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WATER AND SOIL TEMPERATURES ON STOCKS

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The time of flowering of stocks, Ball #22 Supreme, was not influenced by applications of water at various temperatures. Flowering was hastened by 5 days in 70°F soil temperatures at air temperatures of 40°F. During the early stages of growth, from transplanting until as many as 10 leaves were formed, growth increased with increasing soil temperatures in both 40°F and 50°F air temperatures. At maturity, however, the quality of the plants grown at high soil temperatures was reduced. This effect was due to low nutrient levels, especially potassium, in the heated soil plots.

Methods--1954

Stock seed was planted in pots on December 23, 1954, germinated and grown at 60°F until January 6 when the pans were moved to a 50°F temperature. The seedlings were transplanted to deep flats in the various soil and water temperature treatments on February 4. The soil mixture consisted of 1 part peat moss, 1 part sand and 2 parts Dunkirk Silt Loam.

Soil temperature was adjusted by 110 volt plastic heating cables connected with soil thermostats. Low voltage heating (Petersen, 1955) units supplemented this arrangement in the 70°F plots in the 40°F air temperatures.

Soil samples were taken on March 5, April 1 and at the end of the experiment. The plants were fertilized with muriate of potash; 1 lb/100 sq. ft., on March 13; with 15-30-15, 1/2 lb/100 sq. ft. on April 3 and 15-30-15, 1 lb/100 sq. ft. on April 27.

The design of the experiment included 2 air temperatures, 40°F and 50°F and soil temperatures of 40°F, 50°F, 60°F and 70°F. There were no 40°F soil treatments at 50°F air temperatures; thus, no plant received soil temperatures lower than the air temperature. Water at temperatures of 35°F, 50°F, 60°F and 70°F was applied, as required, to the water temperature plots in both air temperatures. Three replications of each treatment were included with 24 plants per replication being harvested at the end of the experiment.

Data from the soil temperature plots were recorded early in the experiment by removing 5 extra plants from the plots each week and drying them to obtain dry weights. The number of leaves present each week was also recorded during the first 5 weeks. Final data consisted of the date of flowering (as determined by the day when 8 florets were fully open), + total height, number of florets showing color, fresh weight and dry weight.

It should be mentioned that air temperatures immediately surrounding the plants were probably higher than the air temperature of the greenhouse, since no attempt was made to insulate the soil surface.

FIGURE 1

GROWTH OF MATHIOLA INCANA FROM FEBRUARY 12 TO MARCH 12 AS MEASURED BY DRY WEIGHT

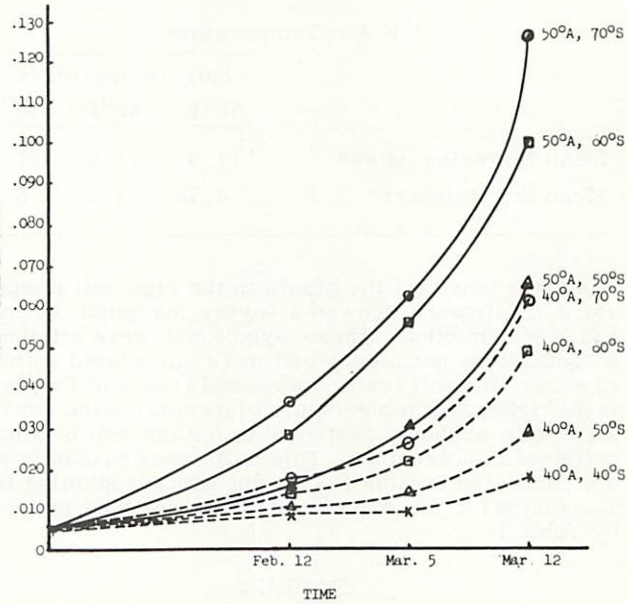

Figure 1 shows the growth during the first 5 weeks in relation to soil temperature as measured by dry weight. Five weeks after transplanting in air temperatures of 50°F and 40°F., plots receiving 70°F soil temperatures had produced 2 and 3 times as much dry weight, respectively, as those grown in unheated soil. In the 50°F greenhouse, soil temperatures of 70°F produced 5 times as much dry weight as those plants in the unheated soil at 40°F.

It is significant to note that plants grown in heated soil at 40°F air temperatures produced essentially the same amount of dry weight as those plants grown in unheated soil at 50°F. Figure 2 shows these relative Con't. on page 2.

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positions graphically.

This relationship, however, was reversed at the end of the experiments as seen by the mean dry weights given in Table 1.

TABLE 1

Mean flowering dates and the mean dry weights of the soil temperature treatments

$40^{o}F$ Air Temperature

	Soil Temperature			
	$70^{o}F$	$60^{o}F$	$50^{o}F$	$40^{o}F$
Mean flowering dates*	19.5	20.5	22.0	25.0
Mean dry weights**	4.89	4.96	5.28	5.57

* Dates given are in the month of May
** Dry weights given in grams

$50^{o}F$ Air Temperature

	Soil Temperature		
	$70^{o}F$	$60^{o}F$	$50^{o}F$
Mean flowering dates*	11.5	13.0	11.5
Mean dry weights**	4.76	4.41	5.81

The lower leaves of the plants in the high soil temperature treatments showed a severe marginal necrosis and were stunted. These symptoms were attributed to potassium deficiency and were correlated with the results of the soil tests. Increased growth of the plants in the higher soil temperature plots early in the experiment was probably responsible for the soil becoming deficient in potassium. This deficiency evidently was not corrected in time to prevent serious stunting thus accounting for the subsequent poor growth as indicated by Table 1.

TABLE 2

Mean flowering dates and the mean dry weights of the soil temperature treatments

$40^{o}F$ Air Temperature

	Soil Temperature			
	$70^{o}F$	$60^{o}F$	$50^{o}F$	$35^{o}F$
Mean flowering dates*	25.0	24.0	24.0	24.5
Mean dry weights**	5.13	5.22	5.57	5.30

$50^{o}F$ Air Temperature

	Soil Temperature			
	$70^{o}F$	$60^{o}F$	$50^{o}F$	$35^{o}F$
Mean flowering dates*	11.0	12.0	11.0	10.0
Mean dry weights**	6.39	6.08	5.81	6.50

* Dates given are in the month of May
** Dry weights given in grams

Water Temperature

Table 2 shows that no consistent differences resulted from the application of cooled or heated water. Table 2 does show, however, that air temperatures affected both dry weight production and flowering date. Plants flowered approximately 2 weeks earlier when grown at $50^{o}F$ air temperatures and weighed 20 per cent more than those at $40^{o}F$.

It seems probable that water temperature has very little affect on growth because of its limited affect on soil temperature. Mastalerz and Cathey (1953) showed that the soil temperature change resulting from applications of $130^{o}F$ or $32^{o}F$ water lasted for no longer than one-half hour.

Discussion

The use of heated soil will, in many cases, increase growth of plants. The increase in this case was particularly evident during the initial stages and probably stems from the fact that the small plants established themselves more quickly in heated soil than in cold soil. New white roots were evident at least 1 week earlier on plants grown in heated plots. It was also noticed that these plants regained turgidity after transplanting sooner than did those in the unheated plots. Bright days did not cause plants in the heated plots to wilt but sometimes severe wilting was noticed in those not heated. This observation indicates that the root system in these latter plots was not active in absorbing water.

The nutrient deficiency encountered in this experiment emphasizes the fact that plants should be fertilized according to soil tests and growth and not according to time alone. More fertilizer was required by the plants grown at $70^{o}F$ soil temperatures than was required at $50^{o}F$, hence these plants suffered from a lack of potassium before those at cooler temperatures. If plants are grown in heated soil, growers should be aware of the fact that they will probably require fertilizer applications more often and if they are going to be grown beyond the small plant stage, the soil should be tested more often than would normally be the case.

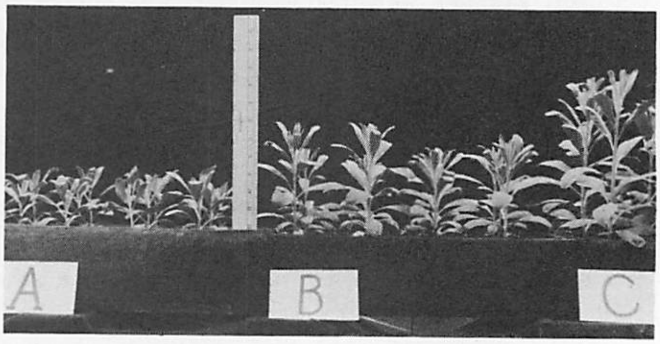

FIGURE 2

(Photo taken 68 days after transplanting)

A. $40^{o}F$ air, $40^{o}F$ soil B. $40^{o}F$ air, $70^{o}F$ soil C. $50^{o}F$ air, $50^{o}F$ soil

The use of heated soil certainly would be of benefit to stocks and probably other plants, especially just after benching. If for some reason houses were maintained at lower than optimum temperatures or if optimum temperatures could not be obtained, it would be

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particularly beneficial. This is evident if the dry weights of plants grown at 70°F soil temperatures at 40°F air temperatures are compared with those grown in unheated soil at 50°F. In many cases it may be cheaper to heat the soil and the air immediately surrounding small plants than it would be to heat the large volume of air in the greenhouse.

Summary

Stocks were grown in electrically heated soil and unheated soil at two air temperatures. A similar group of plants was watered with water at various temperatures. Data indicated that water temperature had little or no affect on the growth of stocks. High soil temperatures, however, did increase the early growth of plants although a nutrient deficiency masked the final results.

Literature Cited

1. Mastalerz, John and H. M. Cathey. Water and soil temperatures do not affect flowering of *Lilium longiflorium*. New York State Flower Growers Bulletin 95:2, 1953.

2. Petersen, Hans. Low voltage heating. New York State Flower Growers Bulletin 115:2-3, 1955.

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