EFFECTS OF SPRINKLER IRRIGATION ON McDANIEL AND EUROPEAN RED MITES IN APPLE ORCHARDS[1]

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ABSTRACT

Overtree sprinkler irrigation of apple trees was effective in keeping populations of McDaniel spider mites, **Tetranychus mcdanieli,** below the economic level. Sprinkling had less effect on European red mites, **Panonychus ulmi,** because the females moved to the undersides of the leaves and continued egglaying during the sprinkling and because the eggs, unlike those of **T. mcdanieli,** were not dislodged by the sprinkling. The effectiveness may be increased by timing the sprinkling to coincide with the first appearance of the immature stages and by increasing the size of the droplets.

INTRODUCTION

Major innovations in orchard management rapidly being adopted in the apple-growing areas of British Columbia and Eastern Washington are integrated programmes for pest damage control and permanent overtree sprinkler systems for irrigation. These two are interrelated because the sprinkling must be a part of any integrated control programme and may be appropriately modified if it affects pests.

This paper summarizes some results of surveys and experiments aimed at answering two questions in relation to the chief pest mites: has overtree sprinkling a significant effect on their populations; and, if it has, how might the effect be modified? The species discussed here are the most important pest mites: the McDaniel spider mite, *Tetranychus mcdanieli* McGregor, and the European red mite, *Panonychus ulmi* Koch. The work was done in orchards in the Yakima district of Washington State in 1968 and in the South Okanagan district of British Columbia in 1969.

Various published records indicate the likelihood that orchard mite populations are affected by irrigation sprinklers. Recent popular reports claim that overtree irrigation has a control effect (Ross, 1968; Stark, 1969; earlier records indicated that the mechanical effects of orchard sprays could reduce mite populations substantially (Frost, 1924, Newcomer and Yothers, 1927; Spuler, 1930; Moore *et al.*, 1939, Chaboussou, 1961); and there are references to rain washing mites from leaves (McGregor, 1914; Ross and Robinson, 1922; Garman, 1923; Frost, 1924; Hamilton, 1924; Garman and Townsend, 1938; Kuenen, 1945; Linke, 1953). The work described here shows that overtree sprinkling has a significant control effect on the populations of both species but normally exerts economic control only on the McDaniel mite (Hudson, 1970).

EFFECTS OF COMMERCIAL SPRINKLER SYSTEMS

The effects of overtree and undertree sprinling on populations of the McDaniel mite were investigated in an orchard at Yakima, Washington. Half the orchard was irrigated by one system and half by the other. Changes in the mite populations were determined by counting the number of mites per leaf on each of ten leaves from the same marked limbs on each of five trees every two weeks during June and every week thereafter until early September.

Results are shown in Fig. 1. It was evident that populations of the McDaniel mite were kept below injurious levels when the trees were irrigated by overtree sprinklers on a normal schedule. In the overtree-sprinkled block the average number of mites per leaf (of 14 samples) was 0.4 and the highest number 1.6 whereas in the undertree sprinkled block the average was 7.3 and the highest 35. There was visible leaf injury to many trees in the undertree sprinkled block but not in the overtree sprinkled one. In an experimental orchard at Summerland, B.C., the mite populations increased by 1.04 and 0.4 times over the pre-treatment counts on two sprinkled trees in six weeks but 17.2 and 11.3 times on two control trees.

Surveys using the same procedures in the Nettleton orchard at Naramata, B.C., showed the effects of sprinkling on populations of the European red mite. Again it was evident that overtree sprinkling was much more effective than undertree sprinkling in reducing populations. The results are shown in Figs. 3 and 4. However, the mites reached injurious population levels in both blocks and chemicals had to be applied to prevent economic damage. Despite this, foliage injury was moderate to severe on all trees of the undertree-sprinkled block.

[1] Part of a thesis submitted by W. B. Hudson for the degree of M.S. of Simon Fraser University. Details of methods and data may be obtained from him at: Yakima County Cooperative Extension Service, 233 Courthouse, Yakima, Washington, U.S.A.

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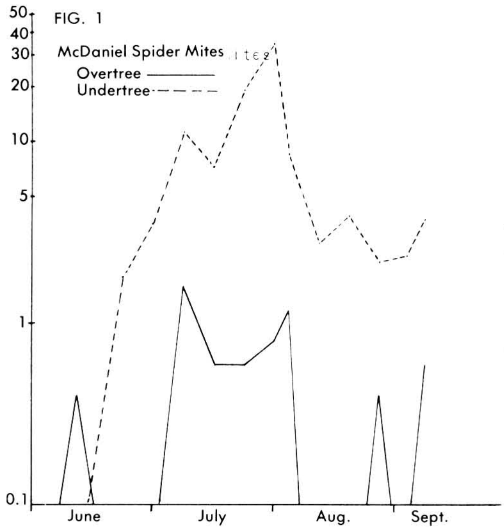
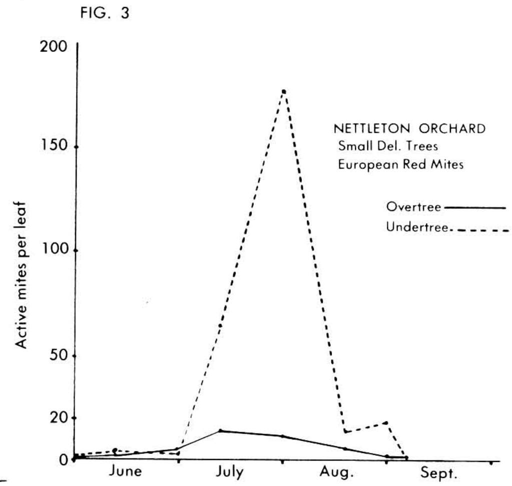
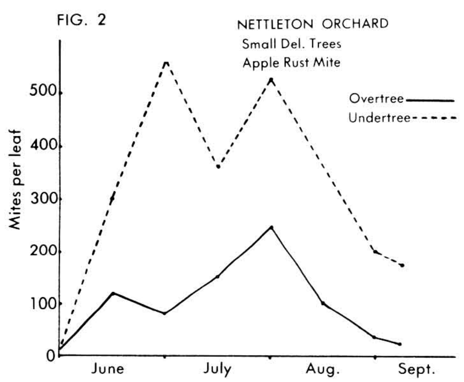
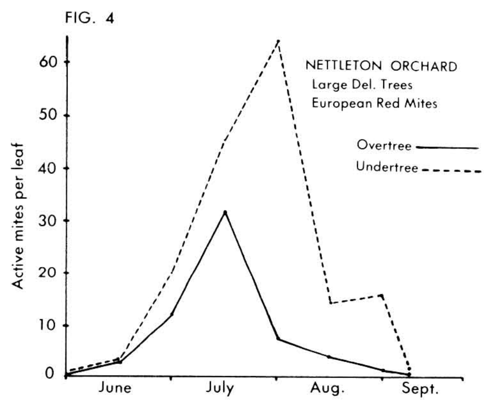








Figs. 1-4. Effects of overtree versus undertree sprinkling on populations of: (1) McDaniel mite at Yakima, Wash.; (2) apple rust mite at Naramata, B.C.; (3 and 4) European red mite at Naramata.

Surveys using the same procedures in a third commercial orchard, at Summerland, gave results for both species that agreed in general with those at Yakima and Naramata. The conclusion is that an overtree sprinkling system operated on a normal irrigation schedule can by itself prevent economic harm from the McDaniel mite but not from the European red mite. The greatest reductions of both species were from the upper surfaces of the leaves; mites on the lower surfaces were less affected.

REASONS FOR DIFFERENT EFFECTS

Experiments with detached leaves indicated why the European red mite is less affected than the McDaniel mite by overtree sprinkling. The numbers, stages and distributions of mites on the same leaves were determined before and after exposure to field sprinkling. Three main differences between the two species were revealed:

Egg removal. Sprinkling washed the eggs of the McDaniel mite from the upper surfaces of leaves but not the eggs of the European red mite. Two h of sprinkling removed 90% of the eggs of the McDaniel mite and 24 h 99% but eggs of the European red mite were not washed off irrespective of the duration or intensity of the sprinkling.

Female migration. Many females of the European red mite escaped by migrating from the upper to the lower surface of the leaf when sprinkling began. They were affected similarly by rain and dew. In one experiment the number of females decreased from 203 to one on the upper surfaces of five leaves but increased from 82 to 128 on the lower surfaces. In another experiment the corresponding figures were from 205 to 174 and from 112 to 164. No such changes were observed for the McDaniel mite; there was no evidence that females migrated to the undersurfaces of the leaves when sprinkling started. In one instance the numbers of active mites increased by about 20% on the lower surfaces but this was attributed to eggs hatching and not to migration because the increase on control leaves was 37%.

Egg-laying. Sprinkling did not prevent egg-laying by the European red mite. The decreases in egg numbers following sprinkling were insignificant in most tests and could have been accounted for by hatching. In other tests the numbers increased, which indicated that egg-laying may increase during sprinkling. During one 12-h sprinkling period the eggs increased 26% on the sprinkled leaves but 6% on the control leaves. In another instance the average number of eggs per leaf on 20 leaves was 246 before 10-h of intermittent sprinkling and 436 after. No evidence indicated that egg-laying by the McDaniel mite increased during sprinkling. In one test the number of eggs on the lower surfaces of five leaves was 221 before sprinkling, 228 after 2 h and 192 after 24 h.

POSSIBLE IMPROVEMENTS

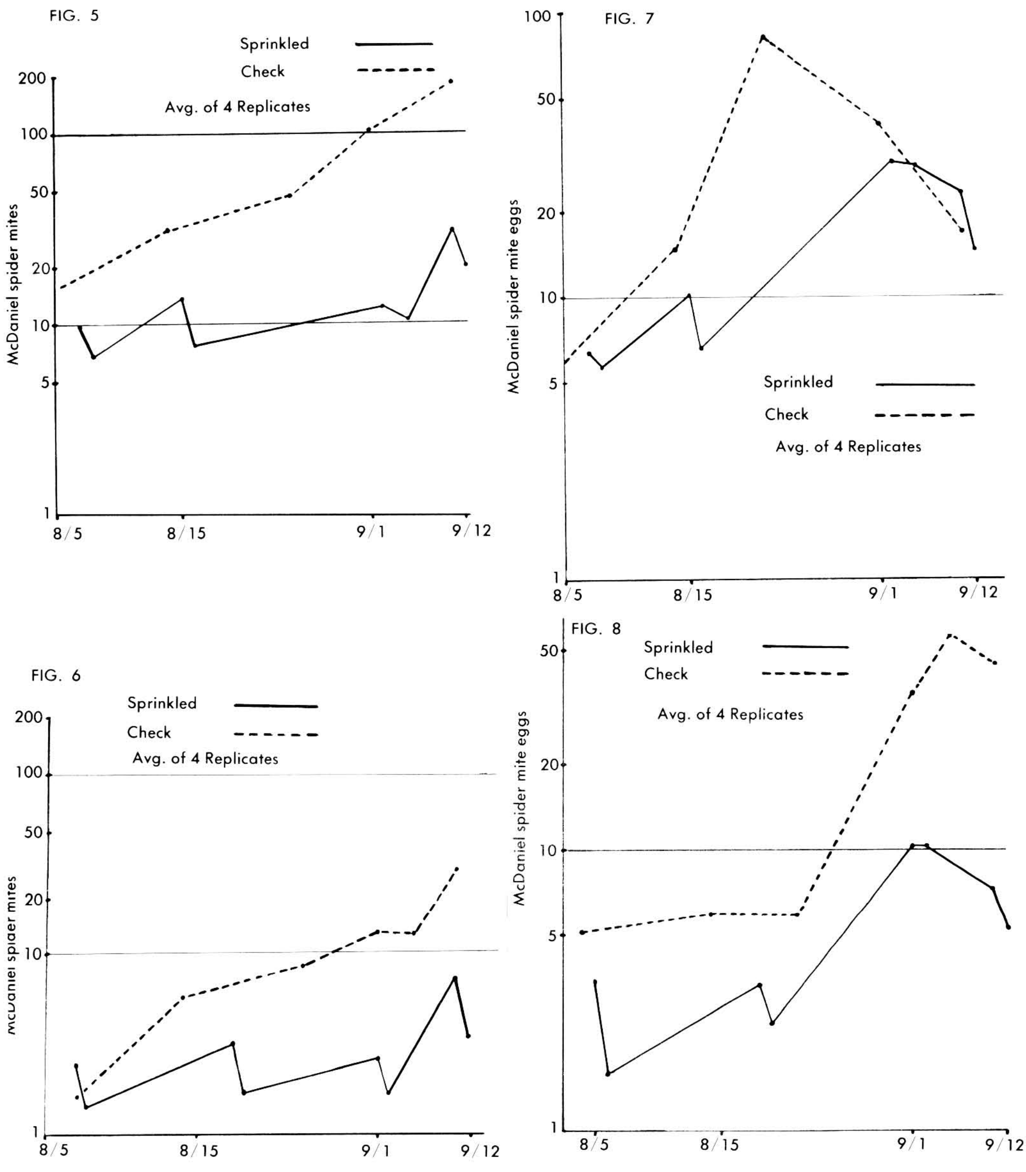
Commercial overtree sprinkler irrigation reduced populations of both species of mites. Counts showed that the usual reduction caused by a single sprinkling was 40 to 60% for both species. A reduction of 60% or less is not sufficient to prevent economic damage by the European red mite because of the high rate of survival of its eggs and females and its ability to oviposit during the sprinkling. Moreover, there are local variations in the habits of mites that vary their susceptibility. Thus, the strain of McDaniel mite in the Yakima district occurs more often on the upper surfaces of the leaves and spins more webbing than does the strain in the Summerland district, where the species tends to be less susceptible to harm by sprinkling that it does around Yakima. Any modification of the sprinkling system that would increase the mortality above the present normal maxima of about 60% for both species would be advantageous.

To explore the possibilities, tests were made in an experimental orchard at Summerland, using a portable overtree sprinkling system. Here the duration, timing, and concentration of the sprinkling and other controls were determined by the experimenter instead of by the grower. Some of the tests used the same procedures as in commercial orchards; others used single leaves. This series also showed that the effects on the apple rust mite, *Aculus schlechtendali* (Napela), were in general similar to the effects on the McDaniel mite. Fig. 2 is given as an example.

Rates of application. Results of conventional (0.3 inches h) and of high (0.7) rates of application of water by overtree sprinkling were not significantly different for active stages of the McDaniel mite (Figs. 5 and 6) or for the eggs (Figs. 7 and 8). But there were slight differences with the European red mite in that 12 h of overtree sprinkling at 0.3 inches h reduced populations by about one-third whereas 12 h at 0.7 inches h reduced them one-half.

Coverage. Mites on the undersides of leaves were little affected by overtree sprinkling. Control would be increased if the undersides could be wetted. This happened when a test was conducted in a windstorm that carried the sprinkler water nearly horizontally. The percent control was greater than from any other single sprinkling. This indicates the possible effectiveness as a pest control agent of a power water spray.

Overtree sprinkling reduced the mite populations on leaves of the upper limbs more than it did on the lower. The average number of females on 20 upper leaves on each of two trees was reduced from 4.3 per leaf to 2.1, but on the lower leaves from 9.8 to 7.4.



Figs. 5-8. Effects of conventional rates of sprinkling (Figs. 5, 7) and of high rates (6, 8) on active stages and eggs of the McDaniel mite at Summerland, B.C.

Tree types. Surveys in the commercial orchard at Naramata showed that the average number of mites per leaf on 50 leaves was lower on small trees with overtree sprinklers than on large ones: 4.9 as compared with 7.3 with peaks of 14 and 31.4, respectively; but it was higher on small trees with undertree sprinklers than on large ones: 35.3 as compared with 20.3 with peaks of 178 and 64.

In the commercial orchard at Summerland overtree sprinkling was apparently more effective in reducing mites on Spartan than on Delicious apples, but this may have been because of varietal preference: mites are generally more of a problem on Delicious than on Spartan. The average number per leaf was 1.5 on Spartan and 4.5 on Delicious, with the highest numbers 3.0 and 16.2, respectively. The corresponding figurs for undertree-sprinkled trees were 2.3 and 5.7 and 11.3 and 20.

Timing. Overtree sprinkling washes off a greater proportion of the immature stages of the European red mite than of the adults. Four h of sprinkling reduced adult populations by 54.9% (differences significant at the 5% level) but the immatures by 58% (differences significant at the 1% level). After 12-h of sprinkling the corresponding figures were 47% and 87%. The relative susceptibility of the immatures of this species to sprinkling and the immunity of the eggs suggests that for maximum control overtree sprinkling should be timed to affect the larval and protonymph stages of the first summer generation, after the overwintered eggs have hatched but before the adults have developed. Results of experiments suggested that sprinkling to control the McDaniel mite should begin when the mite population is still low; it will then be kept low. There were indications that at high population densities control by sprinkling may be nearly offset by the rapid rate of increase of the mites.

CONCLUSION

It is clear that overtree sprinkler irrigation contributes to the suppression of populations of phytophagous mites. It does so without added cost to the grower, without harming the environment, and, so far as existing information indicates, without favouring other orchard pests or diseases. The effectiveness of an overtree sprinkler system in controlling mite populations may be increased, if sprinklings are timed to coincide with the first appearance of the immature stages, if the water droplets are as large as possible, and if the sprinklers are so arranged that every part of the tree is drenched.

Acknowledgements

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OBSERVATIONS ON *RHAGOLETIS INDIFFERENS* AND RELATED SPECIES IN THE OKANAGAN VALLEY OF BRITISH COLUMBIA

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ABSTRACT

The western cherry fruit fly, **Rhagoletis indifferens** Curran was first recorded in the Okanagan Valley of British Columbia in 1968, and trapping during 1969 established the presence of this species in most of the cherry growing district in the region. **R. indifferens** emerges as an adult in early June, and flies continue to appear until mid-July. The principal host of this species, **Prunus emarginata,** Dough. was not found in the Okanagan, and no flies were found on **Prunus virginiana demissa** (Nutt.) which has been reported as a host.

A comparison of lures to trap the flies showed that ammonium carbonate traps were more efficient than yellow sticky boards or glycine-lye bait pans. The sticky boards, however, seem to be adequate for determining the presence of cherry fruit flies.

In addition to **R. indifferens,** 5 other **Rhagoletis** were trapped in commercial cherry orchards. The common species were **R. zephyria** Snow, **R. ribicola** Doane, and **R. berberis** Curran. **R. fausta** (Osten Sacken) and **R. tabellaria** (Fitch) were trapped in very low numbers in a relatively few locations.

INTRODUCTION

The western cherry fruit fly, *Rhagoletis indifferens* Curran was recorded for the first time in the Okanagan Valley of British Columbia during the summer of 1968. This species has been present for several years on Vancouver Island and in the Kootenay district (Madsen and Arrand 1966). The black cherry fruit fly *Rhagoletis fausta* (Osten Sacken) is present in the Shuswap Lake area near Salmon Arm and was recorded in the Okanagan Valley during 1951 and 1965. These two infestations did not spread from the original source and only an occasional fly was found in subsequent seasons. A survey in 1969 established that *R. indifferens* was present in the Okanagan Valley from Vernon to Okanagan Falls, but no flies were found in the Oliver-Osoyoos district or in the Similkameen Valley.

The native host of the western cherry fruit fly is bitter cherry, *Prunus emarginata* Dough. and flies have also been reared from choke cherry, *Prunus virginiana demissa* (Nutt.) (Frick 1954). The presence of native hosts complicates the problem of controlling cherry fruit flies in commercial orchards because they provide a source of flies for reinfestation (Peters and Arrand 1968). Consequently, a research program was initiated in 1969 to determine if wild hosts supported cherry fruit flies in the Okanagan. In addition, data were obtained on the emergence of the western cherry fruit fly in infested orchards and a comparison of various lures for trapping the flies was made.

MATERIALS AND METHODS

Wild hosts were surveyed for the presence of fruit fly larvae and collections from all suspect hosts were

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[1] Report on the cherry fruit fly survey in the Okanagan Valley 1969. Canada Department of Agriculture, Plant Protection Division, September 4, 1969. Mimeograph.