COLORADO FLOWER GROWERS ASSOCIATION, INC.

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Effect of Soil Depth and Type on Growth and Flowering of Carnations

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Several greenhouses in Colorado have experienced difficulties that are usually attributed to poor physical condition of old soils. One means of overcoming this has been to reduce the depth of the soil in the bench. In the study at CSU, it was found that, where shallow and deep soils were subjected to equal irrigation intervals, shallow depths caused reduced yield and grade. The two growers' soils produced well with no disease, suggesting that problems from disease result largely from either insufficient steaming or reintroduction of pathogens after steaming.

METHODS AND MATERIALS

Two growers' soils, labeled "A" and "B" were brought from the Denver area. These soils have a record of disease and poor production, and had been reduced in depth in the benches. The soils were placed in plots, one series 8 inches deep, the other 4 inches deep, and compared with a Fort Collins loam (CSU New), 8 inches deep, with no modification, and a 10-year old soil (CSU Old), 8 inches deep, with a record of high productivity. Figure 1 shows plot arrangement in the CSU Temperature House, the treatments replicated in each compartment under 4 covers. Results for Scoria-Idealite are not given here. The covers of each compartment, from left to right in Fig. 1, were: 1) frosted fiberglass, 2) clear fiberglass, 3) clear PVC and 4) glass. Both frosted and clear PVC were installed in 1964, the clear fiberglass in 1965.

The relationship between moisture content and soil moisture suction was determined for each soil. Carnations, 'CSU Red', were planted in the soil plots on June 26, 1966. All soil plots were irrigated simultaneously with a Gates system when the plants in the 4-inch plots showed signs of flagging. Nutrients were injected at each watering. Records included total yield and mean grade to April 29, 1967.

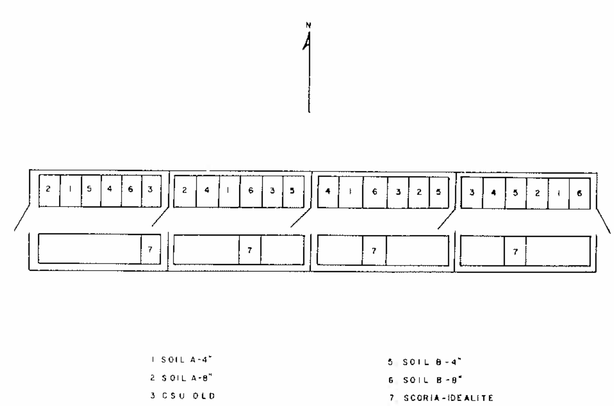

Fig. 1. Plot arrangement of the CSU Temperature House. Covers for each compartment from left to right were: 1) frosted fiberglass, 2) clear fiberglass, 3) clear polyvinylchloride and 4) glass.

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RESULTS AND DISCUSSION

As shown in Table 1, both growers' soils, 8 inches deep, and CSU Old out produced all other treatments. Mean grade was also higher for the 8-inch depths. Figure 2 shows the average plant height on September 19. During initial stages of growth, plants in CSU New exhibited chlorosis that later disappeared. All plots produced reasonably well, and there was no disease evident during the experiment. There were no statistically significant differences in yield or mean grade between compartments as the result of greenhouse cover.

Figure 3 shows the distinct differences in soil moisture content and suction between soils. CSU Old and Soil A were fairly close, but Soil A held the most water at low suctions. Soil B held more water at all suctions, CSU New held less water than the others at all suctions. Essentially Fig. 3 shows the force required to remove water from a soil. In general, it may be stated that the higher the suction to which a plant is subjected, the slower the growth of the plant and yield and quality will be reduced. A suction of 0.01 bar is approximately equal to a value of 1 on a tensiometer, and is the suction the upper surface of a 4-inch deep soil would have after watering and drainage is completed. The upper surface of an 8-inch deep soil will have a suction of 2, or 0.02 bar. Suction at the bottom of both 4- and 8-inch deep soils after watering will be zero. The results may be explained almost entirely on the basis of total available water for use in the substrate, and the suction necessary to extract that water.

Using the data in Fig. 3, the total water content after watering and before watering was calculated for each soil type and depth. The results are given in Table 2. The estimated amounts extracted are given in the last two columns. The following conclusions

Table 1: Influence of soil depth and type on production of CSU Red.

	CSU Old	Soil A-8	Soil B-8	Soil B-4	CSU New	Soil A-4	LSD (5%)
Total flowers per treatment	1054	1046	1032	871	867	813	178[a]
Flowers per sq. ft.	37.6	37.4	36.9	31.0	31.0	29.0	
Mean grade	4.49	4.37	4.32	4.07	4.19	4.06	0.18
Percent distribution of grade							
Fancy	61	58	58	45	49	46	
Standard	30	25	29	23	27	21	
Short	6	15	11	27	19	25	
Design	3	2	2	5	5	7	

[a]Values underlined by the same line are not significantly different from each other.

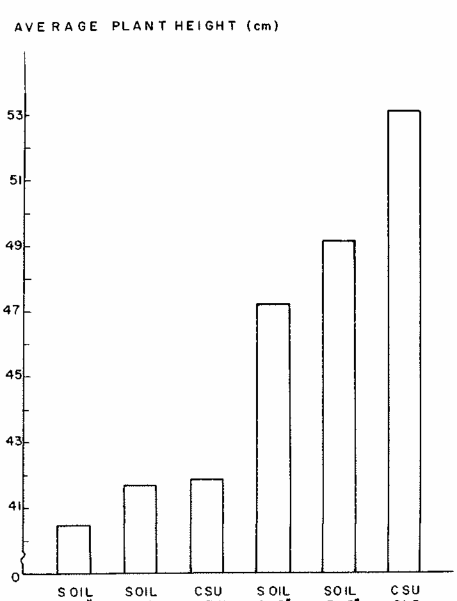

Fig. 2. Effect of soil depth and type on height of carnations, measured September 19, 1966.

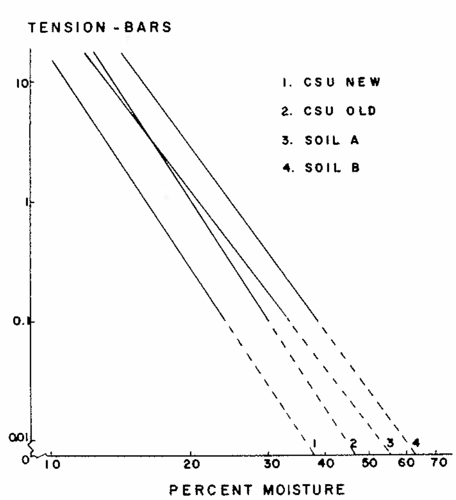

Fig. 3. Relationship between moisture content and soil moisture suction (tension) of 4 soils employed in the experiment. Lines are plotted logarithmically, if plotted lineally they would be curved. One bar is approximately equivalent to one atmosphere, 1000 cm water or a reading of 100 on a tensiometer.

Table 2. Calculations of water content (cubic inches) before and after watering, and amount removed from the soil between waterings for various soil depths and types. Based upon estimated moisture contents shown in Fig. 3.[a]

Soil	Moisture content after				Moisture content before				Water extracted	
	8''	Suction[b]	4''	Suction	8''	Suction	4''	Suction	8''	4''
Soil B	680	0.02	363	0.01	242	3.0	75	15.0	438	288
Soil A	593	0.02	317	0.01	207	2.0	81	9.0	386	236
CSU Old	506	0.02	207	0.01	161	5.0	81	5.0	345	189
CSU New	409	0.02	219	0.01	126	10.0	63	10.0	283	156

[a]The assumption was made that moisture content in a 4-inch depth was uniform throughout. For the 8-inch depth, a uniform moisture content, at 0.01 bar, was assumed for the bottom 4 inches, and a uniform moisture content for the top 4 inches at a suction of 0.02 bar. In reality, moisture content would increase to a maximum at zero suction at a bottom of either 4- or 8-inch depths.

[b]Suctions in bars, one bar approximately equivalent to one atmosphere, 1000 cm water or a reading of 100 on a porous cup tensiometer.

may be made: 1) Even though the percentage of moisture after watering a 4-inch deep soil was higher than in the upper surface of an 8-inch deep soil, the total amount of water available was reduced. 2) The total amount of water remaining, just before irrigation, was more for the 8-inch depths than the 4-inch depths. 3) The total amount of water removed between irrigations was more for the 8-inch depths than the 4-inch depths. 4) Suctions at which plants were watered were always higher for the 4-inch treatments.

The response of CSU New soil, even though 8 inches deep, emphasizes the usual problem of field soils employed without adequate modification. Initially, insufficient drainage, when water requirements are low, are likely to cause trouble from deficient aeration. Secondly, the total water holding capacity is likely to be low. As a result, when water requirements are high, higher suctions are usually encountered that tend to reduce growth. It would have been possible to have watered 4-inch soils more frequently and obtained better yield. But, in borderline cases, the possibilities of poor drainage and deficient aeration are increased in 4-inch depths, since the percentage of moisture present is higher. The particular plant response under given conditions will be a function of depth, physical characteristics of the medium, water requirement and cultural practices. Thus, a deep soil may give indications of both poor aeration and insufficient water holding capacity at different times of the year, or increasing the depth of a poorly drained 4-inch deep soil may not be sufficient to improve aeration, and actually increase problems of deficient aeration. With soils, each problem must be solved for each grower.

The fact that both growers' soils produced high yields under the conditions of this experiment indicate that physical characteristics and moisture holding capacity were not out of line. Problems experienced from disease probably result from inadequate steaming or re-introduction of pathogens after steaming.