TOMATO PLANT growth can be affected by changes in both soil moisture content and in the size of air spaces accompanying changes in soil bulk density. In studying the effects of different levels of soil bulk density (soil compaction) on plant growth there appear to be three primary factors to consider: (1) soil aeration status, (2) soil moisture-plant relationships, and (3) mechanical impedance of roots. Associated with these three factors influencing plant growth are nutrient uptake, plant respiration rates, thermal conductivity of the soil, air and water permeability, and certain physiological disorders.

W. J. FLOCKER · D. R. NIELSEN

Tomato Plant Growth

Influenced by Soil Compaction, Soil Moisture and Air Space

Soil moisture suction, mechanical impedance through alteration of the air spaces in the soil, or a combination of both factors can influence the growth of tomato plants.

Air space

In the first part of the experiment, the air space was kept at about 15 per cent by reducing the mean soil water content as soil density increased. It was also necessary to maintain the soil suction at higher levels for each increase in soil bulk density. The mean water content or suction was maintained by irrigating the pots twice daily with distilled water (at the beginning and end of the daytime 8 hours when water consumption was highest). One irrigation was added to the surface of the pot while the other was allowed to enter from the bottom. The amount of water needed for each irrigation was determined by loss of gross weight of the complete pot and attached equipment and also from tensiometers installed in the soil when moisture ranges permitted their use.

Soil suction

In the second part of the experiment, the soil suction was maintained at about 0.5 bar. Therefore, soil air spaces necessarily decreased as soil density increased. Mean soil suction was maintained in the manner already described, by direct weighing and tensiometers. Twice-daily records were maintained of the quantity of water used. Water content was determined from the amount of water needed to return each pot individually to its original content.

V-shaped trenches ¼ inch deep were made in the surface of the soil after the pots were packed to desired densities. Ten Pearson VF-11 tomato seeds were planted in each pot. The plants were thinned to one per pot about one week after emergence and selected for uniformity of size. The pots were kept in growth chambers so that day length and temperatures could be accurately maintained. Day length was 14 hours and temperature, 80°F ± 1°F. Night temperatures were maintained at 65°F ± 1°F.

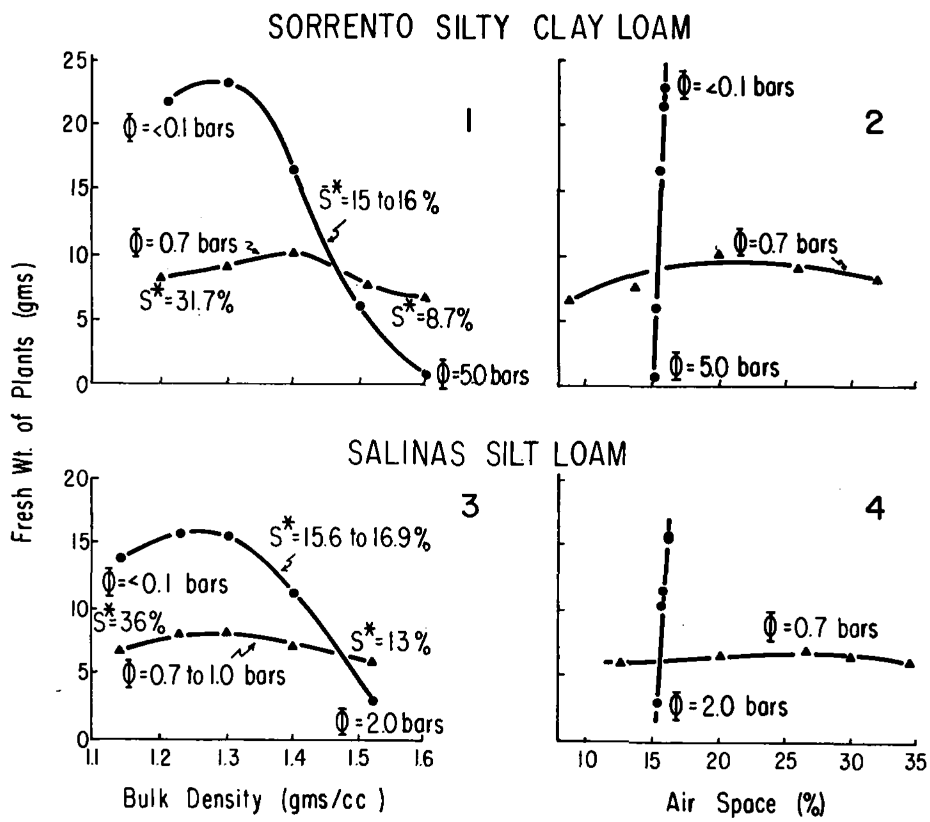
Pots were rotated within the cabinets daily and, except for the watering procedures mentioned, nothing further was done to them. After six weeks, plants were harvested and weighed fresh. Pots were then sampled for moisture content and distribution of moisture.

In problems dealing with controlled soil moisture contents or air spaces it is imperative that ranges or extremes be known. The ranges were determined between irrigations for each pot from knowledge of the amount of water needed to return the pot to its original moisture content. These ranges, however, gave no information as to distribution of moisture or air spaces within a given pot. Therefore, at the conclusion of each run, soil cores were removed from two sides and the center of each pot and cut into thirds. Moisture content was determined on each of these samples.

Graphs

The plant-soil-water-air relations obtained for the two soils are shown in the graph. The shape of the curve for each soil shows that both behaved similarly. The decrease in plant yields, corresponding to increases in bulk density at nearly constant air space, may be attributed to increasing soil suctions. The graphs also indicate that if the mean soil suction was maintained at about 0.7 to 1.0 bar, fresh weight yield was independent of bulk density provided air spaces were not limiting. At 14 per cent air space, fresh weight was dependent only on soil suction. At nearly constant suction, yields were not influenced by increasing density even

Plant-soil-water-air relations for Sorrento silty clay loam and Salinas silt loam. Φ represents soil suction (bars), and S* represents mean air space (cm³/cm³).



though air spaces varied from 32 per cent to about 10 per cent.

On the other hand, the decrease in plant yield may be attributed to mechanical impedance associated with high soil suctions. Fresh weight of plants was independent of bulk density levels at 0.7 bar soil suction. This may mean that soil strength was not sufficient to impede root growth. However, when mean air space was maintained at 15 to 16 per cent and soil suction increased from 0.1 to about 5.0 bars, soil strength may have increased sufficiently to restrict root growth and consequently affect the fresh weight of plants. Therefore, over these ranges of air spaces and for these two soils, soil suction or a combination of soil suction and mechanical impedance played the dominant role in reducing tomato yields.

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