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BOTANY

THE EFFECT OF GIBBERELLIC ACID ON WATER LOSS BY BEAN PLANTS [1]

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Gibberellins have been shown to affect higher plants in many ways, including breaking of dormancy (Leben and Barton, 1957; Rappaport, 1956; Wittwer and Bukovac, 1957), substituting for vernalization (Wittwer annd Bukovac, 1957), substituting for day length requirement (Lang, 1956), reversing of light-induced inhibition of seed germination (Lockhart, 1956), and increasing stem elongation (Marth *et al.*, 1956).

Hayashi and Murkami (1953) and Kato (1956) studying the effect of gibberellin on peas concluded that increased growth of etiolated stem sections was accompanied by increased water uptake. Indole acetic acid has also been shown to affect absorption of water by potato tuber slices (Hackett and Thimann, 1950). To test the effect of gibberellic acid on the water economy of intact plants, this study was undertaken to measure transpiration of plants which had received root treatments of gibberellic acid.

MATERIALS AND METHODS:

Seeds of *Phaseolus vulgaris* L., variety Black Valentine, were placed in moist quartz sand in the greenhouse and allowed to germinate. At the end of 15 days, when the first trifoliate leaf had begun to expand, the plants were removed from the sand and their roots washed. Uniform plants were placed singly in 250 ml. Erlenmeyer flasks to which was added a modified Hoagland's solution with one of the following concentrations of gibberellic acid: 1 ppm; 10 ppm; or 100 ppm. Check plants received only Hoagland's solution. Each plant stem was then sealed to the mouth of the flask with modeling clay, sealing the roots and part of the hypocotyl in the flask with the solution, while the aerial portion remained in the atmosphere. Additional flasks containing Hoagland's solution and into which was sealed a portion of bean stem only (not extending into the solution) were also prepared as a check on the clay seal. The exposed cut end of the stem was sealed with clay. Each treatment was replicated five times.

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At the beginning of the experiment the flask, the clay, the solution, and the plant were weighed individually for each system, and the second internode (primary leaf node to the node of the first trifoliate leaf) and the stem apex (from the first triofoliate leaf node to the stem tip) of each plant were measured. Five representative plants were oven dried and weighed.

The plants in flasks were placed in a controlled-environment room with a 12 hour 75°F. day period and a 12 hour 65°F. night period. At daily intervals each plant and flask was weighed and the lengths of the second internode and stem apex of each plant were measured. The experiment was concluded on the fifth day, and at this time the final weight of the flask and plant was determined.

RESULTS AND DISCUSSION

The results are summarized in Fig. 1, 2, and 3. The rate of transpiration from treated plants was greater and increased with time.

Mean difference in water loss at the end of 24 hours and the cumulative loss of water at the end of 48 hours for all treatments was not significant. However, for all other cumulative values of water loss the mean differences were significantly higher for the gibberellic acid treated plants (Table 1). For each array in which statistical significance occurs a Student-Newman-Keuls multiple range test was performed. In all items the means fall into two groups, the means arising from gibberellic acid treated plants and the means arising from non-treated plants, indicating that the significance was contributed by the

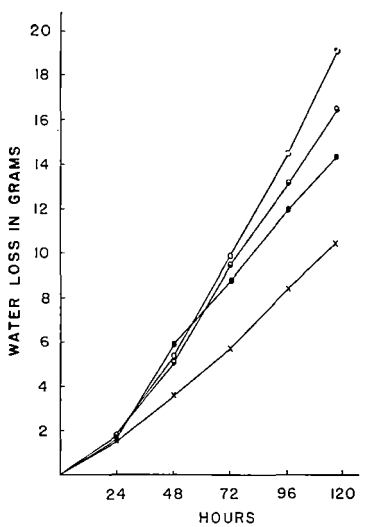
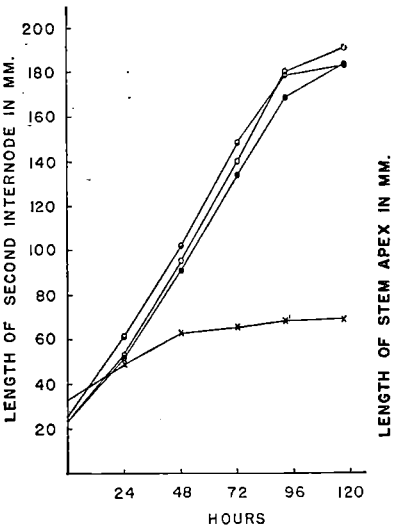


FIGURE 1. The effect of gibberellic acid on the water loss of bean plants.

No gibberellic acid .....X—X;
1 ppm gibberellic acid .....O—O;
10 ppm gibberellic acid .....O—O;
100 ppm gibberellic acid .....O—O.



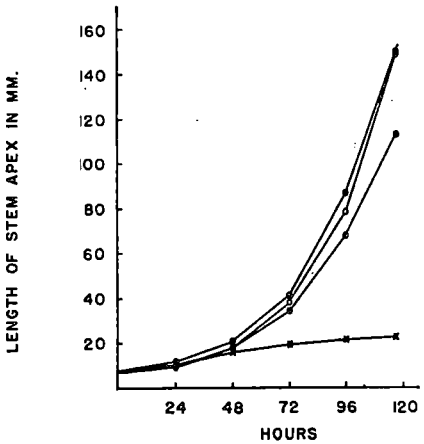


FIGURE 2. The effect of gibberellic acid on the growth of the second internode.
No gibberellic acid .....X—X;
1 ppm gibberellic acid .....O—O;
10 ppm gibberellic acid .....O—O;
100 ppm gibberellic acid .....O—O.

FIGURE 3. The effect of gibberellic acid on the growth of the stem apex.
No gibberellic acid .....X—X;
1 ppm gibberellic acid .....O—O;
10 ppm gibberellic acid .....O—O;
100 ppm gibberellic cid .....O—O.

latter. Thus the amount of gibberellic acid present was not as important as whether or not the plant received any gibberellic acid.

The difference in water uptake and subsequent transpiration with respect to time appears to be correlated in time to the growth of the second internode and the stem apex. In fig. 2 are compared the growth of the second internode of plants treated with gibberellic acid and those not treated. Differences among treated and non-treated plants were not significant either initially or after 24 hours. At the

Table 1. F VALUES FOR ANALYSIS OF VARIANCE FOR WATER LOSS, AND GROWTH OF SECOND INTERNODE AND STEM APEX OF PLANTS TREATED WITH SEVERAL CONCENTRATIONS OF GIBBERELLIC ACID AND NON-TREATED PLANTS.

	HOURS					
	0	24	48	72	96	117
Water loss		0.60	3.20	9.40†	10.04†	13.97†
Second Internode	1.59	0.79	4.30*	19.64†	42.65†	51.5†
Stem Apex	1.19	1.20	1.17	8.434†	18.82†	23.15†

* Significance at the 0.05 level.
† Significance at the 0.05 and 0.01 level.

end of 48 hours, however, the differences were significant. The second internodes of treated plants were, in many cases, twice as long as the corresponding structure of the non-treated plants. Table 1 contains F ratios for each time interval of secondary internode growth. The Student-Newman-Keuls multiple range test again indicates that the means can be arranged into two groups according to significance with all gibberellic acid treated plant means in one group and the non-treated plant mean in the other.

Figure 3 contains the data for the growth of the stem apex during the same time interval of the water loss. The configuration of the curves for stem apex growth is similar to that for the growth of the second internode, however, the significant difference among growth means appears at the 72 hour interval instead of the 48 hour interval where the first significant difference occurred for water loss and growth of the second internode. *F*-ratios are contained in Table 1. A Student-Newman-Keuls multiple range test indicates that where significance is found among the means, the means are separable into two distinct groups, the gibberellic acid treated plant means and the non-treated plant mean. Increases of almost 7-fold occurred in the treated plants when compared to the non-treated for growth of stem apex.

To assess the effects of the dry weight and fresh weight increase on the measurement of water loss, the dry weight gains of all plants were calculated by subtracting the average dry weight of the 5 plants harvested at the beginning of the experiment from the individual dry weights of all plants at the end of the experiment. By subtraction the increase or decrease in fresh weight could also be calculated. Differences between mean fresh weight and mean dry weight gains were not significant as indicated by an analysis of variance. While there was in fact an absolute fresh weight and dry weight increase in the treated plants over the non-treated plants this was not significant. The F ratio for dry weight is 0.55, and the F ratio for wet weight mean differences is 2.07. At the .05 and .01 levels the expected F ratio is 3.24 and 5.19 for the appropriate degrees of freedom.

SUMMARY

A significantly greater volume of water was lost by plants treated with gibberellic acid from 48 through 117 hours than by the untreated plants. Gibberellic acid at a concentration of 1 ppm. resulted in greater water loss than at 10 or 100 ppm.

The onset of an increased rate of water loss by treated plants coincided with the increased rate of elongation of the second internode. Increased rate of growth of the stem apex lagged behind that of the second internode by about 24 hours.

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