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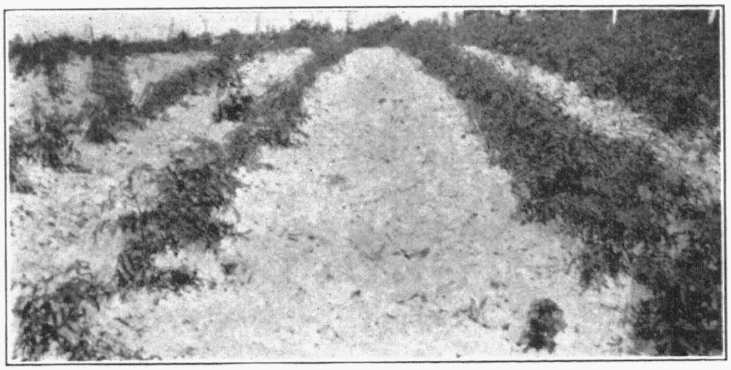
PROFITABLE TOMATO FERTILIZERS



Tomatoes on stony Ozark soil: On left, no fertilizer; on right, 125 lbs. per acre 5-8-0 fertilizer applied

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Profitable Tomato Fertilizers

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About 10,000 acres of tomatoes are grown for canning purposes in Missouri each year, and many more are grown for market and home use. The larger part of the acreage grown for canning is on the gravelly loam soils of the "Ozark" region in the southern part of the state, where there are many canning factories. In this region, tomatoes of the finest canning quality are produced, being unexcelled in color, flavor and solidity of fruit. However, the yields have been in many cases too small to be profitable, ranging from one to three tons to the acre, depending upon the season. In the belief that use of commercial fertilizers might be the means of growing larger and more profitable crops, the tests reported in this bulletin were undertaken in the spring of 1919, in cooperation with ten tomato growers, seven of whom were located on typical Ozark soils. The objects were to determine the effect of different commercial fertilizers and mixtures of the same, as well as of stable manure, on the yield and time of maturity of the tomato crop. Much credit is due the growers who carried out these tests, for their careful work in handling the plots and harvesting the fruit.

DESCRIPTION OF THE TESTS

One test was located in Livingston County, two in St. Louis County, one in Green County, three in Newton County, and three in Howell County. Each test consisted of a series of eight plots which received the same treatment in each test. Each plot consisted of one hundred plants, or about one twenty-fifth of an acre, except in the case of the three tests in Howell County, in which the plots were one-eighth acre in size. The fertilizers used were prepared by the Department of Horticulture and distributed to the growers early in the spring. The site of each test was selected with a view to uniformity of soil, being in each case located in a large field of tomatoes. The fertilizers were applied and plants set under the personal supervision of the writer. Fertilizers were applied just before setting the plants, by drilling into the row and mixing the fertilizer with the soil. Notes were taken on the plants in each test the latter part of July, just before the fruit began to ripen. The fruit was gathered regularly

by each grower, the weight of fruit at each picking being recorded for each plot.

FERTILIZERS USED

The first and last plots in each test were checks, no fertilizer or manure being applied to them. The composition of the fertilizers used, and rate of application were as follow:

Plot 1.—No fertilizer.

Plot 2.—250 pounds to the acre: 4.6% Nitrogen, 8% phosphorous, 7% potash, made up of 500 pounds dried blood (11% N), 250 pounds nitrate of soda (15% N), 1000 pounds acid phosphate (16% P), and 276 pounds sulphate of potash (51% K). A total of 2026 pounds.

Plot 3.—250 pounds to the acre: 5% Nitrogen, 8% phosphorous, made up of 500 pounds dried blood (11% N), 300 pounds nitrate of soda (15% N), 1000 pounds acid phosphate (16% P), 200 pounds filler, a total of 2000 pounds.

Plot 4.—150 pounds to the acre: Nitrate of soda (15% N).

Plot 5.—150 pounds to the acre: Sulphate of potash (51% K).

Plot 6.—250 pounds to the acre: Acid phosphate (16% P).

Plot 7.—8 tons to the acre: Rotten stable manure.

Plot 8.—No fertilizer.

FIELD NOTES ON TESTS

Phillip Lochhaas, Valley Park, St. Louis County.—Plants were set May 12 on poor, sticky, red clay soil on which mulched Irish potatoes were grown last year. The variety used was June Pink. On June 25 the plants in Plots 1, 4, and 8 were rather small and spindling with no fruit set, while in Plots 2, 3, 6 and 7 the plants were large, dark green, and full of green fruit. In Plot 5, which received potash, the plants were intermediate in size.

Charles N. Daub, Valley Park, St. Louis County.—Plants were set May 12, on rather poor clay loam hillside, previously in blackberries. The variety used was Livingston's Beauty. On June 25, the plants in the two unfertilized check plots, 1 and 8, were only medium sized, as compared to plants in the fertilized plots, 2, 3, 6 and 7. Plants in plots 4 and 5 were only slightly better than the checks.

Henry C. McElhaney, Brookline, Green County.—Plants were set May 29, a week after the fertilizers had been applied. A separate test was made of 2-12-1 fertilizer, applied (a) five days before setting plants, and (b) as a top dressing ten days after setting. On July 16 there was a marked difference in the plants on these plots, the plants being thirty-three per cent larger and hav-

ing a larger set of fruit in the case where fertilizer was applied five days before setting. The following gives a summary of the yields of fruit from these two plots.

Fertilizer Applied	Yield per acre	Gain over unfertilized check	Percent gain
5 days before setting	14,860 lbs.	3,820 lbs. per acre	34.6
10 days after setting	12,200 lbs.	1,260 lbs. per acre	11.4

The soil in this test was red clay loam, free from rock. Clover sod and stable manure had been plowed under the preceding fall. The soil was thoroly prepared, and the crop well cultivated.

It is noticeable from Table 1 that the per cent of increase in yields caused by the various fertilizers was less in this test, where the soil was well manured and cultivated, than in the case of some other tests on poorer soils. The variety used was Greater Baltimore.

On July 16, the plants in the check plots were of medium size and were medium green in color, with no fruit set. The plants in plots 2, 3 and 6 were fairly uniform, being 150 per cent larger and much stockier than the plants in the check plots. Plants in plots 4 and 5 were very slightly superior to the checks.

C. R. Epperson, Neosho, Newton County.—This test was located on poor, gravelly loam soil which was quite stony, and had been in tomatoes the preceding year, with no manure applied for several years. Plants were set May 13; Livingston Stone was the variety used. On July 14 the plants in the check plots were small and weak, with little fruit set. In plots 2 and 3, plants were about one hundred per cent larger, and there was considerable fruit set. Plots 4 and 5 wre little better than the checks while plots 6 and 7 were considerably larger and more vigorous than the check plots.

F. E. Wuerzberger, Neosho, Newton County.—This land was quite stony and rough, having been recently cleared of trees. Fertilizers were applied May 24 as a top dressing to plants set several days before. The variety used was Stone. On July 14, the plants in the check plots were rather small, erect, spindling, with no fruit set. Plots 2 and 3 bore large, dark green plants, well branched and heavily set with fruit. Plants in plot 4 were larger than those in plots 2 and 3, but had less fruit set. Those in

plot 5 were medium-sized plants with no fruit set. In plot 6, the plants were almost as large as in plots 2 and 3, and had a large number of fruit set.

William C. Grimes, Newtonia, Newton County.—This soil was a medium sandy loam in fine condition, free of stone, had been in tomatoes last year, and the plants had been rather seriously affected with wilt. The fertilizer plots were set on May 24, to plants of the Arlington and New Century varieties, which have been developed for their resistance to the wilt disease. The rest of the six-acre field was set to plants of ordinary varieties. By August 17, a large proportion of these plants had died from the wilt disease, while the plants in the fertilizer plots which were of the wilt-resistant varieties were ninety-five per cent healthy. It was a good demonstration of the value of wilt-resistant varieties on infected soils. One variation in this test was that of a light application of poultry manure instead of stable manure to plot 7. This plot produced the largest per cent of increase in yield in this test, 124 per cent. On July 15, the plants in the check plots were only medium in size, with little fruit set. In plots 2, 3, 6 and 7 the plants were quite uniform in size, all being relatively much larger, more fruitful and more vigorous than the plants on the check plots. The plants in plots 4 and 5 were only slightly larger than those in the check plots.

W. J. Rhodes, Brandsville, Howell County.—The soil was a gravelly loam, quite stony in spots, but fairly fertile. The fertilizers were applied on May 24, and plants set a few days afterward. The variety used was Red Rock. On July 17 the plants in the check plots were medium in size, rather straggling and weak, with little fruit. Plots 3, 2, 7 and 6 were relatively much larger and more fruitful than the check plots. The size and fruitfulness of the plants in these plots was in the order mentioned. Plots 4 and 5 were slightly superior to the check plots.

J. W. Pierce, West Plains, Howell County.—The soil was a clay loam, free of stone and gravel, in a fair state of fertility. Fertilizers were applied and the plants set May 21; the variety used was Matchless. On July 17 the field was found to be in very good condition, and striking differences were exhibited by the plants in the various fertilizer plots. The plants in the check plots were medium sized, rather weak and spindling, with no fruit set. On the other hand, the plants in plots 2, 3, 6 and 7 were

very dark green and vigorous, and 200 per cent larger than plants in the check plots. Plots 4 and 5 appeared to be somewhat inferior to the check plots.

James Spence, Burnham, Howell County.—The soil was a light gravelly to stony loam. Fertilizers were applied and plants set June 6, which was rather late. The variety used was Red Rock. On July 18 the plants in the check plots were decidedly weak and small, while the plants in plots 2, 3, 6 and 7 were relatively much larger and more fruitful than the plants in the check plots. The plants in plots 4 and 5 appeared somewhat inferior to the checks, and considerable difficulty had been experienced in securing a stand of plants on these plots.

Mrs. Blanche Reeder, Girls' Reform School, Chillicothe, Livingston County.—This test was located on black silt loam, the typical "corn-belt" prairie soil of north Missouri. This test is particularly interesting in that the trend of the results produced by the various fertilizers here was the same as that secured on the rocky and gravelly clay loams in the Ozark region of the state. The fertilizer was applied with the fertilizer drill on a corn planter, which also served to mark off the rows. Plants were set on the same day, May 2, but many had to be reset afterward due to injury by rains and cool weather. The variety used was Bonny Best, which is an early type of tomato. On July 11, the plants in the check plots were of medium size, and bore a fair quantity of half-grown fruit. Plants in the fertilized plots, 2, 3 and 6, were all about the same, being relatively much larger than those in the check plots, and bearing a heavy crop of fruit which was beginning to ripen. Plot 7, receiving stable manure, was not quite so good as the best fertilized plots, yet was much superior to the checks. Plots 4 and 5 were somewhat better than the check plots.

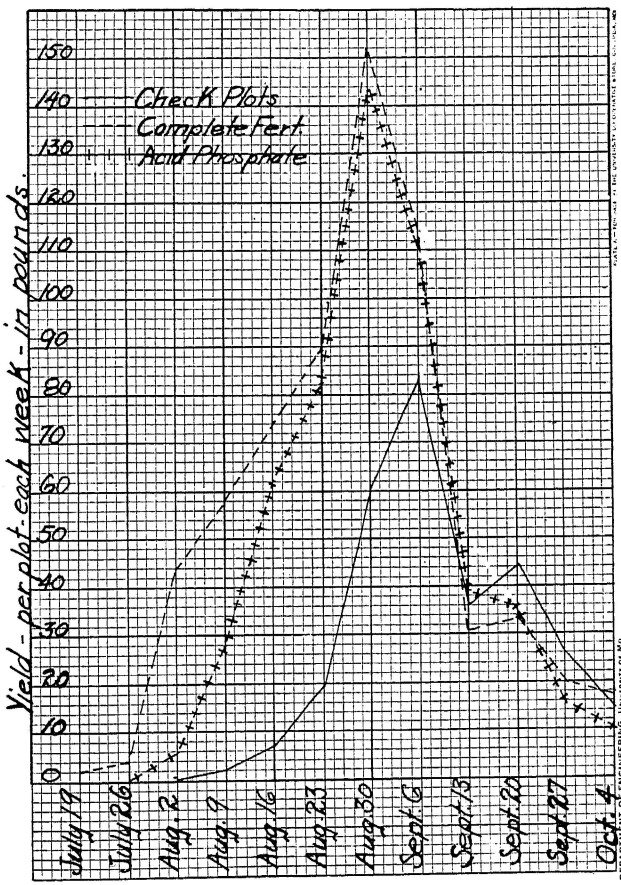
RESULTS

Table 1 presents a summary of the yields secured from each plot in each of the ten tests, expressed in terms of pounds per acre. The first column gives the total yield for each plot, the second column gives the number of pounds increase or decrease over the adjacent unfertilized check plot, and the third column gives the per cent gained by the fertilized plot over the unfertilized check plot. It will be noticed that the yields produced on different plots receiving the same kinds and amounts of fertilizer vary considerably, as well as the percentage of increase. The first point

TABLE 1.—YIELDS OF TOMATOES ON FERTILIZER PLOTS—1919. EXPRESSED IN POUNDS PER ACRE

Cooperator	Plot 2.—250 lbs. of 4.6-8-7			Plot 3.—250 lbs. of 5-8-0			Plot 4.—150 lbs. Nitrate of Soda			Plot 5.—150 lbs. Sulphate of Potash			Plot 6.—250 lbs. Acid Phosphate			Plot 7.—Stable Manure		
	Yield	Gain over check	Per cent gain	Yield	Gain over check	Per cent gain	Yield	Gain over check	Per cent gain	Yield	Gain over check	Per cent gain	Yield	Gain over check	Per cent gain	Yield	Gain over check	Per cent gain
Phillip Lochaas	14,160	10,480	285.0	14,910	11,100	291.5	4,118	178	4.5	8,280	4,200	103.0	14,500	9,835	233.1	16.300	11,940	274.0
C. N. Daub ..	21,950	11,960	120.0	17,000	7,010	70.8	13,130	3,140	31.7	16,120	6,130	62.0	25,410	15,420	156.0	26,765	16,770	169.5
H. C. McElhaney...	14,600	2,880	24.6	13.430	1,825	15.7	9,850	-1,625	-14.2	9.600	-1,700	-15.5	12.390	1 035	9.2	11,540	402	3.6
W. J. Pierce..	10,500	6,840	187.0	7 620	4,100	116.4	3,060	-316	-9.4	2,930	-301	-9.3	8.950	5 864	190.0	8.800	5 856	198.7
James Spence.	5,600	3,367	150.6	6,420	3,967	161.4	1,405	-1,200	-45.0	2,190	-691	-24.0	6,160	3,063	99.0	5,350	2,036	61.4
W. J. Rhodes.	6,440	2,530	64.6	11,000	6,901	168.4	7,400	3,090	71.7	7,560	3,039	67.2	9,600	4,869	103.0	8.850	3,897	78.7
Wm. Grimes .	8.210	3,650	80.0	7,800	3,240	71.0	5,005	250	5.3	4,926	30	0.6	10,300	5,350	108.0	11,100	6,144	124.1
F. E. Wuerzberger ...	10,820	5,836	117.0	8,300	3,360	68.0	4,520	-370	-7.6	5,100	250	5.2	4,620	-186	-3.8	....	....	....
C. R. Epperson	6,520	5,389	464.0	6,720	5,658	533.0	....	....	....	1,200	336	38.9	1,635	873	114.6	3,690	3,026	456.0
Mrs. Reeder .	14,660	3,910	36.4	12,830	3,060	31.1	10,200	985	10.7	8,760	319	3.2	10,250	2,570	33.5	11,540	4,625	67.0
Average yield in pounds per acre .	11,346	5,684	....	10,803	5,022	....	5,859	359	....	6,196	1,155	....	10,582	4,869	....	11,548	6,072	....
Average number of tons per acre .	5.67	2.84	....	5.40	2.51	....	2.93	.18	....	3.1	.58	....	5.29	2.43	....	5.77	3.04	....

may be explained by the fact that better land was used in some cases than others, the season was more favorable, or the picking season was longer. The second point, that of variation in per cent of increase produced by the same fertilizer, may be explained by the fact that on the poorer lands fertilizers produce a greater per cent of increase in yield than upon fairly good land. The tests



Effect of fertilizers on date of ripening and yield

of H. H. McElhaney and W. C. Grimes illustrate this point, for these tests were located on very good land in the best of physical condition. The increases produced by fertilizers on these soils were not so great as upon some of the poorer and more rocky soils. Yet the general trend of the results secured in all ten of these tests is about the same, despite the differences in soils and other factors.

Taking the average of the ten tests as a basis, well rotted stable manure at the rate of eight tons to the acre caused the greatest percentage increase in yield, followed closely by the 4.6-8-7 and the 5-8-0 mixture. The average difference in yield caused by these two mixtures is insignificant, indicating that the omission of potash from the fertilizer did not seriously affect the yield of tomatoes, generally speaking. In six cases the mixture containing potash caused a greater percentage increase, and in four cases the "no-potash" fertilizer caused the greater percentage of increase.

Nitrate of soda caused practically no increase, on the average. In four tests, nitrate of soda caused a slight increase, and in five tests the nitrate caused a decrease in yield. This decrease was probably due to injury to the plants soon after setting, by the strong salt coming in contact with the roots of the tender plants.

Sulphate of potash alone caused a slight increase in yield on the average of the ten tests, producing an increase in seven tests and a decrease in three. This indicates that on the soils used in these tests, potash is not likely to be an important element in fertilizing tomatoes.

Acid phosphate produced a substantial increase in every test except one, where a small decrease resulted. This decrease was probably due to the proximity of trees as the plot in question appeared very promising when noted in July. The indications are that phosphorous is the most important single element of plant food in fertilizing tomatoes in Missouri.

COST OF FERTILIZERS AND NET PROFIT

It has been shown in the preceding pages that commercial fertilizers may markedly increase the yield of tomatoes. What does it cost to produce the larger crop, and does it pay to grow a larger crop with the aid of fertilizers? The extra expense includes the cost of the fertilizer, the cost of application, and the cost of picking the extra quantity of fruit produced. These items are estimated on the basis of 1920 prices for fertilizers as furnished by the Department of Agricultural Chemistry and allowing 5 cents a bushel for picking. The price of the fruit is placed at $15 a ton. The results are shown in Table 2.

TABLE 2.—EXTRA COST OF GROWING TOMATOES WITH FERTILIZERS, AND NET RETURNS BASED ON AVERAGE OF TEN TESTS IN 1919.

Plot No.	Fertilizer used	Amt. applied per acre	Cost of fertilizer per acre	Cost of application per A.	Extra cost of picking increased yield	Total extra expense by using fertilizer	Yield, Tons per acre	Value of the yield per acre	Net gain per acre from use of fertilizer
1 & 8	None	...	.....	.....	.....	....	2.86	$42.50	.....
2	4.6-8-7	250	$9.00	$1.00	$5.62	$15.62	5.67	85.00	$26.48
3	5-8-0	250	7.00	1.00	5.08	13.08	5.40	81.00	25.02
4	Nitrate of soda	150	6.50	1.00	.18	7.68	2.93	44.00	-5.78
5	Sulphate of potash	150	11.50	1.00	.30	12.80	3.1	46.50	-9.26
6	Acid phosphate	250	2.75	1.00	4.75	8.50	5.29	79.40	28.00
7	Stable manure	8 tons	12.00	2.00	5.82	19.82	5.77	86.60	23.88

NOTE: "—" indicates loss.

It is seen from this table, that after deducting the cost of the fertilizer, cost of application, and cost of picking the extra amount of fruit produced by the fertilizer, that the acid phosphate, the 4.6-8-7 mixture, the 5-8-0 mixture and the stable manure plots afforded substantial net gains per acre, in the order named. Nitrate of soda alone, and sulphate of potash alone, resulted in a loss. It seems that high-grade acid phosphate (16%) is the most economical fertilizer to use, altho a complete mixed fertilizer may produce larger yields.

EFFECT OF FERTILIZERS ON EARLINESS

One of the most important effects of fertilizers observed in these tests on tomatoes is the rapid early growth of the plants, and the early date at which fruit begins to ripen on the fertilized plots. This was very noticeable in every series of fertilizer tests made in 1919, as the fruit began ripening on the plots fertilized with the 4.6-8-7 and 5-8-0 mixtures, as well as acid phosphate, long before the check plots came into bearing. The difference in total yield and earliness of fruit are shown graphically in the figure. This is based on the average weekly yields of the check plots, the complete fertilizer and the acid phosphate plots, in the Pierce, McElhaney and Grimes tests. It is seen from this chart that the check plots did not begin heavy bearing until the week of August 23-30, while the complete fertilizer plots came into bearing the week of July 26-August 2, or four weeks earlier than the checks. The acid phosphate plots came into heavy bearing about August 9, three weeks before the check plots. Both the complete fertili-

zers and acid phosphate plots reached the peak of their bearing season a week before the checks. After September 6, there is little difference between fertilized and check plots, as both declined rapidly.

It may be readily seen how important this increased earliness of the crop would be in case of the market grower, for the early fruit has a higher market value than does that produced later in the season. In the case of the cannery grower, the increased earliness is an advantage, for it distributes the season of heavy picking over a period of about six weeks, instead of three weeks in the case of the unfertilized crop. This would permit both the grower and the cannery to handle more tomatoes.

SUMMARY

The complete fertilizer produced a marked increase in yields of tomatoes, and the per cent increase is greater on the poorer soils.

In these experiments, a mixed fertilizer containing no potash produced practically as good yields as the complete fertilizer.

Acid phosphate alone produced a good increase in yield, but not as much as the mixed fertilizers.

Nitrate of soda alone and sulphate of potash alone, did not produce a large increase in any of these tests, and in some cases decreased yields thru injury to young plants.

Stable manure and poultry manure were found to be excellent fertilizers for tomatoes, altho these materials did not stimulate early maturity to as great an extent as did the 4.6-8-7 and 5-8-0 commercial ferilizers.

Mixed fertilizers, and acid phosphates alone, produced a striking increase in the amount of early fruit, the plants reaching quantity-production four weeks earlier than plants on unfertilized check plots. It seems that fertilizers stimulate plants to rapid growth during the early part of the season, resulting in a large plant, capable of bearing many fruits. This is particularly important in Missouri, where the latter part of the summer is usually unfavorable for plant growth.

As a result of the tests reported in this bulletin, it would appear that tomato growers could profitably increase the yield and earliness of the crop, by the use of at least 250 pounds to the acre of a commercial mixed fertilizer. It is suggested that a fertilizer analyzing 3 or 4 per cent nitrogen and 10 to 12 per cent phosphorous be used for tomatoes.