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Effect of Apple Root Sucker on Density and Dispersal of Spider and Predatory Mites

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ABSTRACT

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The results from Perry apple orchard (in northern Utah, 1992) showed that the spider mites could migrate from ground vegetation through tree root sucker, tree trunk, and then into tree canopy. Leaves of root sucker let the overwintering spider mite establish their first population there, and did appear to contribute to the higher spider mite densities in tree canopy. The total percentage of spider mites was found higher and the relative density of total predatory mites was found lower in treatments with root suckers. The movement in mid-July and outbreak in early August of mites might be due to disturbed cultivation on ground covers. In addition, the score method used in this experiment could give the similar population density estimates.

(Key words: Sucker, mite, density, dispersal, ground cover)

INTRODUCTION

Apple root suckers are the good food sources for overwintering spider mites to establish their early population in the orchards. As the nearest vegetation and best host, root suckers provide the high quality, newly growing leaves for spider mites and give them the good place for reproducing their progenies. Following the spider mites, the overwintering predatory mites come a little later and also establish their population on root suckers owing to the sufficient preys. Then, both spider and predatory mites will keep their population dynamics within the suckers. Sometimes mites may migrate into ground covers and tree canopies when their populations are getting too high.

In Michigan apple orchards, high densities of the predatory mite species, *Amblyseius fallacis* Garman, were found on ground cover plants preceding their movement up into orchard trees. The mites were found to move from the cover vegetation into the trees during mid-summer to feed on European red mite, *Panonychus ulmi* (Koch), and then return to the ground cover when prey populations became depleted[1].

In northern Utah, the major predominant predatory mite is *Typhlodromus occidentalis* Nesbitt, which spends the winter as an adult in protected sites on or near the tree base. Spider mites, *Tetranychus mcdanieli* McGregor and *Tetranychus urticae* (Koch), also overwinter as adults among the bark scales at the base of the trees, in surface debris and on the ground cover. Spider mites emerge in the spring (April and May) and begin feeding on the broadleaf weeds in the ground cover[2,5]. As temperatures warm in May the predators begin to search for mite prey on the cover crop and weeds around the tree base. In approximately mid-July, the predatory mites may follow the orchard spider mite population into the main part of the tree.

Improper timing of mowing and herbicide applications have been shown to drive plant feeding mites from the ground cover into orchard fruit trees, causing early season mite infestations[3]. So, the management of suckers (and the vegetation around the tree base) may be very important in spider mite control programs because the incorrect manipulation may break the population equilibrium and cause the mite outbreak on tree canopies. For example, root sucker removing or ground vegetation mowing in the wrong time should disturb the mite population and influence the mite dispersion. In addition, we know herbicide and miticide applications also can effect the mite migration.

Few or no experimental data can be used in the field for understanding the effect of root sucker on mite population. The experiment is to determine the influence of apple tree root suckers on timing and rate of mite disperal into trees.

MATERIALS AND METHODS

In 1992, a commercial orchard in Perry (about 40 miles from Utah State University) with abundant root suckers was used for this study. Twenty trees were randomly selected and root suckers were removed from half of these trees (i.e., keep suckers in odd trees and remove suckers in even trees) every two weeks from May through July. Twenty leaves and one ground vegetation sample (average is 25.9 g) were randomly collected every two weeks from each of the 20 trees and examined with a 20-30X microscope for spider mites (*Tetranychus urticae* (Koch) and *Tetranychus macdanieli* McGregor) and predatory mite (*Typhlodromus occidentalis* Nesbitt). Tree trunks were examined for presence of mites (10 cm band, about 50 cm above ground) as described by McGroarty and Croft (1978) by using a 10X hand lens[4], and 10 leaves from root sucker per tree were also brought back to laboratory to examine for spider and predatory mites on each sampling date.

A score method was used for estimating both mite densities to avoid time consuming (Table 1), just recording a category by a symbol and giving the mite number a score (for example, if each leaf or sample includes 50 mites, it will be categorized as many, recorded by VV, and gets 5 scores). Differences in the abundance of mites between treatments with and without sucker across sampling dates were tested using a general t-test method.

RESULTS AND DISCUSSION

First, the scores of mites estimated from vegetation samples over time showed that population density of spider mites were similar between treatments with and without root suckers. Higher spider mite densities were found on vegetation surrounding trees without suckers in the early May to early June and early August, but differences were not significant except on 4-June ($p<0.01$). This may indicate that some mites had migrated up to root sucker on trees from ground vegetation, or spider mites began moving up into trees with root suckers earlier in season than on trees without suckers.

Table 1. The counting method for mite scores

Mite no.	Category	Symbol	Score
1-20	few	V	1
21-100	many	V V	5
>100	very many	V V V	10

Second, scores for spider mites on apple root suckers were found on the first sampling date in early May on root sucker leaves and in relative higher densities than on ground vegetation. This suggests that overwintering mites from the tree base may prefer to colonize root sucker leaves and disperse there first when these mites are available before they move to the ground cover vegetation in the spring and early summer. Spider mite densities declined on the last sampling date because of the poor condition of the sucker leaves due to the heavy mite feeding damage. Some of these mites might move up into tree canopies helping to form the highest population peak there in early August. The predatory mite population on root sucker leaves came a little later and didn't get their highest densities until early August.

Third, spider mites and predatory mites were not found on tree trunks until the last two sampling dates. These results indicate that most spider and predatory mites didn't begin to disperse from ground vegetation and root suckers into the tree canopy until later in the season, beginning in mid-July. The root sucker leaves may be slowing down mite movement up the trunk into the canopy. However, these big mite movements may be due to the cultivation done by the grower before 14-July [3].

Last, spider mites and predatory mites were first found on canopy leaves from trees with root suckers (Fig 1). Low numbers of spider mites were detected on the first sample date, 7-May, which coincides with the first observation of spider mites on root sucker leaves. It's possible that the mites found in the canopy early are from the overwintering population[2,5] which established their first colony on sucker leaves. More predatory mites were found in without sucker treatment at the last sampling date. This may indicate that some predatory mites might have moved back to sucker leaves from canopy[1].

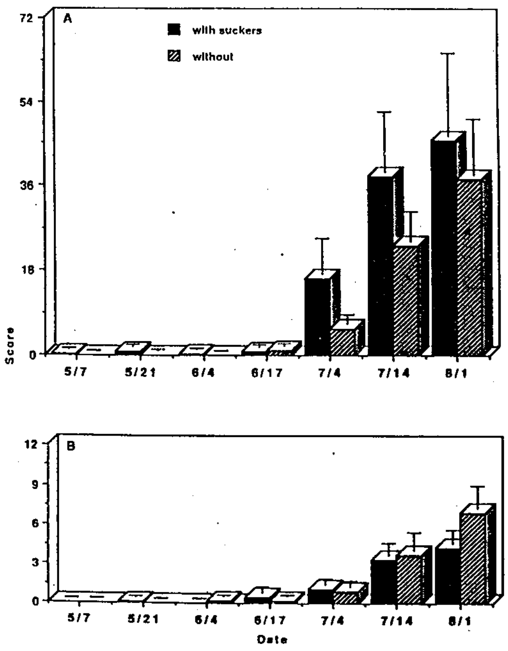

Fig 1. Scores (mean+se, n=10) for spider (A) and predatory (B) mites on 20 leaves from trees with and without root suckers.

Comparing the average sum scores on 7 dates between canopy and sucker leaves we found that the density of spider mites on tree canopy was lower than on root sucker leaves (1:1.15, 169.4 per 280 leaves on canopy and 48.8 per 70 leaves on suckers). Do the mites like to stay on sucker than on canopy due to the suitable temperature and good nutritional quality in suckers?

To sum up from vegetation, sucker, trunk and canopy, the spider mites were first found on suckers and on canopies (7-May). Then, some spider mites were found beginning their populations on ground vegetation (4-June), and finally found on tree trunks (14-July). Above all, we can see the population dynamics of these mites. Mites began to increase first on suckers (17-June), then on canopies (4-July), and next on vegetation (7 to 14 July), at last on tree trunks (14-July to 1-August). It looks like that lots of mite migrations began at mid-July through early August from vegetation, via tree trunks. and suckers, and then into tree canopies. In addition, for all 4 sampling types, we found that the mite population dynamics was as bellow: the spider mite came first, and then the predatory mites followed. However, we found that the differences between almost all the treatments with and without suckers were not significant in t-test. The population densities (mean) were so low at some dates and the variances (sd) were so high. We should take larger sample size (n>30 instead of n=10) in next experiment, and then we can increase the statistical power and decrease the P values.

In analyzing summary, the total percentage of spider mites found on trees (root suckers, trunks, and tree canopies) and ground vegetation from all 7 sampling dates was 64.3% in treatments with root suckers and 35.7% in treatments without suckers (Table 2), however, this difference was not significant (P=0.46).

Although the presence of root suckers may slow the dispersal of mite into the tree canopy, spider mite populations on suckers do appear to contribute to higher densities in the tree canopy. In contrast, the relative density of predatory mites was higher in canopies on trees without root suckers than on trees with suckers (1.29:1). We don't know whether this means some overwintering predatory mites on tree base directly going to the tree canopies because there was no sucker to maintain these mites. However, the predatory mite densities were so low in the earlier season, so we could not detect well by taking samples every 2 weeks.

Table 2. Total percentage of mites on trees with and without root suckers on 7 dates

Treatment	Spider mite	Predatory mite
With sucker	64.3(173.8)[1)]	51.0(22.5)
Without sucker	35.7(96.5)	49.0(21.6)

[1)] Number in ( ) is the sum score of mite from ground vegetation, root sucker, trunk, and tree canopy.

In addition, comparing the percentage of spider mites in the tree canopy using the score method to the actual counting method, the score method gave similar mite population density estimates. The actual mites counts from treatments with and without root suckers were 13,344 and 7,833 per 1,400 leaves, or 63% and 37%, respectively. Using the score method, the scores from trees with and without root suckers were 101.9 and 67.5 per 140 leaves, or 60.15% and 39.85%. respectively.

The relative composition of spider mites and predatory mites when scores from all 4 sampling types at 7 dates in treatments with and without suckers was summed in Fig 2. In the treatment with root suckers, the rate of spider/predatory mites was 7.7, but the rate was only 4.5 in the treatment without root suckers. So, we can obviously see the trends that the root suckers were favorite for the occurrence of spider mites.

In conclusion, tree root suckers were favorite for spider mites. They provided a good food source and a habitat for both mites to establish their early population. If removing apple root suckers in early May, we could decrease the spider mites and increase the predatory mites in tree canopy. Also, if the grower didn't cultivate the ground vegetation, maybe the spider mite outbreak in early August was neither happened, nor the miticide application was necessary just as the mite population observed in the neighbor orchard which was not disturbed. In

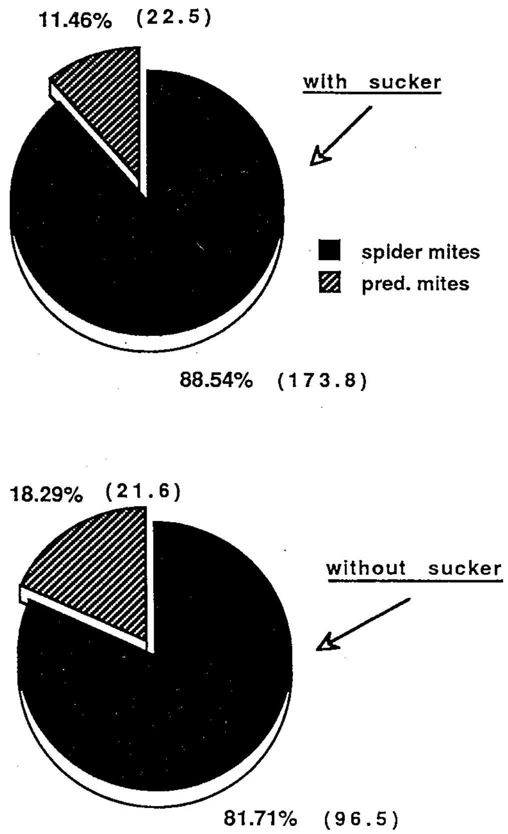

Fig 2. Relative total composition of mite population (spider mites vs. predatory mites) on trees with and without root sucker. Numbers in parentheses are scores from all sample types on 7 dates.

mite control programs, we might do all the cultural practices (include sucker removing, vegetation cultivation, herbicide and miticide applications) in early or late season if necessary, but should avoid doing these things in mid-summer.

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摘　要

何坤耀　1993　蘋果樹基吸芽對葉蟎及其捕食蟎密度與分散之影響　植保會刊 35:277-283.（嘉義農業試驗分所，嘉義市民權路2號）

依1992年在北猶他蘋果園所作之調查，顯示葉蟎之族群可從地上植被經由樹基之吸芽及樹幹，然後遷移至樹冠之葉片上。位於樹基之吸芽葉片，能提供越冬蟎類於春天開始活動時之棲所與取食需求，進而造成以後樹上蟎類的大發生。整體而言，在留有吸芽之樹上，可發現較高比率之葉蟎數，而其捕食蟎之密度相對較低。在7月中旬之蟎類大發生與大遷移，可能與地面植被之耕培行爲有關。另外，在本試驗中所使用之積分估算法，能相當準確的估算蟎數。

（關鍵詞：吸芽、蟎類、密度、分散、地面植被）