Net Photosynthesis and Respiration of Apple Leaves Influenced by (2-Chloroethyl)phosphonic Acid

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Abstract. Concentrations up to 4000 ppm of (2-chloroethyl)phosphonic acid (ethephon) did not affect the net photosynthesis (Pn) of leaves on greenhouse grown apple trees. Leaf respiration was increased by 4000 ppm ethephon, but not by lower concn. Pn rates did not differ between cvs., but respiration of 'Golden Delicious' leaves was greater than that of 'York' leaves.

Ethisphon has been shown to have potential as an aid to mechanical harvesting of apples and cherries by accelerating fruit abscission (1, 7, 8). If applied to eliminate fruit set on young apple and peach trees ethephon may be without apparent phytotoxicity to the foliage (7), but it may also suppress the size of leaves developing after treatment (12, 14).

Upon degradation in plant tissues, ethephon liberates ethylene gas (16). Treatments with this compound induced leaf yellowing and abscission (2, 7, 8) and increased the ripening rate of fruits (1, 13, 15). These plant responses have long been known to occur following ethylene treatments (2, 11).

In our study the effects of ethephon were determined on Pn and respiration of leaves on young apple trees at various stages of growth.

Materials and Methods

Apple trees were grown in 1-gal cans. The steam sterilized medium consisted of 3 parts loam soil and 1 part finely shredded peat moss. The trees were sprayed weekly with insect control and fertilized every 3 weeks. Beginning August 1, 1969 and throughout the 1970 experiment, minor elements were also added. The greenhouse was shaded each year in mid-June which resulted in a max light intensity of 5000 to 6000 ft-c. Prior to shading the greenhouse, the trees were subjected to full light intensity.

Experiment I. Two-year-old 'Golden Delicious' trees on seedling rootstocks were potted on May 6, 1969 and only 1 shoot was allowed to develop. One hundred uniform trees were selected on June 17, and divided into 5 replications on the basis of shoot growth. Ethisphon was applied at 4 treatment dates. The treatments were applied 30, 64, 98, and 128 days after bud break which started May 17.

Pn and respiration were measured for each treatment date 1, 8, 15, and 21 days after treatment on similar age leaves. They were measured by placing an intact leaf in a sealed chamber with an air flow rate of 3 l-min. The leaf chambers and respiration chambers were maintained at 32 ± 2° C and 27 ± 2° C, respectively. The avg CO2 concn of the outside air used was 318 ppm.

Results and Discussion

Interactions among main effects were not significant; therefore, the Pn and respiration data are presented as means for treatments, days after bud break, and cultivars.

Pn was not affected by ethephon treatments (Table 1). Pn of leaves in the first treatment group was higher than that of leaves in the subsequent groups in both experiments (Table 2). The leaves in the first treatment group developed under lower light intensities.

Leaf respiration was not affected by any of the ethephon treatments in Exp. I., but was increased by the 4000 ppm ethephon treatment in Exp. II (Table 1). Time of treatment had no consistent effect on leaf respiration (Table 2). Ethylene has been shown to increase respiration rate of pea and sunflower stem sections (3) and cotton leaves (10). Russo et al. (13) reported that 1000 ppm ethephon increased respiration of banana fruit to the same degree as 100 ppm of ethylene. Preharvest sprays of ethephon increased respiration rate and shortened the interval between harvest and the start of the climacteric rise in 'McIntosh' apples (6). It is apparent that respiration were computed from the leaf area, the change in CO2 concn of the air passing over the leaf, and the flow rate through the leaf chamber, and were expressed as mg CO2 dm⁻²·hr⁻¹.

Ethephon concentration (ppm) | Pn (mg CO2 dm⁻²·hr⁻¹) | Respiration
---|---|---
0 | 12.36 a² | 13.83 a | 1.27 a | 1.10 b
125 | 13.05 a | 13.17 a | 1.41 a | 1.15 ab
250 | 13.24 a | 13.61 a | 1.41 a | 1.15 ab
500 | 13.05 a | 14.06 a | 1.39 a | 1.16 ab
1000 | 13.05 a | 14.06 a | 1.39 a | 1.16 ab
2000 | 13.05 a | 14.34 a | 1.39 a | 1.20 a
³Means of all Pn and respiration determinations made 1, 8, 15, and 21 days after treatment at 4 times after bud break of 'Golden Delicious' (Exp. I), and 1, 8, 15, and 29 days after treatment at 3 times after bud break of 'Golden Delicious' and 'Red Yorkshire' (Exp. II).
²Means within a column not followed by a letter in common differ significantly at the .05 level by Duncan's Multiple Range Test.

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Table 2. Influence of plant age at time of ethephon treatment on the net photosynthesis (Pn) and respiration of apple leaves.

<table>
<thead>
<tr>
<th>Time of treatment</th>
<th>Mg CO_2 dm^{-2}hr^{-1}</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of days after bud break</td>
<td>Exp. I</td>
</tr>
<tr>
<td>30</td>
<td>16.49 A^Y</td>
</tr>
<tr>
<td>64</td>
<td>10.98 B</td>
</tr>
<tr>
<td>98</td>
<td>11.80 B</td>
</tr>
<tr>
<td>128</td>
<td>12.38 B</td>
</tr>
</tbody>
</table>

^XMeans for 5 rates of ethephon on 'Golden Delicious' with determinations made 1, 8, 15 and 21 days after treatment (Expt. I) and 4 rates of ethephon on 'Golden Delicious' and 'Red Yorkings' with determinations made 1, 8, 15, 22, and 29 days after treatment (Expt. II).

^YMeans within a column not followed by a letter in common differ significantly at .01 level, capitals; or .05 level small letters, by Duncan's Multiple Range Test.

ethephon has the potential to increase respiration of various plant tissues.

The overall Pn means for 'Golden Delicious' and 'York' leaves were 13.73 and 14.18 mg CO_2 dm^{-2}hr^{-1}, respectively. These means were not different at the 5% level. The mean leaf respiration rates (1.22 and 1.08 mg CO_2 dm^{-2}hr^{-1}) for 'Golden Delicious' and 'York' differed at the 1% level of significance.

Ethephon at the rates used did not affect the Pn of individual apple leaves and the effect on leaf respiration appears to be of minor consequence. Although Pn per unit leaf area was not reduced, ethephon treatments could be expected to result in a lower Pn for the whole plant because of lower leaf area on the post-treatment shoot and the induced senescence reported by Dozier.

**Literature Cited**


