the same as those obtained at Davis, namely, that the yield and content of sugar in the beets was not affected until the soil moisture had reached the permanent wilting percentage; and the first wilting does not occur until all the readily available water has been extracted from the top four feet during the first part of the growing season. During the latter part of the growing season water will be extracted to the depth of six feet. The results indicate the rational system of irrigation is one in which water is applied just before the soil moisture is exhausted. Such a system is probably most economical since waste is lessened by less frequent application of water.

SOIL MOISTURE STUDIES IN CALIFORNIA

J. E. Coke
General Agriculturist
Spreckels Sugar Company

The influence of soil moisture variations on the development of weight, sucrose percentage, purity, and nitrogen of the sugar beet root was studied in tests conducted in the Sacramento, San Joaquin and Salinas Valleys of California by the Spreckels Sugar Company during the two seasons, 1936 and 1937. As a result of these studies, an attempt is being made to establish an accurate basis for determining irrigation procedure in commercial beet fields.

While the primary purpose of this discussion is to show soil moisture conditions as they existed in normally irrigated commercial beet fields in California and to discuss the procedure developed to improve irrigation practices, a summary of the more outstanding and practical results secured from the detailed study of soil moisture and beet growth is of importance.

Plots for this study were located at Woodland, Manteca, Salinas, and King City in 1936 and 1937 and were conducted in cooperation with the Division of Irrigation, University of California. At each location two plots received four hundred pounds of Ammonium Sulfate per acre and two received no fertilizer. Also two plots received irrigation treatments differing from another set of two plots. At two-week intervals sixty beets from each plot were removed for weighing and analysis. These beets were taken from six different locations in each plot.

Conclusions drawn from these studies are as follows:

1. The maximum growth of beet root and maximum development of sucrose and purity were secured when soil moisture was maintained, throughout the growing season, above the permanent wilting point and below the moisture equivalent for the majority of the soil column in which the roots penetrated. Under normal conditions the roots, by the middle of June, were removing soil moisture from at least the first six feet of the soil column, the depth to which moisture determinations were obtained in this study. When soil moisture was maintained above the permanent wilting point but below the moisture equivalent, the rate of root and sucrose development was not greatly influenced by the quantity of moisture in the soil.

2. When soil moisture was maintained above the permanent wilting point the application of irrigation water to the soil did not result in a significant reduction of the sucrose percentage of the beets, except late in the season, when the sucrose percent was temporarily lowered. In the majority of cases, irrigation in the later part of the growing season resulted in a decrease in sucrose and approximately two weeks were required to regain the loss.

3. The rate of development of weight of root and sucrose was retarded or stopped entirely when the major portion of the soil column reached the permanent wilting point. Purity, which developed more rapidly and reached a maximum point earlier in the season than either sucrose or weight of root, was, in these tests, not materially affected by soil moisture variations as it had usually reached its limit previous to any major moisture deficiency.

4. A soil containing moisture above its full capacity for any large portion of the rate and area normally supporting roots produced crops of low yield and sucrose content.

5. The application of ammonium sulfate at the rate of four hundred pounds per acre, applied as a side dressing at the time of seeding, resulted in increased yields when sufficient moisture was available to support the increased growth caused by the nitrates. When the soil moisture of any appreciable area in which the roots were located reached the permanent wilting point and remained there for a considerable period, the effect of the application of the nitrogen was nullified and no increase in weight of root was noted. The extent to which this nullification took place depended on the length of the period the soil column was maintained at the permanent wilting point.

6. The ammonium sulfate applied in these tests did not result in a lowering of the purity of the beets. In certain cases the sucrose percent was slightly less in fertilized plots than in unfertilized plots.

It is safe to conclude, after reviewing the moisture conditions in these typical fields that:

1. Of approximately equal responsibility for low yields is the practice of maintaining an excessive (above the full capacity) and a deficit (to the permanent wilting point) soil moisture supply.

2. More accurate methods must be developed for determining when and for how long water should be applied to land than by observing the growing crop or kicking a surface clod. Irrigations applied too frequently increase costs and result in a water-logged soil. Irrigations delayed to a point where the majority of the soil column reached the permanent wilting point retarded root and sucrose development.