The Effects of Different Rotations on Sugar Beet Production in Land Infested with the Sugar Beet Nematode, Heterodera Schachtii, in the Salinas Valley of California

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Rotation as applied to general farming practices refers to the succession of crops planted on the land. Three rough categories of rotation are usually recognized. These are the specialist, the opportunist, and the planned rotation.

The specialist type of rotation is one in which only one crop is grown continuously. The common examples of this are orchards and vineyards. Annual or biennial plants do not usually fall into this category because of problems that arise with regard to insect and disease incidence in the land. Although there is some of this still being done with annual and biennial crops, there is becoming less and less of it.

The planned rotation is one in which crops are grown in a succession which is planned several years in advance. This type is most common in areas where hay, grain, and a few row crops comprise most of the acreage.

The opportunist type of rotation is where there is a choice of several crops and the farm operator selects those each year from which he expects to derive the greatest financial returns. This is a typical rotation for much of the land in the Salinas Valley of California. Crops grown under this type of rotation include lettuce, sugar beets, broccoli, cauliflower, spinach, onions, and potatoes.

For a long time it has been known that cruciferous crops such as broccoli and cauliflower would propagate the sugar beet nematode, *Heterodera schachtii*. This made beet growing risky following one of the crucifers in ground infested with the sugar beet nematode. Damage to sugar beet crops by sugar beet nematode has been observed in land that had not grown beets for many years, but had grown one of the crucifers as one of the intervening crops. Usually this damage was observed when the broccoli, cabbage, or cauliflower was planted immediately preceding the beet crop. While the main reason for the current study was to determine the effects of each of the selected rotations, one of the other important purposes was to compare beet

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production on land that had broccoli planted immediately preceding the beets with production on land where broccoli had been planted two years before the beets.

The land used was relatively heavy adobe type soil with a moisture holding capacity of about 25 percent. The particular field had periodically been planted to sugar beets for the past 60 years. It was known to be infested with sugar beet nematode.

Six rotations were selected that might be found in the Salinas Valley of California. These were three-year rotations each of which included sugar beets with two years of crops intervening between successive crops of sugar beets. The intervening crops included lettuce, beans, barley, broccoli, and carrots. Alfalfa was not included in this test because of the difficulty of handling it on the size of plots used. The plot size was four beds wide by approximately 250 feet long. The bed used was the standard bed for most crops in the Salinas Valley of 40 inches from center to center, on which two rows of the particular crops (except barley) were planted 14 inches apart on the beds leaving 26 inches between the rows separated by the furrows. Three replications of the rotations were used in a randomized complete block arrangement.

In 1953 the entire plot was in sugar beets, in 1954 and 1955 the intervening crops were planted, and in 1956 sugar beets were again planted to measure the effects of the preceding crops on the yields and sucrose concentrations. The plot is designed to continue for several cycles of the rotation. The study here reported is from the results of data after one complete rotation.

Table 1 shows the sequences of crops used during 1954 and 1955 together with the production of sugar beets during 1956 for each rotation.

Table 1.—Showing Yields, Sucrose Percentages, and Pounds of Sugar per Acre of Sugar Beets Harvested from Rotation Plots to Determine the Sequence of Crops Most Conducive to the Production of Sugar Beets. Beets Were Planted February 9, 1956, to Variety S-1, and Harvested September 18, 1956, at Spreckels, California. (Average of Three Replications) 1956 Beets.

Rotation Number	1954	1955	Tonnage	Percent Sucrose	Lbs./Acre
1	Lettuce-Lettuce	Lettuce-Lettuce	18.49	12.63	4,690
2	Lettuce-Lettuce	Beans	20.51	12.90	5,320
3	Lettuce-Broccoli	Beans	23.13	12.70	5,870
4	Carrots	Barley	18.14	13.53	4,910
5	Beans	Lettuce-Lettuce	19.85	12.70	5,010
6	Beans	Lettuce-Broccoli	11.93	13.20	3,140
LSD at P = .05			3.26	NS	980

As can be seen from Table 1, some of the rotations included double cropping systems or two crops in the same year. This is a common practice in the Salinas Valley in the production of rapidly growing vegetable crops.

With only three replications experimental errors are rather high, consequently, it takes a relatively large amount of difference between the different treatments to reach statistical significance. The one thing that is striking from these data is the tremendous reduction in the yield of beets following rotation Number 6. The main reason for this is that this particular rotation included broccoli immediately preceding the sugar beet crop. The sugar beet nematodes that survived on the broccoli were present in larger numbers in the plots of rotation Number 6 than they were in any of the other plots. The beets in the rotation Number 6 plots could be distinguished from the seedling stage throughout the growing season by their unthrifty appearance. Examination of the roots of beets in this rotation showed them to have much higher nematode counts than beet roots from other plots.

There may be an additional contributing factor in the reduced vigor of the plots of beets in rotation Number 6. A crop of broccoli leaves a large amount of vegetative matter in the surface layers of the soil that needs to be decomposed before it can be of much value to subsequent crops. During this period of decomposition, nitrogen is required by the organisms of decomposition and it is possible that for this reason, until the decomposition process was almost completed, the young beets, planted after the brococli crop was plowed under, may have suffered some from a temporary nitrogen deficiency. This condition would have been ideal for the nematodes to parasitize the beets.

In the case of rotation Number 3, where broccoli was also included in the rotation, but two years prior to the beets rather than immediately preceding them, there appears to be no such reduction in the beet yields. On the contrary, the beets in that particular rotation yielded best of any of the rotations tested. The exact reason for this is not definitely known. It is probable, however, that sufficient time was allowed for the complete decomposition of the organic refuse of the broccoli crop before the beet crop was planted so that no retarding effect on the small beet plants occurred. In addition, the planting date of early February, or earlier where possible, is definitely an asset in producing satisfactory yields of sugar beets on land infested with the sugar beet nematode.

A comparison between the sugar beet yields from rotations Number 3 and Number 6 leads to an interesting observation. Both of these rotations included the same crops but differed only in the chronological arrangement of them. One produced the highest yield of the entire test while the other produced the lowest. It seems apparent that if both beets and a cruciferous crop such as broccoli are to be included in the same rotation on land infested with the sugar beet nematode the broccoli should follow the beets rather than the beets follow the broccoli. In rotation Number 3 the year of beans between the broccoli and the beets seemed sufficient to allow a satisfactory yield of beets. It should be noted that the sugar beet nematode is not generally considered an economic factor in broccoli production.

It is also interesting to note that the two highest yields of the six rotation studies, occurred on the plots having beans as the immediate preceding crop. This finding is in agreement with the findings of Dubetz et. al. (1) [2], who studied the effects of preceding crops on the yields of sugar beets and found one of the most beneficial crops to precede sugar beets to be field beans.

Summary and Conclusons

A study of six rotations that included crops commonly grown in the Salinas Valley of California was made to determine which had the most beneficial effect on a sugar beet crop at the termination of each.

It was shown that if both sugar beets and broccoli are included in the same rotation, the sugar beets should not immediately follow the broccoli if the land is infested with the sugar beet nematode. The same would be expected with other cruciferous crops. The deleterious effect of the crucifer on the beet crop immediately following seemed two-fold; the large amount of organic debris of the broccoli turned under retarded the early growth of the beets, and presumably, due to this retarded growth, the higher population on sugar beet nematode is that plot appeared to be more effective in reducing beet yields.

Literature Cited

(1) DUBETZ, S., RUSSELL, G. C., and HILL, K. W. 1957. Journal Am. Soc. Sugar Beet Tech. IX (4) :354-359.

[2] Number in parentheses refers to literature cited.