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PLANT WATER STATUS OF APPLE TREES AND ITS MEASUREMENT IN THE FIELD. 3. SOME SOURCES OF VARIATION IN THE WATER POTENTIAL OF APPLE LEAVES IN THE FIELD

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SUMMARY

Leaf water potentials may vary with leaf insertion height for some species, giving rise to errors dependent on sampling heights. Leaf position and leaf age at one insertion height could also influence measured water potentials.

For the apple tree, leaf water potentials determined with the dye technique differed with insertion height. These differences were appreciable and point to the need for standardizing sampling height for routine stress measurement.

With different leaf ages and positions some differences in observed leaf potentials were noted; therefore both of these also need to be standardized in sampling procedures.

Stress condition, crop distribution, fruit-bearing characteristics, competition between young and mature leaves, and the relationships between leaf and fruit water potentials can all influence observed differences in leaf potentials with height, age and position.. Further studies are required to evaluate more carefully the specific reasons for the observed differences with each apple variety.

I. INTRODUCTION

After an examination of the dye technique in earlier work (Chapman 1970 *a, b*), it was considered important to examine some of the variations in water potential likely to be encountered in field studies with apple trees.

Maximov (1929) and Huber (1956) have reported that for a number of species different water deficits may be found in leaves at varying heights of insertion on the same plant. However, more recently Carr and Gaff (1961) found little evidence of such differences. It is interesting and necessary to examine the possibility of this source of variation, particularly with regard to sampling procedures.

Changes in water potential with leaf position and leaf age at one height of insertion may also be important but little information appears to be available on these two aspects. Therefore, in the following work height, positional and leaf age effects on leaf water potentials are examined for Delicious, Jonathan and Granny Smith apple varieties, using the dye technique (Chapman 1970*a*).

II. MATERIALS AND METHODS

For variations in leaf water potential with leaf insertion height, three heights of leaf insertion above the ground (3, 5 and 8 ft) were examined for the three varieties on two separate occasions on which the water stress was judged to be high and low. Five field replicates with single-tree plots were utilized for each variety. Eight fully expanded, exposed, terminal spur leaves were sampled from each height on each tree and brought to the laboratory. The water potential of the leaves was then determined, using the dye technique.

For variations in leaf water potential with leaf position, three leaf positions at a similar height of 5 ft above ground level were chosen for examination. Leaves sampled are defined by position on the tree:

(1) Fully expanded, exposed, terminal spur leaves.

(2) Terminal lateral leaves, not fully expanded. Such leaves are found on current season's lateral shoot growth, close to the terminal bud.

(3) Basal lateral leaves, fully expanded. These leaves are found at the base of a lateral shoot described above.

There are leaf age differences between (1) and (2) and (2) and (3).

The comparison was made on each of three varieties and five replicate trees of each were used. Eight leaves were collected from each position on each tree and brought to the laboratory, where water potentials were determined using the dye technique.

Observations were made on two separate occasions with each variety in an attempt to show positional effects on water potential under high and low stress conditions.

III. RESULTS

Height effects.—Table 1 presents the height effects for the three varieties. For Delicious, water potential was significantly lower at 3 ft than at either the 5 ft or the 8 ft height for both stress conditions. In Jonathan, it was again lowest at the lowest height but decreased also from 8 ft to 5 ft at both stresses. With Granny Smith, there were no effects of height of leaf insertion at the higher stress, but at the lower stress the water potential in leaves at 8 ft was significantly lower than at 3 ft.

TABLE 1

VARIATIONS IN WATER POTENTIAL (ATM) WITH LEAF INSERTION HEIGHT FOR THREE APPLE VARIETIES AT TWO LEVELS OF WATER STRESS

Variety	Stress	Insertion Height			L.S.D.	
		3 ft	5 ft	8 ft	5%	1%
Delicious	Low	−14·80	−11·70	−11·50	0·98	1·42
	High	−16·40	−13·66	−12·50	1·22	1·78
Jonathan	Low	−14·80	−13·43	−11·12	1·11	1·61
	High	−18·82	−14·80	−12·26	1·60	2·33
Granny Smith	Low	−2·31	−2·90	−3·32	0·65	0·94
	High	−19·60	−19·80	−19·40	n.s.	n.s.

It would seem therefore that differences in water potential at different heights of leaf insertion exist in apple trees. The effect of height on potentials developed can result from differences in leaf exposure and leaf age, but since these have been avoided here, other factors are responsible. Crop distribution on the tree and the relationships between leaf and fruit water potentials possibly account for some of the height effects. The possibility of younger leaves competing with the mature leaves sampled may have also influenced potentials. This latter aspect is considered in part in the following section.

Leaf positional effects.—Results for leaf positional effects are presented in Table 2. For Delicious there were no differences in water potential with leaf position at the lower stress. However, at the higher stress both terminal and basal lateral leaves had lower potentials than those of spur leaves, with the younger terminal lateral leaves having lower values than the fully expanded basal laterals. With Jonathan, no significant effects were recorded. Granny Smith at the higher stress showed no differences in water potential with varying leaf position, but at the lower stress young lateral terminal leaves had lower potentials than those of the mature fully expanded terminal spur leaves.

TABLE 2

VARIATIONS IN WATER POTENTIAL (ATM) WITH LEAF POSITION FOR THREE APPLE VARIETIES AT TWO STRESSES

Variety	Stress	Leaf Position			L.S.D.	
		Spur Terminal	Lateral Terminal	Lateral Basal	5%	1%
Delicious	Low	−5·76	−6·15	−5·95	n.s.	n.s.
	High	−12·50	−14·40	−13·46	0·57	0·83
Jonathan	Low	−5·19	−5·34	−4·74	n.s.	n.s.
	High	−15·60	−15·40	−15·60	n.s.	n.s.
Granny Smith	Low	−2·51	−3·55	−3·32	0·87	n.s.
	High	−16·80	−16·40	−17·02	n.s.	n.s.

IV. DISCUSSION

With apple trees it would seem that differences in water potential do exist at different heights of leaf insertion. These differences are appreciable and point to the need for a constant sampling height for stress measurements. The effects of height on potentials developed can result from differences in leaf exposure and leaf age, but since these were avoided, other factors are responsible. Crop distribution on the tree and the relationships between leaf and fruit water potentials possibly account for some of the height effects. Competition between younger leaves and mature leaves may also have influenced potentials developed.

Overall where potentials varied with leaf position, the lowest values were associated with younger immature terminal lateral leaves. Basal lateral leaves appear to occupy the intermediate potentials, with terminal spur leaves having the highest values. This effect of position on leaf potentials appears to be dependent on variety, this in turn probably being related to both fruit-bearing characteristics and leaf age.

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