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SNAPS NEED GOOD DRAINAGE

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The growth of snapdragons is markedly affected by short exposures to waterlogged soil while the plants are small. A significant decrease in grade can result from submerging the roots of seedling snapdragon plants for as short a time as 3 days.

Decreasing amounts of growth resulted from increasing exposures to waterlogged soils up to and including 10 days, the longest exposure given.

Experimental Procedure

Snapdragon seeds of the variety Christina were sown on September 16, 1956 and were transplanted to 2 1/4 inch pots 3 weeks later. The plants were grown at 60°F minimum night temperature until October 23, 1956 at which time they were moved to a 50°F minimum night temperature greenhouse. On this date 120 uniform plants were selected and divided at random into 8 groups of 15 plants. One such group was placed in a metal tank 2' x 3' x 6" and enough water added to just cover the soil surface. Five days later and then each day for 4 days, another group was placed in this same tank. An additional treatment was submerged for 12 hours while one group was not treated and served as a control treatment. As a result of this procedure, 8 groups of 15 plants each were subjected to waterlogged soils by submerging for 10, 5, 4, 3, 2, and 1 and 1/2 days while another group received no treatment.

The plants were planted on November 2, 1956 in a raised bench of the "V" bottom type which was provided with an inverted angle iron covered with gravel to insure adequate drainage. The soil consisted of a mixture of 2 parts silt loam, 1 part sand and 1 part peat moss and was steam sterilized before planting.

The plants were arranged in a completely random design to avoid position effects and each treatment was replicated 5 times, each replicate containing 3 plants. A border row was provided around the perimeter of the planting to further reduce variation. No border rows were provided between treatment replications.

The plants were grown to flowering in this position. The first group was harvested on February 22, 1957 and a second group on March 12, 1957. At the time of first harvest, all spikes were not fully open; hence, the need for a second harvest. Plants harvested on March 12 were not of a particular treatment but were distributed among all treatments about equally. At the time of harvest, data were recorded concerning fresh weight, height and the number of florets. Only the number of open florets was recorded.

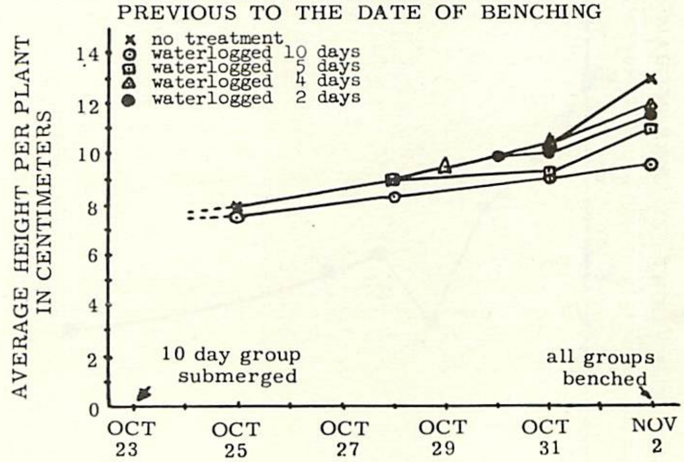
In addition, height measurements were made just prior to benching, three times during the growth period and during the initial period of waterlogging.

* This experiment is part of a larger project investigating the effects of aeration on the growth and pathogen susceptibility of snapdragons in cooperation with the Department of Plant Pathology.

The data were analyzed statistically by means of Tukey's Test (Federer, 1955).

FIGURE 1

THE HEIGHT RELATIONSHIP OF PLANTS SUBJECTED TO WATERLOGGED SOILS PREVIOUS TO THE DATE OF BENCHING



Results

Figure 1 shows the relationship between the amount of growth made by the various treatments during the 8 days previous to the day of benching. It is evident that detectable growth differences resulted within one or two days after submergence. Visual observations were made during this period. Obvious wilting was evident 17 hours after waterlogging in some groups. The rapidity and amount of wilting depended on the amount of sunlight, being severe on bright days and less severe when the sun was obscured. It was noted, however, that wilting was most severe just after waterlogging, the plants gradually regaining turgor with time. As an example, on October 29, 1 day after the 5-day treatment was submerged, it was wilted more severely than the 10-day treatment which had been waterlogged for 6 days. This phenomenon will be discussed later.

On October 31, 1956, 8 days after waterlogging, it was observed that 11 out of the 15 plants in the 10-day treatment showed yellowish areas in the upper leaves characteristic of the lack of iron in the growing regions. Nine plants of the 5-day treatment were showing signs of chlorosis. By November 13, 10 days after the plants were benched, marked chlorosis was evident in the upper foliage of all plants in treatments waterlogged for 10, 5, 4, 3, and 2 days. By the 29th of November, 27 days after planting in well drained soil, all evidence of chlorosis had vanished in all treatments. On this date, however, severe wilting was still evident in some previously waterlogged treatments even though the plants had been in well drained soil for 27 days.

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Figures 2 and 3 show, respectively, the final fresh weight and height relationships of the various treatments. The interpretation of figure 2 is difficult but it is obvious that plant height is no true criterion for comparison since mutual shading tends to cause weaker plants to elongate, become "soft" and grow in height at the expense of quality. From the fresh weight data, however, it is plain that the adverse effects of waterlogging are manifested very soon after the soil becomes waterlogged. These data are in keeping with the previously mentioned observation that plants were less severely wilted on bright days if they had been submerged for a considerable length of time than were similar plants treated for only 1 or 2 days. This same trend is observed in figure 4 which shows the average number of florets per spike.

FIGURE 2

THE INFLUENCE OF WATERLOGGED SOILS DURING THE SMALL PLANT STAGE ON THE FRESH WEIGHT (GRAMS) OF MATURE SNAPDRAGONS

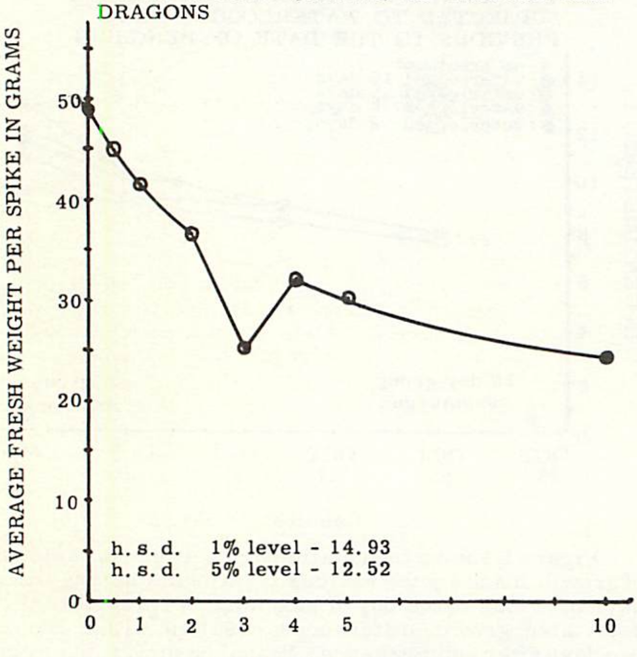

Table 1 gives the numerical data from which figures 2, 3 and 4 were constructed. Statistical analysis of the data showed that differences in fresh weight significant at the 5% level occurred within 3 days after submergence. It is evident, however, that no sharp line may be drawn between injurious and non-injurious exposures since the slope of the curves shown in figures 1, 2 and 3 definitely show a decrease with even shorter exposures than 3 days. The h. s. d. (honestly significant difference) values given in Table 1 were used to compare the means of the various treatments. The means of 2 treatments must differ by more than the h. s. d. to be considered different.

Discussion

Although growers have long been aware of the ill effects of overwatering, poor soil preparation, inadequate drainage, etc., waterlogged soils are often found in commercial greenhouses. In many cases, growers are unaware of the condition since drainage holes may become plugged suddenly, the demands of other work prevents frequent checking, etc. The results of this experiment indicate the importance of paying close attention to these matters.

It is evident from figures 2 and 4 that very short periods of waterlogging can result in severe damage. It is also important to note that although a crop may be damaged, it may appear quite normal and without uninjured plants for comparison, the reduction in yield and "quality" may go unnoticed.

The real reason for the injurious effects of waterlogging is, of course, the inadequate supply of oxygen available to the plant. Since soil moisture and soil oxygen available to plants occupy the soil pore spaces, an increase in the amount of soil water leads to a decrease in the amount of oxygen. With soils containing large amounts of easily decomposable organic matter such as manure or raw composts, the oxygen supply to plants may be reduced further due to the use of oxygen by microorganisms for their growth. It has been shown by Peech and Boynton (1937) and by Andreasen (1952) that flooding almost completely removes the oxygen available to plants since even the small amount of oxygen dissolved in the water is utilized by soil microorganisms and the growing crop.

Peech and Boynton (1937) have further shown that this process may take place very rapidly being almost complete in one hour in some cases. In many instances, the oxygen content of waterlogged soils may rise somewhat as a result of reduced microorganism activity due to a depletion of the supply of readily available food.

The observation that the snapdragon plants wilted shortly after flooding indicates that the oxygen supply was indeed reduced and that this in turn caused the root system to become inactive in the absorption of water. Further, the chlorotic appearance of the waterlogged plants indicated that the absorption of mineral nutrients was reduced. Although wilting and chlorosis cannot be considered to be diagnostic symptoms of injury due to waterlogging, they are closely associated with it and soil should be checked if these symptoms are seen.

Table 1

Mean fresh weight in grams, height in inches and the number of open florets of plants exposed to waterlogged soils previous to benching in a well drained soil

	Days Waterlogged Before Benching							
	0	1/2	1	2	3	4	5	10
Average fresh weight[1]	49.0	45.0	41.6	36.6	25.2	32.2	30.2	24.2
Average height[2]	47.9	45.2	41.9	43.6	39.3	42.0	40.6	38.2
Average number of florets[3]	17.32	14.10	11.36	10.10	7.44	8.56	6.18	2.98

1 h. s. d. at 5% level – 12.61; at 1% level – 14.93

2 h. s. d. at 5% level – 4.15; at 1% level – 4.94

3 h. s. d. at 5% level – 4.88; at 1% level – 5.82

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From the fact that each successive day of waterlogging resulted in less injury than the day before, it appears that snapdragons are able to adapt somewhat to waterlogged soils. This interpretation is further supported by the previously mentioned observation that plants subjected to waterlogged soils for very short lengths of time wilted under conditions which did not cause wilting of plants waterlogged for longer periods. This adaption phenomenon in other plants has been noted previously by other investigators. As an example, Cannon and Free (1920) found that normal roots of sunflowers died when the oxygen supply was depleted in the surrounding atmosphere. New roots immediately started, however, from the base of the plants and, under some conditions, could support apparently healthy tops. An apparently similar situation has been noted by the author with snapdragons growing in nutrient solutions aerated with various gas mixtures. In this case, the initial root system died and new roots formed. These new roots were different in internal structure and external morphology from the original roots. The fact that this can occur is of commercial importance because serious crop injury can result even though the plants may appear normal.

From the observation that several plants remained in a wilted condition for as long as 23 days after benching in a well drained soil and since this permanent wilting was not associated with plants not submerged, it is apparent that the adverse effects of waterlogging snapdragons do not stop with restoration of suitable soil moisture and oxygen levels. It has been suspected that root rot producing organisms may become established in root systems weakened by lack of oxygen due to overwatering, etc., and although no attempt was made to isolate any pathogen from the roots of wilted plants, it is possible that this condition was present. Pythium sp. have been shown to infect snapdragons beyond the seedling stage but erratic results have been obtained and no clear decisions have been made as to the pathogenicity of this group of organisms on healthy snapdragons.

FIGURE 3

THE INFLUENCE OF WATERLOGGED SOILS DURING THE SMALL PLANT STAGE ON THE AVERAGE HEIGHT (INCHES) OF MATURE SNAPDRAGONS

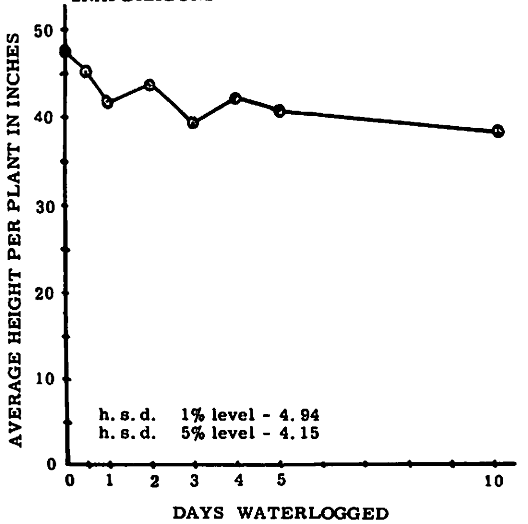
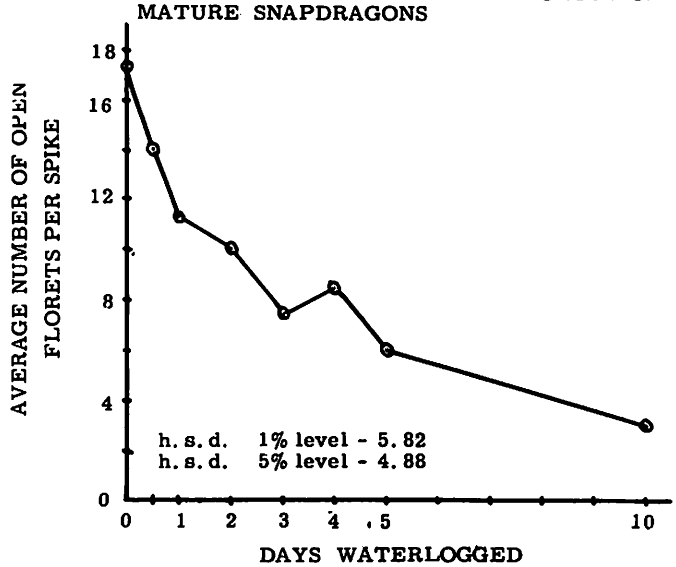


FIGURE 4

THE INFLUENCE OF WATERLOGGED SOILS DURING THE SMALL PLANT STAGE ON THE AVERAGE NUMBER OF OPEN FLORETS OF MATURE SNAPDRAGONS



In order to insure proper soil aeration, it is wise to check drainage before planting by making sure that drainage holes, if present, are not plugged; that wooden benches (especially new ones) have not expanded to close the spaces between the boards, etc. In the preparation of soils for planting, peat moss may be incorporated to insure a friable, well aerated soil which will not become packed and impervious to water and oxygen. By providing adequate drainage and a good soil mixture, overwatering becomes less of a problem.

Summary

Snapdragon plants of the variety Christina were submerged in water to the rim of the pot for periods of 10, 5, 4, 3, 2 and 1 and 1/2 days. Waterlogging for a short a time as 3 days resulted in a significant decrease in subsequent growth in a well drained soil. On the basis of the results of this experiment it is suggested that careful attention be paid in providing drainage, preparing soil and watering to prevent waterlogged conditions.

References Cited

1. Andreasen, R. C. Oxidation-reduction potentials of greenhouse soils as effected by various oxygen concentrations, waterlogging and organic content. Cornell University Ph. D. Thesis, 1952.
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