Effect of Abscisic Acid on Root and Shoot Growth of Tomato

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Additional index words. root-shoot ratio, Lycopersicon esculentum

Abstract. Abscisic acid (ABA) at concentrations between $5 \times 10^{-7}$ and $5 \times 10^{-6}$M, was sprayed on seedlings of 'Sutton's Best of All' tomato (Lycopersicon esculentum Mill). ABA at $5 \times 10^{-7}$ and $5 \times 10^{-6}$M significantly enhanced shoot extension growth but did not markedly affect chlorophyll production. Root, but not shoot, fresh and dry weights were significantly reduced by $5 \times 10^{-5}$M ABA. $5 \times 10^{-6}$ and $5 \times 10^{-5}$M ABA significantly reduced the root:shoot ratio.

As part of a program of transplant physiology, various compounds are being tested for their relative effect on root and shoot growth. ABA is known to inhibit the growth of different plant species (1). It has been shown, however, that $10^{-8}$M ABA significantly stimulated the shoot growth of 'Fireball' tomato (3). The effect of ABA on root growth of intact tomato plants is less well known. If roots are stimulated by ABA there is a possibility that ABA may increase the root:shoot ratio. This study was conducted to determine the effect of ABA on root and shoot growth of tomato. This work complements studies on the effects of ABA on excised roots of the same cultivar (5).

Seeds of cultivar 'Sutton's Best of All' were sown on April 2, 1975 in coarse sand. They were germinated and grown under natural light (approx daylength 11—12 hr) in a controlled environment glasshouse at 20°C and 50% relative humidity. Two-week old seedlings were transplanted into 11 cm plastic pots and grown in U.C. soil mix A(4). Plants were fertilised 10 days after transplanting with a nutrient solution consisting of 6g/liter of 20N—8.6P—16.6K fertiliser. ABA, (RS) 3-methyl-5-(4-hydroxy-4-keto-2,6,6-trimethyl-2-cyclohexen-1-yl)-cis, trans-2,4-pentadienoic acid (Burdick and Jackson Labs. Inc., Muskegon, Michigan) was dissolved in a small volume of ethanol and diluted with 0.05% Tween 20 (Polyoxyethylene sorbitan mono-oleate). Three-week old seedlings at the 3-4 leaf stage of development were sprayed to run-off with different concn of ABA. A second foliar spray was applied one week later. A randomized complete block design of 15 single plant replicates were used.

Growth increments and chlorophyll levels (2) were determined three weeks after the first ABA application.

Tomato shoot elongation was significantly promoted by $5 \times 10^{-6}$ and $5 \times 10^{-7}$M ABA, while $5 \times 10^{-5}$M was inhibitory (Table 1). The inhibition caused by $5 \times 10^{-5}$M was not significant, but other experiments showed that $5 \times 10^{-4}$M or higher was significantly inhibitory. A trend of enhancement by higher and inhibition by higher concn was also seen in root growth (Fig. 1).

Although none of the stimulations differed significantly from the control there was significant reduction in the dry wt root: shoot ratio (Table 1).

Table 1. Effect of ABA on shoot extension growth and root:shoot ratio.

<table>
<thead>
<tr>
<th>ABA concn</th>
<th>Shoot growth (mm)</th>
<th>Root/Shoot ratio</th>
<th>Dry wt</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(M)</td>
<td></td>
<td>fresh wt</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>65.8 ± 4.92y</td>
<td>0.68 ± 0.09</td>
<td>0.66 ± 0.10</td>
</tr>
<tr>
<td>$5 \times 10^{-7}$</td>
<td>81.8 ± 5.01y</td>
<td>0.62 ± 0.08</td>
<td>0.69 ± 0.10</td>
</tr>
<tr>
<td>$5 \times 10^{-6}$</td>
<td>85.1 ± 3.93z</td>
<td>0.69 ± 0.09</td>
<td>0.36 ± 0.06y</td>
</tr>
<tr>
<td>$5 \times 10^{-5}$</td>
<td>59.8 ± 3.60</td>
<td>0.58 ± 0.05</td>
<td>0.22 ± 0.03z</td>
</tr>
</tbody>
</table>

*YSE* significantly different from control at the 5% level of probability.

Literature Cited

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Fig. 1. Effects of ABA on fresh and dry wt of tomato roots and shoots. ABA was applied on days 7 and 14. Plants were harvested on day 28. Cross-hatched columns fresh wt, stippled columns dry wt. “Z” indicates significantly different from control at the 5% level of probability.

Chlorophyll levels were not markedly affected. These results are in agreement with those of Aung (3) with slight exception. 5 x 10^{-7} M ABA enhanced fresh but not dry wt of shoots whereas both parameters were increased in roots.

This concn of ABA increased shoot extension growth. This may suggest a diversion of assimilates to the root at this concn of ABA, thereby causing an increase in root wt, and a reduction in shoot dry wt. These data, further, show that ABA treatment causes a greater inhibition of dry wt increase in roots than in shoots, thereby causing a reduction in the root:shoot ratio. Insofar as an increase in root: shoot ratio may be expected to aid the survival and growth of transplants, ABA treatment does not appear to have potential in this context. The effect of ABA on roots, demonstrated above, is, of course, an indirect effect. When excised roots of tomato were exposed directly to solutions of ABA, 3 x 10^{-6} M ABA caused 60% inhibition of extension growth (5). Approximately the same concn (5 x 10^{-6} M) caused 29% stimulation of shoot extension growth (Table 1). The sensitivity of roots and shoots to ABA is reminiscent of the relative sensitivities of roots and shoots to auxins.

### Literature Cited

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**A Rapid Spot Test for Ascorbic Acid in Tomato Fruit**

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Additional index words. Microassay, field test, Vitamin C, *Lycopersicon esculentum*

Abstract. A portable, rapid, and relatively simple spot test is applied to the determination of ascorbic acid in the juice from single fruit of tomato (*Lycopersicon esculentum* Mill.). For this application reference strips with ranges of 12.5 to 100 mg/ml (± 12.5 mg/ml) and 30 to 46 mg/ml ±2 mg/ml were prepared. Standard titrimetric estimations conducted on the same samples consistently confirmed the spot test results.

The multiplicity of current publications on the subject of ascorbic acid or Vitamin C (C) assay preparation.

The importance of tomatoes as a source of C is well documented (7, 10), however the primary objective of most tomato breeding programs has remained improvement in those fruit and vine attributes which relate directly to an increase in useable yield. Improvement in C content has seldom been a major goal.

If improvement in a single quality factor such as C level is attempted, sampling becomes a major source of error (10). Therefore, in screening a large segregating population for genetic increase in C, it is often desirable to analyze fruit from single plants which have been judged subjectively to be superior in other necessary characteristics. Since C level is dependent upon fruit maturity, exposure to sunlight, and other factors (3), C analysis on single fruit as they reach a chosen stage of maturity can be more meaningful than analysis of bulk samples. Similar rationale can be applied to the monitoring of C levels of tomato cultivars in order to meet recent FDA standards (5). The objective of this research was to develop a rapid and portable test for ascorbic acid which