able phosphates and a surplus of nitrogen. As evidence of this beet rotations with alfalfa always show more symptoms of phosphate deficiency than those in continuous beets or in two year rotations which have a very low amount of phosphates and nitrogen in the soil. Rotations with alfalfa and manure show very little phosphate deficiency.

Fusarium Wilt

Fusarium wilt or yellows occur mostly in one, two, and three year rotations. Three year rotations on the lighter soils always have much wilt, while the four and six year rotations are practically free of wilt.

APHANOMYCES ROOT ROT OF SUGAR BEETS AS INFLUENCED BY PHOSPHATE APPLICATION.

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It is known that species of Aphanomyces, especially A. cochlioides Drechsler cause damping-off of sugar beets and, with older plants, death of lateral rootlets. These effects have been confirmed in experiments at Arlington, Va., as well as in field experiments in Ohio and Michigan. Isolations made from sugar beet plants in which the terminal portion of the tap roots were blackened and killed have shown that a species of Aphanomyces, tentatively assigned to A. cochlioides, is associated with this condition. The rotting usually extends up from the terminal of the root about one-quarter to one-half of its length but may involve the entire root.

General field observations had indicated a probable association of this disease with relatively wet soil conditions. Observations made in experimental plots in Michigan and Ohio, have shown that killing of lateral rootlets of the sugar beet, and the dwarfing of plants from this cause was prevented by application of fertilizers high in phosphate. In the plots in which such observations were made, tip rotting of the beet tap roots were absent where phosphate was applied, but common in untreated plots and in untreated borders.

An experiment was conducted with sugar beets grown from seed in quartz-sand cultures to test the protective effect of phosphate applications against Aphanomyces attack under conditions of optimum and high water levels. The exposure was secured by uniformly inoculating 3-gallon culture jars of autoclaved quartz-sand plus nutrient solution five days before the seed was planted with (a) a pure culture of A. cochlioides or with (b) plant debris and sand from a previous experiment in which Aphanomyces as well as other root rotting organisms occurred. The experiment was started with the numerous seedlings obtained from planting 50 seed balls in each jar and then after 46 days, each jar was thinned to five plants evenly spaced to be carried for an additional period of 132 days. The seedling at approximately the proper distance from its neighbors which appeared most likely to live was left when the jars were thinned. For the most part, this thinning approximated field practice in which the best plant in a clump at approximately the right position in the row is left.

Abundant previous experience had shown that sugar beets could be grown over long periods in nutrient solution, quartz-sand cultures without damping-off or root decay occurring. An observation set of quartz-sand cultures was used in

this test. The seedlings in the check cultures without organisms remained healthy. At the close of the experiment plants in the check cultures were free from root rot.

For each type of inoculum, half of the cultures was grown using a nutrient solution high in phosphate, and the other half was started with a nutrient solution without phosphate. After thinning, complete nutrient solution was occasionally used with the jars in which phosphate was to be held minimal, otherwise these jars received nutrient solution without phosphate. As a rule, throughout the experiment, 200 cc of the respective nutrient solutions were added twice a week to the appropriate culture jars. It was found that this amount was enough to bring about discharge or overflow from the jars. Tap water was added at other times as needed to prevent wilting.

For the contrasts in water level, half of the jars for each phosphate condition were equipped with siphons to prevent water standing in the jars, and the others had 5-inch stand pipes which kept the sand in the lower portions of the jars more or less water-logged.

The cultures were grown throughout the test on rotating tables to equalize light and temperature conditions. Each treatment was replicated 10 times and the results are given as 10-culture averages in Table 1 for the seeding phase. In Table 2 the results are given as sums of the 10 replicates for each treatment after 178 days.

The following conclusions were drawn from the experiment: Increase of mortality in seedlings and in larger plants was shown in the cultures with minimal phosphate nutrition as compared with those cultures grown under conditions of higher phosphate nutrition. The water level relations were over-shadowed by the nutritional effects, but some evidence is afforded that the mortality of seedlings is greater when water level is high and that Aphanomyces attack on the tap root may be increased.

The conditions set up in the experiment represent extremes, but are not entirely outside of those found in the field. Taken in connection with the field observations, they point to a definite relationship between severity of Aphanomyces attack and phosphate deficiency.

Table 1. --Numbers of apparently healthy sugar-beet seedlings remaining in quartz sand cultures after 7- and 46-day exposures to pure cultures of Aphanomyces cochlioides and organisms from debris of diseased plants: High phosphate is contrasted with minimal phosphate under conditions of optimum and high water levels.
(Results given as 10-culture averages.)

			Apparently healthy 1/ sugar beet seedlings after-	
Inoculum	Phosphate	Water Level	7 days	46 days
A. cochlioides (pure culture)	High	Optimum	79.0	32.1
do.	do.	High	68.8	17.2
do.	Minimal	Optimum	77.3	0.4
do.	do.	High	79.0	0.5
Debris from diseased plants	High	Optimum	87.8	73.6
do.	do.	High	91.8	62.0
do.	Minimal	Optimum	90.6	8.5
do.	do.	High	90.8	3.0

1/ As judged by absence of top symptoms or discolored hypocotyls.

Table 2.— Record of sugar beet plants following exposure to Aphanomyces cochlioides and to organisms from debris of diseased plants: Cultures shown in table 1 were thinned to five plants each after 46 days and continued on rotating tables for 132 days. Results are given as sums of the 10 cultures in each treatment.

Treatment			No. of plants after thinning	Results after 178 days			
				Condition of tap roots			
Inoculum	Phosphate	Water Level		Sound	*A. cochlioides* rot	Other types of rot	Dead
A. cochlioides (pure cultures)	High	Optimum	50	50	0	0	0
do.	do.	High	50	39	0	7	4
do.	Minimal	Optimum	50	25	9	0	16
do.	do.	High	50	28	13	0	9
Debris from diseased plants	High	Optimum	50	37	2	11	0
do.	do.	High	50	43	1	6	0
do.	Minimal	Optimum	50	35	6	0	9
do.	do.	High	50	21	7	0	22