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The Effect of European Red Mite Injury to Apple Foliage on Preharvest Fruit Drop and Efficacy of 2,4,5-TP

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Abstract. **'Delicious', 'Golden Delicious', and 'Yorking' apple trees (*Malus domestica* Borkh.) were assessed in 1979–80 for the influence of foliar damage by the European red mite, *Panonychus ulmi* (Koch) (Acari: Tetranychidae) on preharvest drop with and without a stopdrop chemical 2-(2,4,5-trichlorophenoxy) propionic acid (2,4,5-TP). The cumulative percentage of fruit drop did not differ between uninjured and mite-injured trees at mite damage levels that included severe bronzing, nor was there any apparent reduction in the efficacy of the stopdrop spray due to mite damage. Commercially acceptable drop control was obtained with 2,4,5-TP regardless of mite damage. These data do not support the widely accepted view that the uptake and/or performance of stopdrop sprays is impaired on mite-injured apple trees.**

The condition of the apple foliage has been considered to be an important factor in uptake and effectiveness of preharvest drop control chemicals. Low nitrogen status, mouse injury, and poor tree vigor have been cited as possible reasons for poor control of fruit drop following treatment (14). Edgerton (7) noted that sprays must be applied before frost damage or senescence occurs. Foliar damage due to the European red mite and/or apple scab also is mentioned as a possible reason for higher levels of fruit drop following stopdrop treatments (10). Lienk (12) stated specifically that healthy foliage is necessary to obtain full benefits from stopdrop sprays, and mite injury is cited as a general consideration in the use of these materials (1, 2). These authors, however, did not present data to support their views.

Conceivably, mite injury may cause premature fruit abscission prior to harvest even without the use of stopdrop sprays. Earlier observations indicated that fruit from heavily infested trees dropped prematurely in some cases (3, 8, 9). Data from controlled experiments show no differences in fruit drop between uninjured and mite-injured apple trees (5, 13).

The rapid development of resistance to acaricides by the European red mite led to the development of a biological control program in Pennsylvania using the predacious ladybird beetle, *Stethorus punctum* (LeConte). Inherent in the use of a biological control agent is the maintenance of a low prey population to provide food for the predators, and the tolerance of a certain amount of damage. This program prompted the reexamination of the economic injury level of mites on apples (6), including possible effects on other components of the orchard production system. This paper examines the effect of mite injury on preharvest fruit drop, and also the assumption that mite injury to the leaves affects the performance of the stopdrop spray.

Expt. 1. Thirty-two spur 'Delicious' and 32 spur 'Golden Delicious' trees on seedling rootstocks were selected in 1979 from a group of mite-damaged trees. The trees were 18-years-old, vigorous, with an average annual yield of about 6 bushels per tree. In the year of the study, the crop load on the experimental trees ranged from 0.8 to 7.7 bushels per tree. Mite populations were monitored weekly, beginning in late May 1979, by brushing and counting the mites from 25 random leaves from the lower (0–1.5 m) and middle (1.5–3.0 m) canopy of each tree, using a Henderson-McBurnie mite brushing machine. The levels of mite damage varied with the amount and type of registered and experimental acaricides used during the season. It was assumed that these materials had no effect on the leaf uptake of stopdrop material, nor any effect on fruit abscission. Counts were terminated on 22 Aug. when the mites on the experimental trees were killed with cyhexatin (Plictran). The trees were divided into 3 damage levels (equivalent to slight, moderate and severe bronzing): low = 0–200 mite days, moderate = 201–800 mite days, high = > 800 mite days. Mite days are the product of the mite population (all motile forms) and the length of feeding. Thus, 5 mites × 5 days = 25 mite days. The average number of total mite days accumulated in the low, moderate, and high damage levels is 110, 390, and 2267, respectively. These corresponded with a peak number of mites per leaf of 5, 22, and 91.

The experiment was an unbalanced 2 × 2 × 3 factorial design (cultivar × stopdrop × mite level, respectively), with 2 to 8 single tree replications for each treatment combination. On 18 Sept. about half the trees of each cultivar received a dilute handgun application of 20 ppm 2-(2,4,5-trichlorophenoxy)propionic acid (2,4,5-TP). The other half (check trees) were sprayed with water. Fallen apples were removed from underneath the trees before spraying, and all apples that fell thereafter were removed and recorded every 2 to 6 days. The apples that remained on the trees were harvested on 16 Nov. Near normal levels of rainfall fell from April to September with the exception of 5–6 Sept., when about 13 cm of rain fell.

Expt. 2. An experiment was performed in 1980 to determine if mite damage alone influenced the amount of preharvest drop. A block of seven-year-old trees ('Yorking'/EM 26) was subjected to 8 levels of mite damage based on timing and severity of injury. The treatments were: 1–3 = low, moderate, and high mite damage levels, late April to early July; treatments 4–6 = low, moderate, and high mite damage levels, early July to early September; treatment 7 = season-long mite injury; and treatment 8 = mite-free check. Low, moderate, and high levels are represented by the same number of mite days as in Expt. 1. Mite injury levels were obtained through a combination of differential infestation rates, standard acaricides, and predation by *S. punctum*. The trees were uniform in size and crop load, averaging 3.2 bushels per tree. Mite counts were made as in Expt. 1, except that 20 leaves per tree were counted, 10 from each of 2 lower scaffold limbs. Drops were picked up and determined every 2 to 4 days beginning on 8 Oct., after removing apples that had fallen previously. The apples that remained on the trees were harvested 3 Nov. (These data excluded fruit from 2 lower scaffold limbs per tree, which were used in another study, and had been harvested prior to the fruit drop study). These trees did not receive a preharvest drop control spray. Rainfall in the 1980 growing season was 7 cm above normal for April through June, and about 5 cm below normal for July through September.

Insects and diseases in Expt. 1 and 2 were controlled with a standard orchard spray schedule.

The cultivar results in Expt. 1 were analyzed separately, because the 'Golden Delicious' trees had a significantly greater (P = 0.05) tendency to drop fruit prematurely than the 'Delicious' (Fig. 1). These cultivars are

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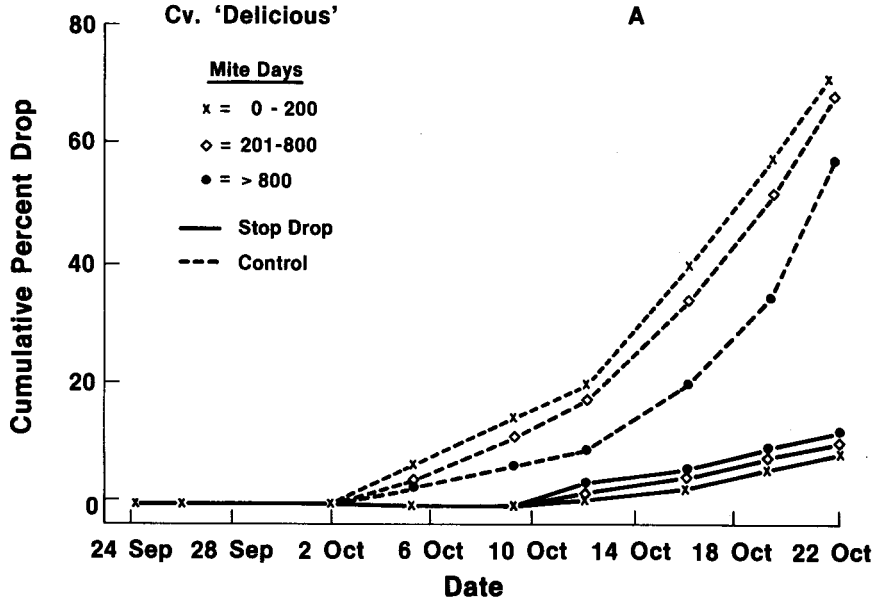

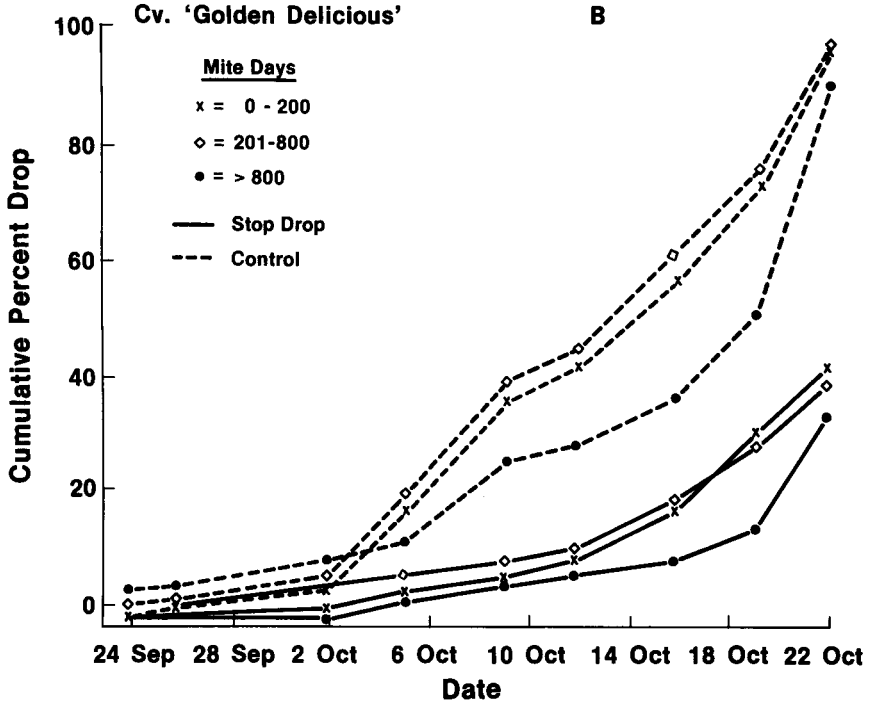

Fig. 1. The cumulative percentage of fruit drop of apple over time at 3 mite injury levels, at 20 ppm and 0 (control) ppm 2,4,5-TP, Biglerville, Pa., 1979. **(1A)** 'Delicious' showed significant differences due to stopdrop treatment occurring from 2 Oct. until the end of the study. **(1B)** 'Golden Delicious' showed significant differences due to stopdrop treatment occurring from 26 Sept. until the end of the study.

normally harvested at about the same time in south central Pennsylvania.

By 22 Oct., the stopdrop-treated 'Delicious' trees ranged from 7.9 to 11.3 cumulative percentage of drop, while the check trees ranged from 59.4% to 73.9%. The cumulative percentage of drop was significantly reduced in all the stopdrop-treated vs. the check trees by 2 Oct., and continued to be low throughout the rest of the study. At no time did a significant effect ($P = 0.05$) occur due to mite level, nor was there any significant interaction between mite level and stopdrop treatment (Fig. 1A).

By 22 Oct., the stopdrop-treated 'Golden Delicious' trees ranged from 33.1 to 43.3 cumulative percentage of drop, while those without stopdrop ranged from 90% to 98%. The significantly reduced cumulative percentage of drop occurred by 26 Sept., due to the influence of the stopdrop treatment, and continued throughout the rest of the study period. There was a tendency for less fruit drop from trees that had experienced the highest level of mite damage, although this trend was not statistically significant. These data points, however, represented only 2 replicates. There was no interaction between stopdrop and mite level on any date (Fig. 1B).

The treatment in Expt. 2 ranged from 10.9 to 17.2 cumulative percentage of drop on 3 Nov., with an overall mean of 15.3% (Fig. 2). No significant effect due to treatment was found on any date; however, there was a significant replicate effect from 20 Oct. to 3 Nov. (Fig. 2).

The mite day levels cover the range typically found in Pennsylvania commercial apple orchards where integrated mite control is practiced. From a survey conducted in 1978 and 1979 for 20 and 16 orchards, respectively, the mean number of accumulated mite days per leaf was 315 (1978) and 574 (1979). Growers were able to manage populations of the European red mite at these levels using the mite predator, *S. punctum* and about 1 acaricide spray per year (11).

The analyses of data from 3 apple cultivars confirm previous observations (5, 13) that the levels of mite damage, including those high enough to cause severe bronzing, have no effect on preharvest drop. It is possible, however, that cultivars prone to preharvest drop may be sensitive to this type of injury (e.g., 'McIntosh'). Early maturing cultivars, whose harvest dates fall into the normal period of mite activity (July and August), also merit further investigation.

There was no evidence in this study to support the intuitive view that mite-damaged leaves are less effective than undamaged leaves in absorbing stopdrop materials, based on the percentage of fruit drop. Commercially acceptable control of preharvest drop was achieved with the use of the stopdrop 2,4,5-TP at all levels of mite damage. Bukovac (4) suggested that the disruption of cuticular waxes, such as that caused by insect feeding, may even increase the penetration of plant growth substances. Direct assays of uptake and translocation are needed to determine if mite injury is affecting these functions, even though no gross effects are evident.

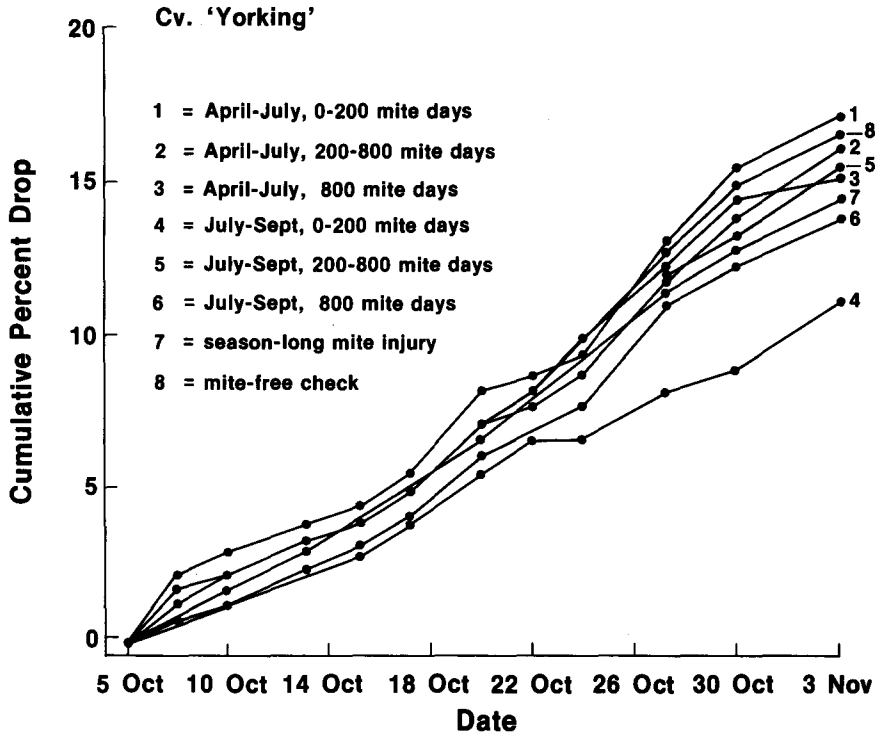

Fig. 2. The cumulative percentage of fruit drop of 'Yorking' apple over time at 8 timing/mite injury combinations, Biglerville, Pa., 1980. No significant differences due to mite injury were found.

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