Table 1. Effect of diuron, monuron, simazine and atrazine[z] on the plastochron index of 'Golden Delicious' apple trees.

	Plastochron index[y]								
	Days after herbicide application								
Treatment	0.5	1.5	25.	3.5	10.5	20.5	30.5	40.5	50.5
Control	16.3a	16.7a	17.1a	17.3a	19.5a	23.1a	25.8a	27.1c	30.7c
Diuron	15.5a	15.8a	16.0a	16.3a	18.3a	22.8a	27.3a	30.8a	34.3a
Monuron	15.8a	16.0a	16.3a	16.5a	18.2a	21.9a	25.1a	26.8c	27.7c
Simazine	16.0a	16.4a	17.0a	17.4a	19.1a	23.0a	27.1a	30.1ab	33.0ab
Atrazine	15.7a	15.9a	16.3a	16.3a	18.7a	22.4a	25.7a	27.5bc	28.5c

[z]80% formulations of the herbicides were used at 4.5 kg/ha.

[y]Youngest leaf with ≥3 cm blade length was used as index leaf for determining index.

[x]Mean separation in columns by Duncan's multiple range test at 5% level.

The influence of herbicides on the plastochron index began to appear 40 days after treatment (Table 1); however, no leaf phytotoxicity was present. Monuron caused the greatest reduction in tree growth as evidenced by the lower leaf plastochron index values, followed by atrazine. At the conclusion of the experiment, control trees had a lower leaf plastochron index than diuron- or simazine-treated trees.

All these herbicides are potential inhibitors of photosynthesis (5, 7). Since monuron (8) and atrazine (13) have greater soil mobility, they probably moved into the root zone and were absorbed, thereby causing a greater reduction in Pn of apple trees than the less mobile diuron and simazine. Monuron and atrazine, through their influence on Pn, also reduced growth as indicated by reductions in leaf plastochron index.

Simazine reduced Pn and increased the leaf plastochron index in the later stages of the experiment. This increase was probably due to the lower leaf plastochron index values for the control treatment rather than a stimulatory influence of simazine. During the experiment, the control treatment in one replication produced only 6 leaves as compared to an average of 15 leaves by the other trees. However, there are reports of increased nitrogen and protein contents of leaves and stimulation in growth and cropping of apples by simazine treatment (2, 9).

It is very difficult to correlate a complex phenomenon like growth directly to Pn. The nature of the herbicide and its influence on other plant processes is an important factor in determining the minimal change in Pn values required to influence plant growth. It is reasonable to assume that the degree of inhibition in Pn is inversely correlated with the time required for the appearance of visible reduction in plant growth. After longer periods of time the reduction in Pn would probably be reflected in the tree growth.

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Multiple Applications of Dicofol and Dodine Sprays on Net Photosynthesis of Apple Leaves[1]

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Abstract. **The effect of dicofol and dodine on photosynthesis (Pn) of greenhouse-grown apple trees (*Malus domestica* Barkh.) was determined by infrared CO_2 analysis. Multiple sprays of dicofol reduced Pn of apple foliage significantly; the reduction was greater in 'Golden Delicious' /M#7 than in 'Delicious'/M#7. The maximum decline occurred after the second spray and subsequent applications did not cause further decrease. Multiple sprays of dodine had no significant influence on Pn.**

Dicofol (2,2,2-tricholoro-1, 1-di (4-chlorophenyl) ethanol), and acaricide, and dodine (n-dodecylguanidine acetate, a fungicide, are commonly used on apple trees for control of mites and diseases. Dicofol did not reduce growth or dry wt of leaves (7). Dodine-sprayed 'McIntosh' apple trees yielded less than zineb- or captan-treated trees (4) and dodine injured 3% of the apples (3). No significant differences were recorded in the fruiting performance of 'Stayman' trees treated with this chemical (2). In a recent study, dodine did not alter the net photosynthesis of apple leaves (1). The objectives of the present investigation were to evaluate the effects of multiple sprays of dicofol and dodine on Pn and the differential response, if any, of 'Delicious' and 'Golden Delicious' apple trees to these treatments.

One-year-old apple trees ('Delicious' /Malling (M) 7 and 'Golden Delicious'/ M#7) were grown in 20 cm plastic containers in a 3 loam:1 peat: 1 perlite mixture. The trees were kept in cold storage at 2°C until planting on July 3, 1973. At the time of treatment, the trees had an average of 36 leaves. Pn was determined on the 15th leaf from the index leaf (youngest leaf with petiole length of 3 cm). The same leaf was measured throughout the trial.

The treatments were applied in a randomized block arrangement with 3

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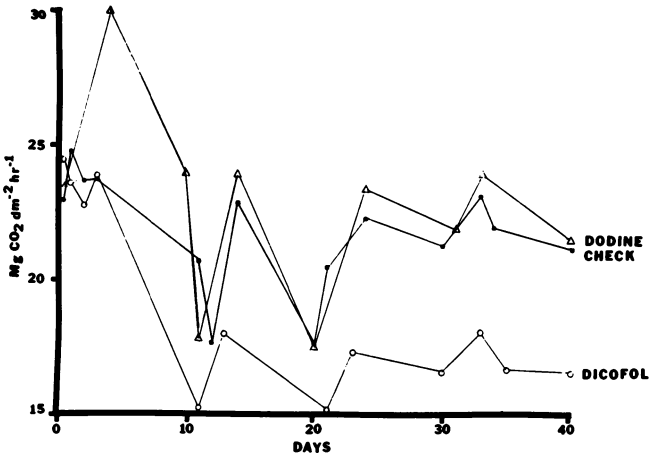

Fig. 1. Effect of 4 sprays of dicofol (1.3 ml/liter and dodine (0.6 g/liter) applied 0, 10, 20, and 30 days to Pn of 'Golden Delicious' leaves (LSD 5% = 2.9).

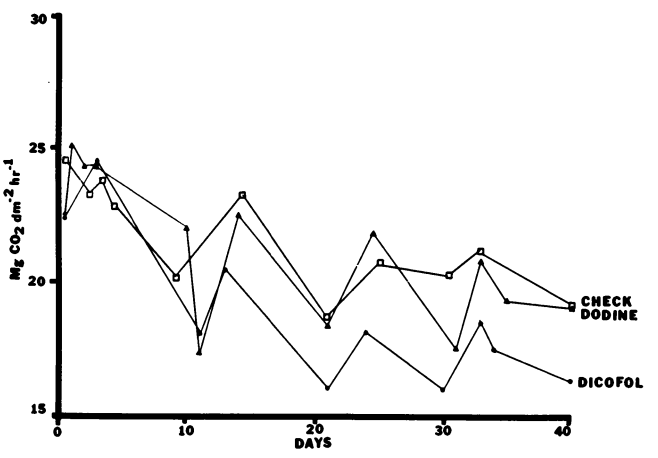

Fig. 2. Effect of 4 sprays of dicofol (1.3 ml/liter) and dodine (0.6 g/liter) applied 0, 10, 20 and 30 days on Pn of 'Delicious' leaves (LSD 5% = 2.9).

replications. Dicofol (42% E.C.; 1.25 ml/liter) and dodine (65% w.p.; 0.6 g/liter were mixed in distilled water and the entire tree was sprayed with a hand atomizer until drip. Distilled water was applied to the check trees. All trees were grown in the greenhouse and moved to a growth chamber the night before treatment. The light intensity at median plant height was 21.6 klx with the lights programmed for a 15 hr light and 9 hr dark cycle. Readings were taken 1, 24, 48 and 72 hr following treatment. The trees were returned to the greenhouse following the 72 hr reading. The first spray was applied on August 31, 1973, and 3 subsequent sprays at 10-day intervals. An additional Pn reading was taken 20 days after the last spray.

There was a sharp rise in the Pn of dodine-treated 'Golden Delicious' leaves 72 hr following the first spray (Fig. 1). In all cases, the rates dropped significantly 10 days after the spray. One hour after the second spray, the Pn declined further, recovering sharply in the next 72 hr, and decreasing again 10 days later. This pattern was repeated in the periods following the 3rd and 4th sprays, but the size of the depression in Pn was less pronounced after each successive spray. The maximum decline in Pn occurred after the 2nd spray and subsequent sprays did not decrease Pn further.

The minimal values of Pn obtained at 1 hr and 10 days after the sprays in all treatments (Fig. 1 and 2) may be due to the way plant material was handled. Low Pn values for all the treatments on the 10th day suggest that 1 night was not sufficient for the plants to become adapted to the change in environment. Since the Pn of leaves on check trees sprayed with distilled water was reduced, it is suggested that the readings taken 10 days, 1 hr, and 24 hr after the spray were influenced by the environmental conditions as well as the pesticide chemical. Because the Pn values at 48 and 72 hr following the treatment were conditioned to the changed environment, therefore, the readings taken at 48 and 72 hr after spraying are considered more valid expressions of the treatment effects on Pn. The decrease in the fluctuation of Pn values after each successive spray probably implies that the leaf was adapted to the changing conditions or possible treatment.

Although the treatments were assigned at random in the experiment, the check trees of 'Golden Delicious' initially had lower Pn. Therefore, dicofol probably has a more retarding and dodine a less stimulating affect on Pn than appears in Fig. 1. The values obtained for the check, dodine, and dicofol treated 'Golden Delicious' leaves 10 days after the last spray were 90%, 82% and 62%, respectively, of their initial CO_2 absorption rates. Dicofol and dodine reduced Pn by 25% and 16%, respectively, in preliminary trials (5).

The fluctuations in Pn values and the effects of the treatments were less pronounced in the 'Delicious' leaves (Fig. 2) than in 'Golden Delicious' (Fig. 1). Dicofol reduced Pn significantly in both cultivars, but the decrease was greater in 'Golden Delicious'. Dodine did not affect Pn of either cultivar.

The reduction of Pn from dicofol, the absence of leaf phytotoxicity symptoms, and the lack of effect on tree growth all substantiates the findings of others (6, 7). The inhibition of Pn following the 1st and 2nd spray (10% and 21%) and no significant recovery during the course of the trial indicates the lasting effect of dicofol on the trees. Additional studies are needed to determine the influence of a decrease of Pn on fruit quality and yield. Since dicofol reduced Pn more in 'Golden Delicious' than in 'Delicious' trees, studies comparing the influence of commonly used pesticides such as dicofol on different cultivars are needed.

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