Potassium has not given significant increases on these glacial soils which have a relatively high but not injurious amounts of water soluble salts, principally sulphates of calcium, sodium and magnesium with some potassium.

Ammonium phosphate has given better response than Triple-sugar phosphate in comparative tests and is used extensively by farmers.

Applications of 60 to 100 pounds of Triple-super phosphate or Ammonium phosphate directly with the seed has depressed germination and early growth when there was a deficiency of moisture but the use of a drill shoe that places no more than 20% of the fertilizer with the seed and the balance in bands about 3/4 inch from the seed on each side has been definitely satisfactory and is used over the entire district for field plantings.

Applying fertilizer with a grain drill before seeding or side applications during the growth period, has not been promising in the few tests made with these methods, but plowing phosphates under with barnyard or green manure in the fall preceding planting has given indications of profitable increases in yields.

In rates of Application tests, yield increases have been indicated with increased amounts of ammonium phosphate up to 200 pounds per acre applied near the seed, but greater yields secured with applications exceeding 100 pounds have not been considered sufficient to justify using higher rates. Farmers are using 60 to 100 pounds per acre and almost all fields have phosphate applied at time of seeding.

It is thought that the almost invariable increase in production secured from the application of a soluble phosphate at time of seeding is associated with the depressed organic activity in the soil during the cool spring period and the resultant slowness with which fixed phosphorous is made available to plants.

SUMMARY OF 1937 FERTILIZER TESTS ON BEETS IN MONTANA

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Increased yield shown in the accompanying chart is the average increase found in the respective tests. The data indicate that there was no response to boron, copper, manganese, zinc or iodine. That is, when these elements were added to treble superphosphate there was no increase over fertilization with phosphate alone, as will be seen by comparing test No. 2 with tests 4 and 5. With other soils and other amounts of these elements the results might have been different.

In the case of complete fertilizer No. 6, nitrogen failed to show any beneficial results. Only 150 pounds of a 4-16-4 fertilizer was used. This is a very small amount of nitrogen and the writer believes it to have been lost by early irrigation. Symptoms of nitrogen deficiency were evident in all fields throughout the summer.

A very poor response was shown in the three tests with H_3PO_4 in irrigation water. The beets were 6 to 8 weeks old at the time of fertiliza-

tion. An earlier treatment may have been more beneficial.

Three tests with bone meal showed a slight improvement of the crop. Three tests with raw rock phosphate caused no increase. The actual data show a negative increase. Tests with raw rock and some of the T. V. A. phosphates on other crops show that insoluble phosphates have little, if any, value as fertilizers under Montana conditions.

Fertilizers 1 to 7, containing treble superphosphate of H_3PO_4, gave consistently good results. There were in all, 38 tests with these fertilizers. The increase ran from 3,274 to 5,675 pounds. The average sugar content of the beets from these tests is a little over 17 percent. In the tests with phosphoric acid in irrigation water, raw rock, and bone meal, all of which gave poor increases in yield, the average sugar content was about 1 percent lower.

Method of Applying Fertilizers

Results of fertilizer tests reported in the summary were obtained this year in Yellowstone and Carbon Counties of Montana. Applications of fertilizer were made with a small drill constructed especially for testing fertilizers. This year the drill was equipped with a tank and manifold to distribute liquid fertilizers into the furrows opened by the discs. In one series of tests liquid phosphoric acid was diluted to 30 or 40 times its original volume with water and put into the drill furrows.

With all fertilizers the tests consisted of strips one rod wide applied just ahead of the planter. The fertilizers used are listed on the chart. At digging time two samples consisting of 30 feet portions of two adjacent rows were taken from the center of each of the strips making a total of 120 feet of row. The beets were cleaned, topped, counted and weighed. Fifteen average beets were selected from each test for the sugar determinations.

The fertilized strips were adjacent to each other and the check strips were on each side of the entire series of tests. The two fields on which results with bone meal are reported were being fertilized by the owner at the time our tests were made.

Only three tests were made with phosphoric acid in irrigation water. Water was directed into five furrows so as to irrigate four rows from both sides. A bucket delivered a small stream of dilute phosphoric acid into the head ditch. The length of the rows was first measured, and as the water progressed the delivery of the acid was adjusted so that the required amount of fertilizer was applied. When the water reached the end of the rows it was turned off and allowed to settle. It was again turned on and allowed to run through the row. The second time no acid was added.

For more detailed discussion of the methods used and results see the 1937 report of the phosphate investigation.

Table 14—Average of Fertilizer Tests on Beets

Test Numbers	Fertilizers and method of application	Number of tests	Stand	Size per beet	Sugar	Yield per acre	Increase per acre
			PERCENT	POUNDS	PERCENT	POUNDS	POUNDS
	CHECKS	16	96	0.95	16.8	23,523	
1	Liquid phosphoric acid diluted and drilled in as other fertilizers at the rate of 40-50 pounds treble superphosphate	6	102	1.13	17.8	29,314	5,675
2	Regular treble superphosphate at rate of 125 pounds per acre	8	95	1.16	17.0	29,610	4,449
3	Fine granular treble superphosphate at the rate of 125 pounds per acre	4	98	0.99	17.7	25,079	4,578
4	125 pounds of regular treble superphosphate and 10 pounds borax per acre	5	97	0.99	17.4	24,803	3,274
5	125 pounds regular treble superphosphate 8 pounds copper sulfate, 10 pounds manganese sulfate, 8 pounds zinc sulfate, and 0.15 pounds iodine per acre	5	97	0.99	17.1	25,341	3,812
6	150 pounds complete fertilizer, 4-16-4	5	96	1.02	17.5	25,431	3,902
7	125 pounds treble superphosphate containing some free phosphoric acid	5	97	1.08	17.6	25,570	4,041
10	400 pounds raw rock phosphate	3	86	1.15	16.1	25,010	-1,123
**	85-100 pounds of bone meal applied by owner with seed	3	88	0.89	16.2	20,106	2,204
11	phosphoric acid in irrigation water at rate of 125 pounds of treble superphosphate per acre	3	103	1.11	15.7	29,196	2,354