did not differ from that of dicofol.

Experiment E69 — Gonamotawa Estate, Haputale

The objects of this experiment were similar to the previous experiment. The treatments and results of 12 weekly samples are presented in Table 6. The numbers of red spider mite eggs were very low and the results were therefore not very conclusive. All treatments other than the lowest dose of oxythioquinox gave significant reductions in the numbers of red spider mite active stages. With regard to Scarlet Mite, the best results were obtained with dicofol (Kelthane), which gave consistent control of both active stages and eggs. Dicofol performed better at the higher rate of 0.26 lb active ingredient per acre. Oxythioquinox too gave good results, but was inferior to dicofol. As in previous experiments, dinobuton (Acres) and tricyclohexyltin hydroxide (Plictran) gave very good results comparable to those of dicofol and oxythioquinox.

DISCUSSION

Red spider mite and scarlet mite outbreaks are seasonal and are associated with the monsoonal rains. In the case of the Red Spider Mite, about 12.5% of the variability in numbers are associated directly with rainfall of the previous month. It is probable that the rest of the variability may be due to certain biochemical changes that take place within the tea leaf and their influence on the reproductive rates of the mites; these changes are also in effect related to seasonal changes of weather. The relationship between red spider mite numbers and the previous month's rainfall showed that prophylactic chemical treatment for mite control should be taken at the end of the first month after the beginning of the dry season. In the case of the Scarlet Mite, methods suggested for the Red Spider Mite may be followed, as scarlet mite outbreaks also seem to follow the same pattern as that of Red Spider Mite.

The results of the experiment on loss of crop indicate clearly that mite control is a worthwhile, economic proposition on tea estates.

From the experimental evidence presented in this paper, a fairly clear picture has emerged in regard to the selection of acaricides for the control of the two species of mites. The best and the most consistent results in controlling all stages of both types of mites were given by dicofol (Kelthane) and oxythioquinox (Morestan). The minimum effective dose of dicofol was found to be 0.26 lb active material per acre (10 fl. oz Kelthane, 42% MF). Oxythioquinox (Morestan) is a new acaricide for tea in Ceylon; this compound gave good control of all stages of the Red Spider and Scarlet Mites and the results were comparable to those of dicofol (Kelthane). The optimum effective dose of oxythioquinox was 0.22 lb active ingredient per acre (14 oz Morestan, 25% WP). It was evident that the minimum effective dose is between 0.11 and 0.22 lb active ingredient (7-14 oz Morestan, 25% WP). Tetradifon

TABLE 5 — Control of the active stages and eggs of Red Spider Mite and Scarlet Mite of tea with various acaricides at Welimada Group (Ambagasdowa Division) (Experiment E68)

Treatment	Mean No. per 100 leaves (corrected for covariance)				
	Rate (lb ai/acre)	Red Spider Mite		Scarlet Mite	
		Active stages log (n+1)	Eggs log (n+1)	Active stages log (n+1)	Eggs log (n+1)
Oxythioquinox	0.11	2.91	4.50	7.39	7.99
Oxythioquinox	0.22	2.88	4.32	6.56	7.13
Oxythioquinox	0.33	2.38	3.98	6.44	7.11
Dicofol	0.13	3.92	5.47	5.85	6.10
Dicofol	0.26	3.14	4.55	5.76	6.00
Dinobuton	0.60	3.02	4.78	6.16	6.72
Prothoate	0.20	4.03	5.04	7.94	8.33
Untreated control	—	4.42	5.81	7.97	8.24
LSD ($P < 0.05$)		1.23	1.09	0.54	0.54

TABLE 6 — *Control of the active stages and eggs of Red Spider Mite and Scarlet Mite of tea with various acaricides at Gonamotawa Estate, Haputale (Experiment E69)*

Treatment	Rate (lb ai/ acre)	Mean number per 100 leaves (corrected for covariance)		
		Red Spider Mite Active Stages log (n+1)	Scarlet Mite Active Stages log (n+1)	Eggs log (n+1)
Oxythioquinox	0.11	4.48	7.37	7.52
Oxythioquinox	0.22	3.62	7.54	7.95
Oxythioquinox	0.33	3.47	7.06	7.15
Dicofol	0.13	3.74	6.58	6.98
Dicofol	0.26	3.67	5.82	6.16
Dinobuton	0.60	3.34	6.14	6.96
Plictran	0.20	3.34	6.86	7.90
Untreated control	—	6.02	8.17	8.52
LSD ($P < 0.05$)		0.98	0.69	0.81

(Tedion-V18), which was previously recommended (Cranham 1966b), did not live up to expectations, and gave comparatively inferior results in all experiments. These experiments showed, however, that tetradifon is more effective at lower dosages than previously recommended. Best results with this acaricide were obtained with 0.05 lb active ingredient per acre (10 fl. oz Tedion-V18), and it can be used as an alternative to dicofol (Kelthane) and oxythioquinox (Morestan).

Of the other acaricides evaluated, the most promising results were given by tricyclohexyltin hydroxide (Plictran) and dinobuton (Acres). These are two new chemicals that need further testing before definite recommendations can be made. Both compounds gave excellent results in controlling all stages of the two mites and could be used on an experimental basis until further tests are done to determine the minimum doses required and other characteristics. Plictran may be used at the rate of 0.2 lb active material per acre (6 oz Plictran 50% WP), and dinobuton at the rate of 0.4 lb active ingredient per acre (1 pint Acres 30% EC).

Correct timing of chemical control is of utmost importance in a positive approach towards effective and economic mite control. Almost all acaricides that gave satisfactory results in these experiments were also highly persistent, a single application providing effective control for over three months. Acaricide applications at the outset of an outbreak, or prophylactic applications in a manner suggested above will obviate the necessity of repeat applications, and will also prevent the spread of the pest to other fields.

RECOMMENDATIONS

- 1 — Spray 10 fl. oz of Kelthane, 42% MF or 10-14 oz of Morestan, 25% WP in 10-15 gallons of water using mistblowers or in 60 gallons of water using knapsack sprayers. The spraying must be uniform and thorough, with the spray directed to all parts of the bushes in order to cover lower and upper surfaces of leaves as much as possible. Repeat the application after two months if necessary and if dry weather continues.
- 2 — Tedion V-18 may be used as an alternative to Kelthane and Morestan at the rate of 10 fl. oz per acre at dilutions indicated in 1 above. Results with Tedion are likely to be inferior to those of Kelthane and Morestan.
- 3 — In areas where mite attacks are anticipated after DDT spraying for caterpillar control, incorporate 10 fl. oz Kelthane or 10-14 oz Morestan into the DDT solution.
- 4 — Prophylactic treatment in areas prone to mite attack is best done at the end of the first month after the dry season begins.

PRECAUTIONS

- 1 — **Spraying of Kelthane, Morestan or Tedion must be done immediately after a plucking round and the next round of plucking should be after a safety period of seven days. The tea made from sprayed areas must be bulked with ten times as much tea made from unsprayed areas.**

If such bulking is not possible, allow a safety period of **fourteen days**, either by discarding one plucking round or by resting the tea.

- 2 — The usual commonsense precautions must be taken when handling Kelthane, Morestan and Tedion, even though these are among the safest of pesticides in use today. For detailed safety precautions, see the TRI Entomology Wall Chart (1970). Whenever pesticides are used, *read and follow carefully the instructions on the label*. Store new and part-used containers in a safe place, under lock and key. Wash out empty containers thoroughly and dispose of them safely. Do not contaminate ponds, waterways or ditches with pesticide concentrate, spray or washings; any excess spray and washings must be buried deep in soil.

SUMMARY

- 1 — Red Spider mite and scarlet mite outbreaks usually occur during the intermonsoonal dry seasons. The changes in mite populations are attributed to direct effects of weather (rainfall).
- 2 — The control of Red Spider Mite and Scarlet Mite is economically worthwhile.
- 3 — Out of 16 acaricides evaluated, dicofol (Kelthane) and oxythioquinox (Morestan) were found to give the best results in controlling all stages of the two mites.
- 4 — Tricyclohexylin hydroxide (Plictran) and dinobuton (Acres) gave excellent control of all stages of the two mites, but further testing is required before definite recommendations can be made.
- 5 — It is recommended that prophylactic spraying be carried out in problem areas. The best time for prophylactic treatment is at the end of the first month after the dry season begins.

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