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Fertilizers for cabbage, peas, and tomatoes

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Summary and Recommendations

A study was made in 1939, 1940, 1941, and 1942 of the effect of varying nitrogen, phosphorus, and potash, and the rates of applying 4-8-4 with cabbage, peas, and tomatoes, in the Copiah County trucking area.

In presenting this information consideration is given to certain factors such as weather conditions, estimated production costs, and profits, as well as the fertilizers which are on the market for the 1943-44 season.

The results show that in varying the amount of nitrogen, phosphorus, or potash in cabbage fertilizer, greater increases came from nitrogen. As the nitrogen was increased the yields and profits were correspondingly increased. Increasing the amount of phosphorus up to 12 percent also gave increased yields and profits. As the potash was varied little difference in yields was obtained.

It is concluded that in order for truck growers in the Copiah County area to realize the most from cabbage fertilizers, approximately 60 pounds of nitrogen (N), 100 pounds of phosphorus (P_2O_5), and 40 pounds of potash (K_2O) per acre should be applied to the soil before setting the plants in the field, and 32 pounds of actual nitrogen should be applied as a side dressing as soon as the danger of severe cold weather has passed. The recommended plant food is supplied by applying 1000 pounds of 6-8-4 to the acre before setting, plus side dressing with 100 pounds of ammonium nitrate or its equivalent.

These results show that for the most profitable production of peas, nitrogen and phosphorus are important, and that potash above 40 pounds to the acre had little influence on yield.

It is recommended to growers of peas that the soil be supplied with 40 to 50 pounds of nitrogen (N), 100 pounds of phosphorus (P_2O_5), and 40 pounds of potash (K_2O) per acre before planting, plus about 16 pounds of actual nitrogen 6 weeks later. This amount of plant food is supplied by 1000 pounds of 5-10-5 before planting and 100 pounds of nitrate of soda, or its equivalent, applied as a side dressing.

Varying each element in tomato fertilizer while the other two remain constant gave results which indicate that all three nutrients are needed in large quantities. These results also show that high applications of nitrogen do not increase the percentage of culls, or seriously affect the storage qualities of tomatoes.

It is recommended to tomato growers that the soil be supplied with 60 pounds of nitrogen (N), 120 pounds of phosphorus (P_2O_5), and 60 to 80 pounds of potash (K_2O) before the plants are set in the field. This is supplied by approximately 1200 pounds of 5-10-5, plus a side dressing of 32 pounds of actual nitrogen supplied by 100 pounds of ammonium nitrate or its equivalent 6 weeks after setting.

Studies of the residual effects of fertilizer under cabbage, peas, and tomatoes upon corn yields showed that nitrogen is the most important element. They also show that tomato land should be planted to a summer cover crop instead of corn, because the yield obtained from corn following tomatoes is not great enough to pay for the cost of producing the crop.

Fertilizers
for
Cabbage, Peas, and Tomatoes

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The production of vegetables in Mississippi to be shipped north for early market, as well as those produced for home use, is an agricultural enterprise of considerable importance.

Vegetables have long been recognized as an important food crop because they contain certain food elements which are difficult to obtain from other sources. With the nation demanding more and more foods for our armed forces, lend-lease, and the civilian population, the importance of vegetables has been stimulated. The new methods of processing foods by dehydration and the increased interest in canning has attached even more importance to the vegetable producing industry.

Commercial Truck Crops in Mississippi

There are four recognized commercial vegetable producing areas in the State. Cucumbers for pickles and watermelons for shipping are produced in the Stone County area. The watermelon producing area extends as far northwest as Covington and Smith Counties. Vegetables are grown commercially for canning in the Marion, Pike, and Jones County areas. The growing of sweetpotatoes for starch manufacturing is a new and increasing enterprise in the Laurel area. Copiah and adjoining counties, long noted for the production of tomatoes, is the most important vegetable area. Although small quantities of certain root crops are grown in the Copiah County area, it is largely devoted to the production of cabbage, snap beans, garden peas, peppers, and tomatoes.

The Copiah County area is one of the oldest commercial vegetable areas in the South. Interest was initiated back in 1875. At present, approximately 20,000 acres of truck crops are grown annually in this area. Vegetable growers are interested in producing high yields of marketable grades, and in having their products ready for the early market which demands premium prices. A delay of three or four days in harvesting may result in a reduced market price of 30 to 40 percent, which makes the early production more important.

Certain conditions in this area are favorable to large production of high quality vegetables, but there are some which present problems of great importance. For this reason the Mississippi Legislature appropriated funds, and an experimental farm was established during the fall of 1938 to study some of the controllable problems. Experimental work has been undertaken to investigate problems of propagation, varieties, fertilization, cultivation, and insects and diseases attacking truck crops grown in this area.

Fertilizer Experiments Described

Because of the large expenditures on commercial fertilizer for the production of truck crops in the Copiah County area, one of the first problems attacked was that of the application of commercial fertilizers.

It is the purpose of this bulletin to report only that part of this work which was designed to study various fertilizer mixtures and different rates of 4-8-4, for cabbage, peas, and tomatoes.

The soil selected for these studies is

*The experiments were planned and the data for 1939, 1940, and 1941 were obtained by Mr. Campbell, who is on military leave. The data for 1942 were obtained and the manuscript prepared by Mr. Moore.

classified as Grenada silt loam. It has grown various truck crops receiving approximately uniform fertilizer treatments for more than 30 years, and since large applications of commercial fertilizer have been made, the soil had a comparatively high content of the various plant nutrients at the beginning of the experiments.

The experiments were conducted in 1939, 1940, 1941, and 1942. In each instance the plots were located on the same site each year, and received the same fertilizer treatments as in the previous year.

Six rates—500, 1000, 1500, 2000, 2500, and 3000 pounds of 4-8-4 per acre, and eleven fertilizer formulas—0-8-4, 4-8-4, 6-8-4, 8-8-4, 4-0-4, 4-4-4, 4-12-4, 4-16-4, 4-8-0, 4-8-8, and 4-8-12, each applied at the rate of 1000 pounds per acre, were tested. Each plot in all experiments received 200 pounds of nitrate of soda about six weeks after the crop was planted in the field, except that only 100 pounds per acre were applied to peas. Each treatment was repeated five times. The fertilizers tested were home mixed of nitrate of soda (16 percent N), superhosphate (20 percent P_2O_5), and muriate of potash (50 percent K_2O). Dolomitic limestone was used as a filler.

Cabbage, garden peas, and tomatoes were used in the tests, and were so rotated that each crop occupied the land once in 3 years. In 1939 and 1940 the Golden Acre variety of cabbage was used, but in 1941 and 1942 Detroit Resistant was used. World Record peas were used throughout the experiments. The Gulf State Market tomato variety was used in 1939 and 1940, but Rutgers was used in 1941 and 1942. Corn was planted following the truck crops, which is a common practice of truck growers, without applying additional fertilizer except a top-dressing of nitrogen. The fertilizer was applied about four weeks prior to the setting of cabbage and planting of peas and about ten days before tomatoes were set in the field. During each year the crops were planted on or as near the same date as weather conditions would permit. The cabbage were set in the field January 28, 1939; February 8, 1940; January 21, 1941; and January 20, 1942. Peas were planted January 28, 1939; February 20, 1940; January 21, 1941; and January 19, 1942. Tomatoes were set in the field on March 27, 1939, April 4, 1940, April 5, 1941, and April 1, 1942.

Factors Influencing Yield and Profits

Yields of cabbage, peas, and tomatoes are affected by several factors, some of which are controllable and some of which are not. Among the controllable factors are fertilizers, varieties, seeding and transplanting dates, spacing of the plants in the row, and to some extent the labor. As any or all of these factors vary the cost of production varies, and in most instances the yield varies. For instance, any variation in the analysis of fertilizer used results in a variation in costs. With peas and cabbage, a variation in the proportions of nitrogen and phosphorus in the fertilizer formula means a variation in yield. The variation in rates of applying fertilizer also results in a variation in costs and yields. The use of better adapted varieties which produce higher yields causes an increase in harvesting and total expense. The additional cost for harvesting, however, may be more than offset by the profits obtained due to higher yields. The same is true with planting dates. If the crop is planted late the harvest date is late also, which means the grower will not share in the higher early-market prices. Labor, a precious item in truck growing, plays quite a part in the costs of production. Any variation in these basic costs results in a variation of profits received. Each of these items varies on different farms, as well as from year to year, but it is believed that an estimate of the average

Table 1. Cost of producing 1 acre of cabbage, peas, and tomatoes with different fertilizer treatments.[1/]

Fertilizer treatment	Cabbage				Peas				Tomatoes			
	Fertilizer[2/] and applications	Other production costs	Harvesting and hauling	Total for cabbage	Fertilizer and applications	Other production costs	Harvesting and hauling	Total for peas	Fertilizer and applications	Other production costs	Harvesting and hauling	Total for Tomatoes
	Varying amounts of nitrogen, phosphorus, and potash in 1000 pounds of fertilizer to the acre.											
0-8-4	$16.18	$35.00	$ 6.85	$58.03	$14.18	$29.25	$36.54	$ 79.97	$16.18	$40.00	$ 9.64	$65.64
4-8-4	20.68	35.00	9.27	64.95	18.68	29.25	64.68	112.61	20.68	40.00	13.87	74.55
6-8-4	22.93	35.00	10.91	68.84	20.93	29.25	68.70	118.88	22.93	40.00	14.82	77.21
8-8-4	25.18	35.00	11.62	71.80	23.18	29.25	70.86	123.29	25.18	40.00	13.88	79.06
4-0-4	16.68	35.00	9.58	61.26	14.68	29.25	45.84	89.77	16.68	40.00	10.33	67.01
4-4-4	18.68	35.00	9.58	63.26	16.68	29.25	65.04	110.97	18.68	40.00	13.20	71.88
4-12-4	22.68	35.00	10.47	68.15	20.68	29.25	68.70	118.63	22.68	40.00	14.41	77.09
4-16-4	24.94	35.00	10.37	70.31	22.94	29.25	69.24	121.43	24.94	40.00	14.81	79.75
4-8-0	19.00	35.00	9.32	63.32	17.00	29.25	66.42	112.67	19.00	40.00	13.88	72.88
4-8-8	22.36	35.00	9.99	67.35	20.36	29.25	67.14	116.75	22.36	40.00	14.82	77.18
4-8-12	24.04	35.00	9.04	68.08	22.04	29.25	66.12	117.41	24.04	40.00	14.82	78.86
	Varying rates of 4-8-4.											
500	$13.34	$35.00	$ 7.56	$55.90	$11.34	$29.25	$60.00	$101.19	$13.34	$40.00	$ 9.28	$62.62
1000	20.68	35.00	8.96	64.64	18.68	29.25	69.06	116.99	20.68	40.00	11.07	71.75
1500	28.02	35.00	9.80	72.82	26.02	29.25	74.88	130.15	28.02	40.00	12.18	80.20
2000	35.36	35.00	10.36	80.72	33.36	29.25	73.68	136.29	35.36	40.00	13.46	88.82
2500	42.70	35.00	11.06	88.76	40.70	29.25	74.82	144.77	42.70	40.00	13.28	95.98
3000	50.04	35.00	11.20	96.24	48.04	29.25	76.38	153.67	50.04	40.00	12.45	102.49

[1/]Nitrate of soda at $40.00 per ton, phosphorus at $23.97 per ton, potash at $46.47 per ton, filler at $4.50 per ton.

[2/]Cost of fertilizer and application includes side dressing with 200 pounds nitrate of soda for cabbage and tomatoes, 100 pounds for peas, and $1.00 each for applying the fertilizer and side dressing.

costs involved will be of value to the reader in interpreting the yield data presented.

Fertilizer Costs

In table 1 is shown the cost of producing one acre of cabbage, tomatoes, and peas. The prices of the ingredients are based on quotations obtained from local dealers in Crystal Springs and Hazlehurst. Nitrate of soda is considered at $40.00 per ton, superphosphate at $23.97 per ton, and muriate of potash at $46.47 per ton. The filler is considered at $4.50 per ton, which is the price the Experiment Station paid in 1942. The cost of applying the fertilizer is shown as a part of fertilizer cost.

Other Production Costs

Other production costs include an estimate on the cost of labor for preparing the land, cultivation, and other practices which vary with the different crops.

Cabbage. The fixed cost of $35.00 for producing cabbage includes the cost of the plants, preparing the land, setting the plants, insect control, and the cultivation of the crop. This cost will vary on different farms, but with the average farm under the present cost of labor this fixed cost is fairly representative. The cost of harvesting and hauling cabbage to town is estimated at $1.40 per ton.

Peas. The estimated fixed cost of $29.25 for producing an acre of peas includes 1943 prices paid for seed, preparing the land, planting, cultivating, twine, staking, and stringing. The harvesting and hauling costs include the 1943 prices for hampers, picking, and hauling to town.

Tomatoes. With tomatoes the estimated fixed cost of $40.00 for producing an acre includes the cost of plants at $2.00 per thousand, preparation of land, setting the plants, cultivation, insect control, pruning, staking, and tying. Cost of harvesting and hauling is calculated at 8 cents per field box. The cost of labor is calculated at $2.00 per day, and the cost per mule is figured at 50 cents per day. It is estimated in cultivating truck crops that one man and one mule can plow eight furrows to an acre in a day.

This schedule of costs does not include the value of the land, buildings, plow tools, and equipment, or any other overhead expense.

Weather

Since the production of vegetables is greatly influenced by weather conditions, especially the amount and frequency of rains, data are presented from the U. S. Weather Bureau. The total rainfall during March, April, May, June, and July, the most important growing months in the area, for each of the 4 years is presented in table 2. Because the frequency of rain is as important as the total amount, the date on which a rain of one-fourth inch or more occurred is presented in table 3.

In 1939 the rainfall for each month, except April and July, was similar and was considered very good. Rainfall was less in April than in any of the other months. On March 30 a 3-inch rain came which was helpful to the crops in

Table 2. Total inches of rainfall for vegetable growing season during 1939, 1940, 1941, 1942, and the past 54-year average, Crystal Springs, Mississippi.*/

Year	March	April	May	June	July	Total
1939	6.98	3.67	6.44	6.45	4.96	28.5
1940	4.27	9.74	0.97	4.23	19.58	38.79
1941	5.22	6.84	2.57	1.62	6.26	22.50
1942	5.26	2.26	4.91	3.21	3.32	18.96
Ave. 1888 to 1942	5.67	4.95	4.41	4.56	5.83	

*/From U. S. Weather Bureau data, Crystal Springs.

Table 3. Frequency of rainfall during vegetable growing seasons of 1939, 1940, 1941, and 1942, Crystal Springs.*/

1939		Inches	1940		Inches	1941		Inches	1942		Inches
Mar.	2	.70	Mar.	13	1.45	Mar.	7	2.15	Mar.	2	.73
	6	.72		28	1.15		16	.51		8	.53
	26	1.67		30	1 63		21	1.32		13	.30
	27	.62	April	4	.4		27	.30		21	2.00
	30	3.00		5	.63		31	.57		26	.98
April	4	.70		7	.82	April	1	.45	April	9	1.43
	6	.33		12	2.00		3	.71		17	.63
	12	.73		18	.38		8	.41	May	12	.31
	17	1.06		19	1.11		20	.61		14	.74
	25	.64		29	1.08		21	1.54		15	2.38
May	7	.34		30	3.20		22	.41		20	1.05
	8	.64	May	1	.22		24	2.64		23	.25
	18	.77		14	.25	May	5	.55	June	5 & 6	.44
	19	1.23		23	.31		6	.34		8	.21
	25	.47	June	7	.48		18	.50		9	.59
	26	2.57		9	.33		26	.33		10	.63
June	2	1.95		16	.43		30	.48		20	.48
	3	1.30		24	.57	June	1	.30		21	.24
	4	.54		25	.41		12	.46	July	1	.51
	16	.55		29	1.12		16	.29		6	.43
	19	.28	July	3	3.58	July	1	1.09		15	.69
	29	1.27		6	6.85		2	.67		19	.99
July	2	.76		7	2.57		4	1.34		21	.40
	10	2.00		12	2.72		11	.58		—	—
	11	.40		13	.71		14	.56		—	—
	23	.27		15	.35		17	.30		—	—
	24	.55		16	1.03		19	.33		—	—
	25	.26		30	.41		23	.25		—	—
	28	.47		—	—		25	.67		—	—
	—	—		—	—		26	.31		—	—

*/From U. S. Weather Bureau data, Crystal Springs.

April. During June there was probably an excess to the extent that it interfered with the harvesting of tomatoes.

Yields were low in 1940. The total rainfall for that season was 10 inches greater than in any of the other years, but the distribution was unfavorable. In March rains were 2 weeks apart and drought was experienced. Sufficient moisture was supplied by rains in April. Less than one inch of rain fell during May. Dry weather in May undoubtedly accounts for some of the low yields obtained in the experiments. Rainfall was favorable in June, and in July the total rainfall was almost 20 inches.

Rainfall in the 1941 season approached the ideal, except for dry periods during May and June.

The total rainfall in 1942 was, in general, somewhat less than desired, but the dates on which rains of importance came were so distributed that the crops did not suffer for moisture at any time to any great extent.

Results of Fertilizer Experiments

Effect of Varying Nitrogen, Phosphorus, and Potash

The results obtained from varying the nitrogen, phosphorus, and potash in a 1000-pound application of fertilizer for the three crops in the 4 years are presented in table 4. This table also shows the crop rotation during the 4-year period. Thus, in 1939 cabbage were in field 1, peas in field 2, and tomatoes in field 3. In 1940 peas were in field 1, tomatoes in 2, and cabbage in 3. In 1941 tomatoes were in field 1, cabbage in 2, and peas in 3. In 1942 the crops occupied the same land as they did in 1939.

Table 4. Effect of varying nitrogen, phosphorus, and potash in a 1000-pound fertilizer mixture on the yield of marketable cabbage, peas, and tomatoes during 4 years, 1939 to 1942.

Treatments[1]	Cabbage—tons per acre					Peas—hampers per acre[2]					Tomatoes—field boxes per acre[3]				
	Fields					Fields					Fields				
1000 lbs. per acre of:	1	3	2	1	4-year average	2	1	3	2	4-year average	3	2	1	3	4-year average
	Years					Years					Years				
	1939	1940	1941	1942		1939	1940	1941	1942		1939	1940	1941	1942	
0-8-4	4.36	5.42	2.56	7.22	4.89	24.6	87.4	74.1	91.1	69.3	60.9	94.2	145.4	172.2	118.2
4-8-4	5.27	6.83	5.34	9.06	6.62	85.4	95.7	142.5	107.6	107.8	108.2	70.8	244.6	270.0	173.4
6-8-4	6.15	9.22	6.94	8.86	7.79	87.6	108.2	155.8	106.5	114.5	126.0	77.2	249.8	288.3	185.3
8-8-4	6.68	9.18	8.06	9.26	8.30	96.4	112.4	150.6	112.9	118.1	119.1	72.8	222.7	279.3	173.5
4-0-4	6.03	7.31	5.67	8.34	6.84	43.9	93.6	79.4	88.5	76.4	78.8	92.4	171.5	173.7	129.1
4-4-4	5.57	6.81	5.95	9.02	6.84	80.8	113.2	134.8	104.6	108.4	92.7	73.8	238.5	255.1	165.0
4-12-4	6.48	8.62	6.22	8.62	7.48	86.0	107.2	155.0	109.7	114.5	116.4	85.0	207.7	311.2	180.1
4-16-4	6.30	7.96	5.81	9.58	7.41	82.1	114.1	146.6	118.9	115.4	107.1	81.6	245.2	306.6	185.1
4-8-0	5.24	7.27	5.57	8.54	6.66	76.3	117.2	143.1	106.3	110.7	115.8	73.2	229.4	275.6	173.5
4-8-8	5.64	7.26	5.84	9.80	7.14	85.6	110.9	145.4	105.6	111.9	110.3	86.6	246.5	297.6	185.2
4-8-12	5.73	7.68	5.96	9.32	7.17	67.0	109.0	150.6	114.2	110.2	108.3	97.8	249.4	285.1	185.2

[1]/All plots received a side dressing with 200 pounds of 16 percent nitrate of soda to the acre except peas which received 100 pounds.
[2]/Hamper of peas weighs 28 pounds.
[3]/Field box of tomatoes weighs 70 pounds.

Table 5. Effect of varying the rates of 4-8-4 from 500 to 3000 pounds per acre upon the yield of marketable cabbage, peas, and tomatoes, during 4 years: 1939-1942.

Treatments[1]	Cabbage—tons per acre					Peas—hampers per acre[2]					Tomatoes—field boxes per acre[3]				
	Fields					Fields					Fields				
Amount of 4-8-4 per acre	2	1	3	2	4-year average	1	3	2	1	4-year average	3	2	1	3	4-year average
	Years					Years					Years				
	1939	1940	1941	1942		1939	1940	1941	1942		1939	1940	1941	1942	
3000	7.0	7.8	7.0	10.2	8.0	148.4	89.6	147.5	123.8	127.3	52.6	71.7	177.9	320.1	155.6
2500	6.9	7.3	7.7	9.5	7.9	157.4	85.2	135.3	120.8	124.7	68.4	73.5	169.5	352.5	166.0
2000	6.8	6.9	7.0	8.8	7.4	137.6	87.1	142.0	124.6	122.8	66.0	74.2	190.5	342.6	168.3
1500	7.1	6.0	6.2	8.5	7.0	144.4	85.3	156.0	113.5	124.8	66.7	83.4	146.8	311.7	152.2
1000	6.4	5.8	5.7	8.0	6.4	120.5	84.0	144.0	112.0	115.1	55.3	82.4	124.7	291.4	138.4
500	5.9	5.1	3.9	6.7	5.4	87.2	73.6	139.0	104.4	101.0	77.1	57.1	88.7	240.9	116.0

[1]/All plots received a side dressing with 200 pounds of 16 percent nitrate of soda to the acre except peas which received 100 pounds.
[2]/Hamper of peas weighs 28 pounds.
[3]/Field box of tomatoes weighs 70 pounds.

In general, increased yields were obtained with all three crops when the levels of nitrogen and phosphorus were increased in the fertilizer. Response to nitrogen was obtained with all crops during each year. Cabbage showed response to high levels of phosphorus in 1941 and 1942 but did not show any response in 1939 and 1940. Increased yields were obtained with peas and tomatoes from plots receiving 4 percent phosphorus as compared to those from plots receiving no phosphorus during each of the 4 years, and by 1941 higher levels of phosphorus gave some response. Increased yields were not obtained from increasing the levels of potash on either of the crops until 1941, and then slight differences were obtained with tomatoes only.

These results indicate that excessive quantities of 4-8-4 were applied during preceeding years, and while the nitrogen either leached out or was used by the crop, the phosphorus and potash accumulated in the soil in sufficient quantities to supply the needs of the plants for the first two or three years of these experiments.

The variation in yields during different years with each crop receiving identical fertilizer treatment can be attributed to weather conditions, improved cultural practices, and a change in varieties. The change in varieties of cabbage and tomatoes in 1941 probably accounts for the greater part of the increase in yield in 1941 and 1942 over 1939 and 1940.

Varying Rate of 4-8-4

The data presented in table 5 show, in general, that yields were increased with peas and cabbage by increasing the rates of 4-8-4 up to 3000 pounds. With tomatoes, an increase in yields was not obtained by applying more than 2000 pounds of 4-8-4 to the acre. With each crop it is noted that the increase in yields began to diminish after the rates were raised above 1500 pounds. The data in table 5 might be misleading unless they are studied along with the data in table 4.

Experiments With Cabbage

Varying the Quantity of Nitrogen

Table 6 shows the 4-year yield, the 1943 costs of production, and the estimated profits under these conditions from

Table 6. Effect of varying nitrogen, phosphorus, and potash in a 1000-pound fertilizer mixture on average yields, costs, and profits to the acre with cabbage.

Fertilizer[1] treatment	Yield, 4 yr. av. (tons)	Production[2] costs	Profits[3]
Varying nitrogen			
0-8-4	4.89	$65.64	$ 81.06
4-8-4	6.62	74.55	124.05
6-8-4	7.79	77.75	155.95
8-8-4	8.30	79.06	169.94
Varying phosphorus			
4-0-4	6.84	67.01	138.19
4-4-4	6.84	71.88	133.32
4-8-4	6.62	74.55	124.05
4-12-4	7.48	77.09	147.31
4-16-4	7.41	79.75	142.55
Varying potash			
4-8-0	6.66	72.88	126.92
4-8-4	6.62	74.55	124.05
4-8-8	7.14	77.18	137.02
4-8-12	7.17	78.86	136.24

[1]/All plots in this experiment received a side dressing with 200 pounds of nitrate of soda to the acre.

[2]/Production costs based on 1943 prices.

[3]/Profits based on cabbage selling at $30.00 per ton.

Figure 1. Effect of increasing the level of nitrogen in the 1000-pound fertilizer mixture. Row on left received 6-8-4; row on right received 4-8-8. Each plot received top-dressing with nitrogen at the rate of 200 pounds of nitrate of soda to the acre. Photo by C. M. Tingle.

growing cabbage. The profits are based upon cabbage selling at an average price of $30.00 per ton. Plots receiving 4 percent nitrogen, in 4-8-4, produced 1 3/4 tons more cabbage to the acre than plots receiving no nitrogen (0-8-4) in the 1000-pound fertilizer mixture. Plots receiving 6 percent nitrogen (in 1000 pounds 6-8-4 fertilizer) produced slightly over a ton more cabbage than plots receiving 4 percent nitrogen in the formula. Increasing the proportions of nitrogen from 6 to 8 percent increased the yields of cabbage from 7.79 to 8.3 tons to the acre. In this experiment, the one-half ton increase in yields due to the 2 percent increase in nitrogen in the fertilizer mixture is not great enough to be of practical importance.

As the yields increased from 4.89 to 6.62 tons to the acre due to the 40 pounds of actual nitrogen supplied in 1000 pounds of 4-8-4, the profits increase from about $81.00 to $124.00, a difference of about $43.00. As the yields further increased due to an additional increase of 20 pounds in actual nitrogen the profits increase to almost $156.00. The profits from the use of 6-8-4 were about $32.00 more than from 4-8-4, and approximately $75.00 greater than the profits from 0-8-4.

Illustrating the stimulating effect of nitrogen on cabbage, figure 1 shows cabbage growing on a plot which received fertilizer carrying 6 percent nitrogen and another plot which received fertilizer carrying 4 percent nitrogen. Each plot received a side dressing with nitrate of soda at the rate of 200 pounds per acre 6 weeks after the plants were set in the field. Each fertilizer was applied at the rate of 1000 pounds per acre before the plants were set in the field.

These data indicate that in order to produce a most profitable crop of cabbage on the soils in this area, approximately 92 pounds of actual nitrogen should be applied to an acre. This amount of actual nitrogen is supplied

by 1000 pounds of fertilizer carrying 6 percent nitrogen, applied before setting, plus 200 pounds nitrate of soda or its equivalent applied after the danger of severe cold weather has passed.

Varying Quantity of Phosphorus

The 4-year average effect on cabbage yields of varying the level of phosphorus in a 1000-pound application of fertilizer containing 4 percent nitrogen and 4 percent potash, is also presented in table 6 Little increase in yield was obtained by increasing the levels of phosphorus from 0 (4-0-4) to 16 percent (4-16-4). However, it will be noted in table 3 that in 1941 and 1942 a response was obtained from the application of phosphorus, whereas, during the first 2 years of the experiments very little difference was noted. This can be attributed to the residual effect of the heavy applications of complete fertilizer during the years preceding this experiment.

The 4-year average yields for plots receiving 4-0-4 and 4-4-4 are each 6.84 tons to the acre. Plots receiving 4-8-4 produced slightly lower yields, but the 4-12-4 plots produced 7.48 tons to the acre and the increase of over three-fourths of a ton is large enough to be of practical importance. Increasing the levels of phosphorus above 12 percent gave no increase in yields. The data show that when yields are increased by two-thirds of a ton due to increasing the levels of phosphorus to 12 percent or to 16 percent in the fertilizer formula the profits increase from $138.00 to $147.00. This is an increase of only $9.00 to the acre.

Observations during the fourth year of these investigations indicated further that cabbage respond to fairly high levels of phosphorus. Figure 2, which shows two of the experimental plots in April of 1942, illustrates the response of cabbage to phosphorus.

Figure 2. Effect of increasing the level of phosphorus in the 1000-pound fertilizer mixture. Row on left received 4-0-4 (no phosphorus). Row on right received 4-8-4 (8 percent phosphorus). Photo by C. M. Tingle.

From these results it is suggested that in order to produce a good crop of cabbage approximately 90 to 100 pounds of actual phosphorus (P_2O_5) should be applied to the soil. The suggested amount of phosphorus can be supplied in 1100 to 1200 pounds of fertilizer carrying 8 percent phosphorus.

Varying the Quantity of Potash

The effect on cabbage yields of varying potash in a 1000-pound fertilizer mixture containing 4 percent nitrogen and 8 percent phosphorus is presented in table 6. It will be noticed in table 3 that even though there were slight differences between yields from plots which received different levels of potash in 1939, no consistent differences were obtained until 1941 and 1942. This indicates that prior to this experiment, fertilizer usage had been in excess.

The 4-year average yields increased only one-half ton to the acre when the proportions of potash were raised from 0 to 12 percent, an increase not great enough for practical importance. Even in 1942 the difference obtained with varying the proportions of potash were not great. Therefore, under the conditions of this experiment some potash will be needed to produce a most profitable cabbage crop, but perhaps 40 pounds of potash (K_2O) per acre is sufficient.

Varying the Rate of 4-8-4 Fertilizer

The results obtained from varying the rates of 4-8-4 fertilizer from 500 to 3000 pounds to the acre are presented in table 7. These data show that as the rate of 4-8-4 is increased from 500 to 1000 pounds to the acre the yields are increased by one ton. Another increment in fertilizer of 500 pounds increases the yield 0.6 of a ton. As the rate of 4-8-4 is raised above 1500 pounds to the acre the increases in yields are not so great. Plots receiving the 2000-pound rate produced less than one-half ton more cabbage per acre than plots receiving the 1500-pound rate.

Considering the results discussed in the cabbage fertilizer formula experiment, attention is directed to the fact that greatest increases in yields were obtained by increasing the proportions of nitrogen. It is also noted that significant differences in yields were not obtained by high applications of phosphorus. Increases in yield with potash, which were not great enough to be important, were obtained only when yields from certain potash (4-8-8) plots were compared with yields from no potash (4-8-0) plots. Inasmuch as these facts were established from studying different fertilizer formulas, the belief is that the increases in yields from higher applications of 4-8-4 are principally due to the increased applications of nitrogen in the 4-8-4 fertilizer. This is further brought out by a comparison of the 4-year average yields from plots receiving 1000 pounds of 6-8-4 plus 200 pounds of nitrate of soda and plots receiving high rates of 4-8-4. The yields

Table 7. Effect of varying the rates of 4-8-4 from 500 to 3000 pounds to the acre upon yields, cost of production, and profits with cabbage.

Fertilizer[1] treatment lbs. 4-8-4	Yield, 4 yr. av. (tons)	Production[2] costs	Profits[3]
500	5.4	$55.90	$106.10
1000	6.4	64.64	127.36
1500	7.0	72.82	137.18
2000	7.4	80.72	141.28
2500	7.9	88.76	148.24
3000	8.0	96.24	143.76

[1]/All plots in this experiment received a side dressing with 200 pounds of nitrate of soda to the acre about 6 weeks after the cabbage were set in the field.

[2]/Production costs based on 1943 prices.

[3]/Profits based on cabbage selling at $30.00 per ton.

from the 6-8-4 (1000 pounds) plots are about 8 tons per acre. The yields from plots receiving the 2500- and 3000-pound rates are approximately 8 tons.

Since the fertilizer formula experiment has shown that nitrogen is the main limiting factor and that 6-8-4 is the most profitable formula to use, the profits received from it make a good comparison with the profits received from the various rates of applying 4-8-4. The data show that profits received from 1000 pounds of 6-8-4 plus 200 pounds of nitrate of soda were $155.95 as compared to $148.24 realized from 2500 pounds of 4-8-4 plus 200 pounds of nitrate of soda. Profits received from 3000 pounds of 4-8-4 were $143.76. The profits from plots fertilized with 6-8-4 plus the side dressing are almost $10.00 greater than the profits from the high rates plots. The profits from 2000 pounds of 4-8-4 to the acre are $141.28. Profits from 1000 pounds of 6-8-4 are almost $15.00 greater. It is seen that the profits favoring the use of 1000 pounds of 6-8-4 increases as the rate of 4-8-4 is decreased. The profit based on the yield from the 1000-pound rate of 4-8-4 in the fertilizer rates tests is $127.36 which is almost identical with the profit received from the 1000 pounds of 4-8-4 in the fertilizer formula tests.

Summarizing the above, it appears that greatest profits from cabbage fertilizers will be obtained from applying about 92 to 100 pounds of nitrogen (N), 90 to 100 pounds of phosphorus (P_2O_5), and 40 pounds of potash (K_2O) to the acre. The suggested amounts of plant food can be approximately supplied by applying 1000 to 1200 pounds of 6-8-4, plus a side dressing with 200 pounds of nitrate of soda or its equivalent.

Experiments With Peas

Varying the Quantity of Nitrogen

The 4-year average yield, the 1943 cost of production, and the estimated profits from peas are presented in table 8. These data show that plots receiving 4-8-4 produced about 1½ times as many hampers of peas as plots receiving 0-8-4. All of the plots received nitrate of soda at the rate of 100 pounds per acre as a side dressing. As the proportion of nitrogen in the 1000-pound fertilizer mixture was increased from 4 to 6 percent, the increase in yield was not great. Plots receiving 4

Table 8. Effect of varying nitrogen, phosphorus, and potash in a 1000-pound fertilizer mixture on average yields, costs, and profits to the acre with peas.

Fertilizer[1] treatment	Yield, 4 yr. av. (hampers)	Production[2] costs	Profits[3]
Varying nitrogen			
0-8-4	69.3	$ 79.97	$ 58.63
4-8-4	107.8	112.61	102.99
6-8-4	114.5	118.88	110.12
8-8-4	118.1	123.29	112.91
Varying phosphorus			
4-0-4	76.4	89.77	63.03
4-4-4	108.4	110.97	105.83
4-8-4	107.8	112.61	102.99
4-12-4	114.5	118.63	110.37
4-16-4	115.4	121.43	109.37
Varying potash			
4-8-0	110.7	112.67	108.73
4-8-4	107.8	112.61	102.99
4-8-8	111.9	116.75	107.05
4-8-12	110.2	117.41	102.99

[1]/All plots in this experiment received a side dressing with 100 pounds of nitrate of soda to the acre about 6 weeks after the crop was planted.

[2]/Production costs based on 1943 prices.

[3]/Profits based on peas selling at an average price of $2.00 per hamper (28 lbs.).

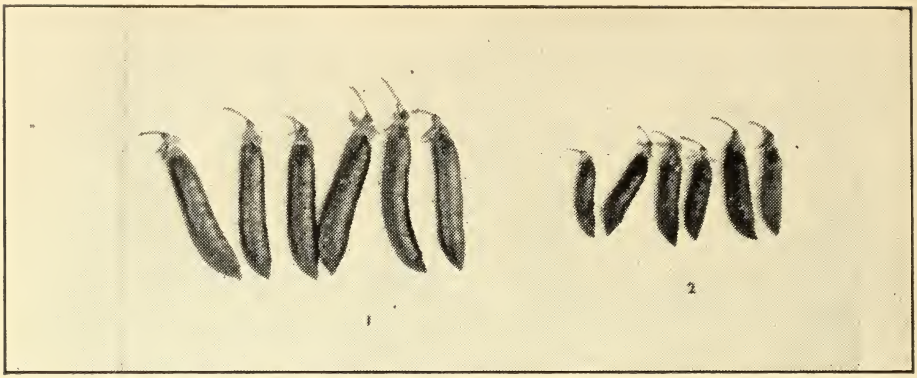

Figure 3. The effect of different levels of nitrogen upon the relative size of pods. Left, peas grown on plots receiving 1000 pounds of 8-8-4 to the acre. Right, peas grown on plots receiving 1000 pounds of 0-8-4 to the acre. All plots received 100 pounds of nitrate of soda to the acre.

percent nitrogen (4-8-4) produced 107.8 hampers of peas, and plots receiving 6-8-4 produced 114.7 hampers to the acre. Plots which received 8-8-4 yielded 118.1 hampers of peas to the acre. As shown in these data increasing the level of nitrogen above 6 percent in the 1000-pound fertilizer mixture does not increase the yields enough to be of practical importance. The response to different levels of nitrogen were much alike from year to year.

These data show that as the yields are increased by 38½ hampers due to increasing the proportions of nitrogen from 0 to 4 percent in the fertilizer formula, the profits increase from $58.63 to $103.00. The increase in profit due to raising the levels of nitrogen above 4 percent is small.

Observations during these experiments have shown that about 56 pounds of actual nitrogen (N) is sufficient to produce a good crop of peas, and that this amount is essential for the production of good marketable pods. Figure 3 illustrates that nitrogen is essential for the production of long, well-filled, marketable pods. Pods from plots which received only 100 pounds of nitrate of soda to the acre are of definitely inferior quality, and if marketable the price received for them would be very low; whereas, pods from plots receiving 56 pounds of nitrogen are of good quality, well-filled, and of marketable length and shape.

Figure 4. Peas growing on one of the 0-8-4 fertilizer plots.

Figure 4 shows young peas growing on a plot which received 1000 pounds of 0-8-4 to the acre and 1000 pounds of nitrate of soda. It is seen that the three rows in the foreground are much smaller and have a lighter color than the plot to the extreme left which received an ample supply (6-8-4) of nitrogen.

Varying the Quantity of Phosphorus

The 4-year average yields of peas obtained from varying the amounts of phosphorus in a 1000-pound mixture also carrying 4 percent nitrogen and 4 percent potash, are presented in table 8. These

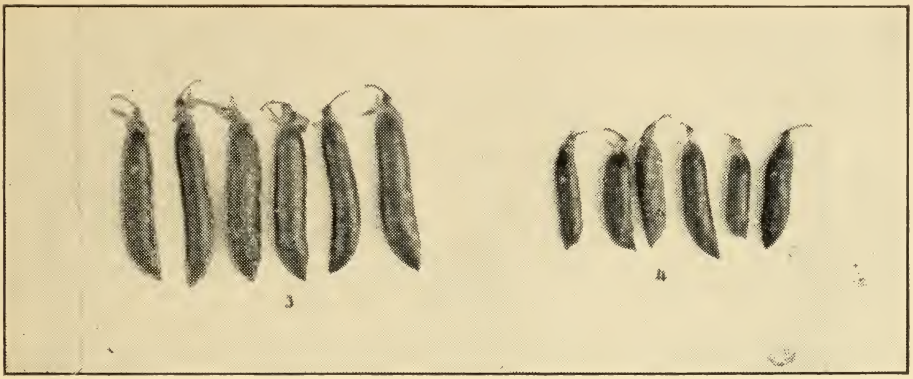

Figure 5. Effect of different levels of phosphorus upon the relative size of pods. Left, peas grown on plots receiving 1000 pounds of 4-12-4 to the acre. Right, peas grown on plots receiving 1000 pounds of 4-0-4 to the acre.

data show increases in yields similar to increases obtained with different amounts of nitrogen. In all 4 years peas responded to applications of phosphorus; however, it was observed that greater response to higher levels of phosphorus were obtained during the last year of the experiment. The 4-year average yields show an increase from 76.4 to 108.4 hampers to the acre as the level of phosphorus was increased from 0 to 4 percent. This increase in yield shows an increase in profit of about $40.00 to the acre. The yields, according to the 4-year average, were not greatly increased by raising the proportions of phosphorus above 4 percent. Considering the yields for each of the 4 years it is seen that in the later years of the experiments the yields were increased by increasing the amount of phosphorus up to 8 percent.

Figure 5 shows that phosphorus is essential for the production of long, well-filled pods.

Figure 6 shows a plot (in the foreground) of peas growing on a (4-0-4) no phosphorus plot. The peas growing to the left of the painted stake have sufficient phosphorus, and a satisfactory growth is being made for the production of large, well-filled pods.

Figure 7 shows peas just before harvest in 1942 growing on two of the experimental plots receiving different levels of phosphorus. In section A the peas are growing in 4-12-4 (12 percent phosphorus) and in B they are on 4-0-4 (no phosphorus). It is seen that the vines growing on the plots receiving phosphorus are reaching the third string and have a good crop of long, well-shaped pods. The vines shown in section B are up only to the second string and have only a few pods which are of poor shape and quality.

It is observed that yields of peas were not greatly increased by increasing the levels of phosphorus above 4 percent (4-4-4 formula). However, the data, the figures, and observations made in the field during 1942 indicate that higher amounts of phosphorus are needed in

Figure 6. Young peas growing on a no-phosphorus plot. Row on which stake is located and 2 rows to the right received no phosphorus.

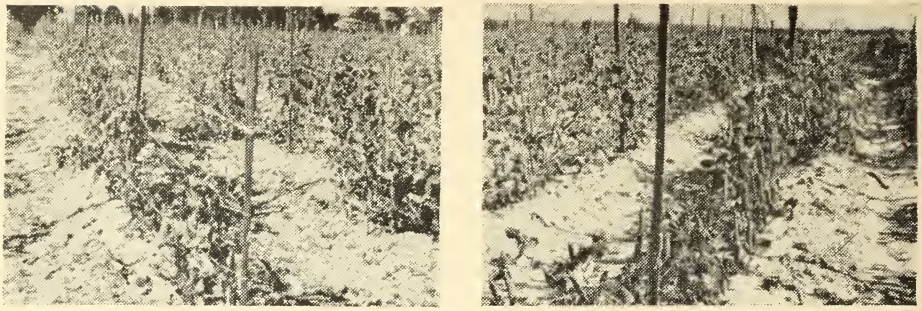

Figure 7. Influence of phosphorus on peas at harvest time. Right, peas growing on 1000 pounds of 4-12-4 to the acre; left, peas growing on 1000 pounds of 4-0-4 to the acre. Photographs made April 23, 1942, by C. M. Tingle.

order to produce a good crop of peas on soils which do not contain large residual quantities of this element as a result of high applications of complete fertilizer for the production of previous crops.

Varying the Quantity of Potash

The data in table 8 show the influence of potash upon yield, costs, and profits, and indicate that the potash requirement for peas is rather low. In fact, peas growing on plots receiving no potash were considered about as good as those receiving 12 percent potash in the 1000-pound fertilizer mixture.

Varying the Rate of 4-8-4 Fertilizer

Data are presented in table 9 on the yields of peas and on profits obtained from varying the rates of 4-8-4 fertilizer from 500 to 3000 pounds to the acre.

These data show that yields of peas were increased with increased rates of 4-8-4 up to 1500 pounds to the acre. These increases are similar to those obtained in varying the amounts of nitrogen and phosphorus in the fertilizer analysis tests.

The data indicate that about 56 pounds of nitrogen, and 100 pounds of phosphorus appear to be needed to produce the most profitable crop of high quality peas. It is believed that more than 40 pounds of potash is excessive. In 1500 pounds of 4-8-4 there is one and one-half times as much potash as suggested. Therefore, it seems more profitable to lower the rate of potash by applying about 1000 pounds of a complete fertilizer which carries 4 percent potash.

The results show that as the rate of applying 4-8-4 is increased from 500 to 1000 pounds the yields increase about 14 hampers. Increasing the rate to 1500

Table 9. Effect of varying rate of 4-8-4 from 500 to 3000 pounds to the acre upon yields, costs, and profits with peas.

Fertilizer[1/] treatment lbs. 4-8-4	Yield, 4 yr. av. (hampers)	Production[2/] costs	Profits[3/]
500	101.0	$101.19	$100.81
1000	115.1	116.99	113.21
1500	124.8	130.15	119.45
2000	122.8	136.29	109.31
2500	124.7	144.77	104.63
3000	127.3	153.67	100.93

[1/]All plots in this experiment received a side dressing with 100 pounds of nitrate of soda to the acre about 6 weeks after peas were planted.

[2/]Production costs based on 1943 prices.

[3/]Profits based on peas selling at an average price of $2.00 per hamper (28 lbs.).

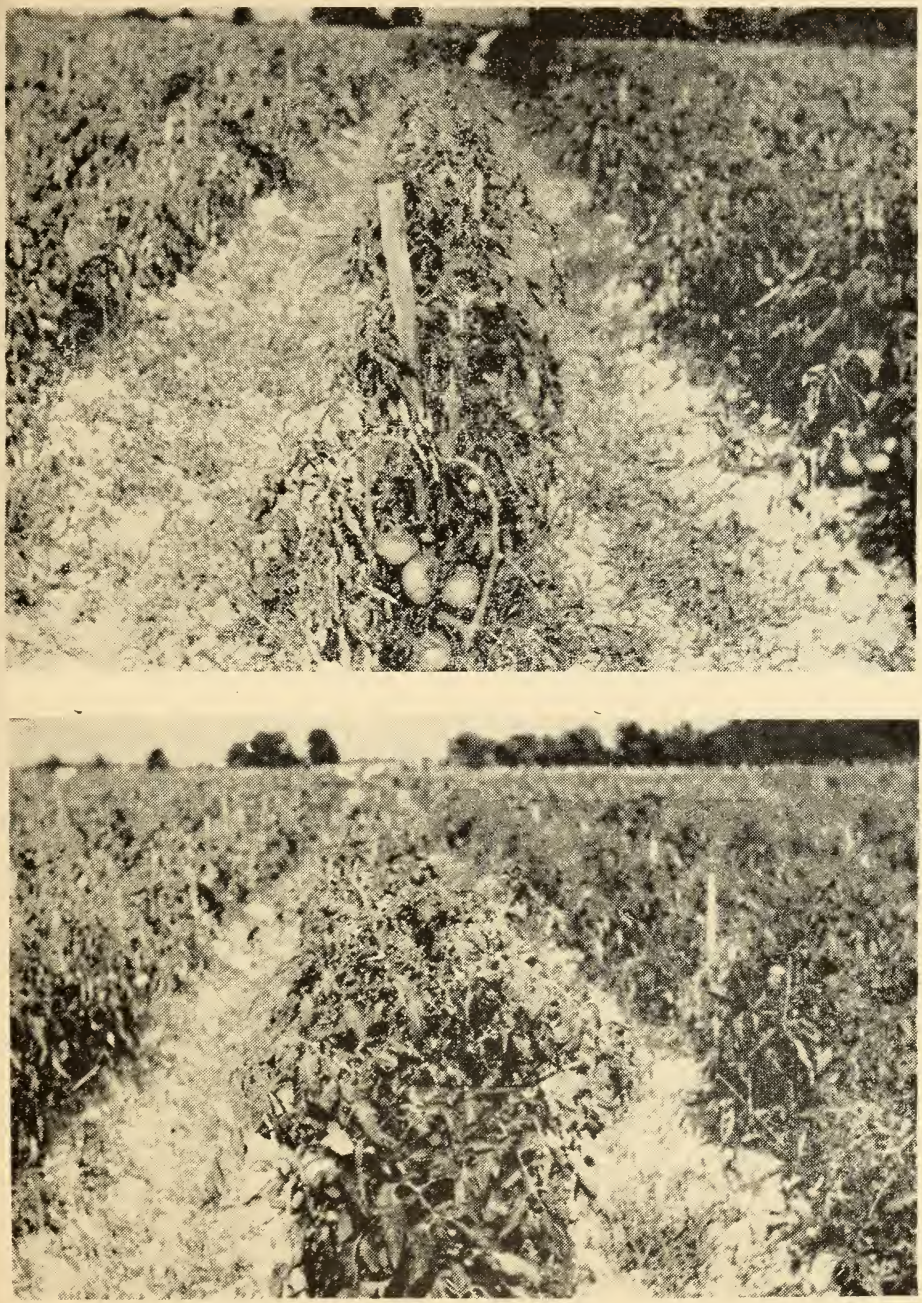

Figure 8. Influence of nitrogen upon growth of tomato plants a week before harvest time. Upper, tomatoes growing on 1000 pounds of 0-8-4 plus 200 pounds of nitrate of soda to the acre; lower, tomatoes growing on 1000 pounds of 6-8-4 plus 200 pounds of nitrate of soda to the acre. Photo by C. M. Tingle.

pounds shows another increase of about 9 hampers. Increasing the rate of 4-8-4 above 1500 pounds shows no increase in yield. The profits increase about $13.00 when the yields are increased by 14 hampers from increasing the rate from 500 to 1000 pounds. As the rates of fertilizer are increased above 1500 pounds the profits drop considerably.

The most profitable production thus appears to result from applications of 56 to 60 pounds of nitrogen (N), 80 to 100 pounds of phosphorus (P_2O_5), and 40 pounds of potash (K_2O). These suggested amounts of plant nutrients are supplied by approximately 1000 pounds of 4-8-4 plus 100 pounds of nitrate of soda to the acre.

Experiments With Tomatoes

Varying the Quantity of Nitrogen

Results obtained from varying nitrogen, phosphorus, and potash and the effect of such variations on the 4-year average yield, costs of production, and profits received from tomatoes, are shown in table 10.

These data show that tomatoes respond to fairly high levels of nitrogen. As the nitrogen is increased in a 1000-pound fertilizer mixture, from 0 (0-8-4) to 4 percent (4-8-4), the yield increases by 55 field boxes. As the nitrogen is increased further to 6 percent (6-8-4) an additional increase of 12 field boxes is obtained. All the plots received a side dressing with 200 pounds of nitrate of soda to the acre.

The data show that profits increase somewhat in proportion to the increase in yield. As the yields increase 55 field boxes, due to the application of the additional 4 percent of nitrogen, the profits increase $156.60. The additional increase of 12 boxes, due to the additional 2 percent nitrogen, results in an increase of $32.50 profit. The plots receiving 8-8-4

Figure 9. Influence of nitrogen upon yields of tomatoes. Left, 1000 pounds of 4-8-4 plus 200 pounds of nitrate of soda. Right, 1000 pounds of 6-8-4 plus 200 pounds of nitrate of soda. Photo by C. M. Tingle.

Table 10. Effect of varying nitrogen, phosphorus, and potash in a 1000-pound fertilizer mixture in average yields, costs, and profits to the acre with marketable tomatoes.

Fertilizer[1] treatment	Yield, 4-yr. av.[2] (field boxes)	Production[3] costs	Profits[4]
Varying nitrogen			
0-8-4	118.2	$65.64	$288.96
4-8-4	173.4	74.55	445.65
6-8-4	185.3	77.75	478.15
8-8-4	173.5	79.06	441.44
Varying phosphorus			
4-0-4	129.1	67.01	320.29
4-4-4	165.0	71.88	423.12
4-8-4	173.4	74.55	445.65
4-12-4	180.1	77.09	463.21
4-16-4	185.1	79.75	475.55
Varying potash			
4-8-0	173.5	72.88	447.62
4-8-4	173.4	74.55	445.65
4-8-8	185.2	77.18	478.42
4-8-12	185.2	78.86	476.74

[1]/All plots in this experiment received a side dressing with 200 pounds of nitrate of soda to the acre.
[2]/Field box of tomatoes weighs 70 pounds.
[3]/Production costs based on 1943 prices.
[4]/Profits based on tomatoes selling for an average of $3.00 per field box.

showed no increase in yields over 6-8-4; therefore, the profits were less since the higher nitrogen fertilizer costs more.

Figure 8, A and B, shows the influence of nitrogen on the growth of tomato plants about one week before harvesting. In A the tomatoes are growing on a plot which received 1000 pounds of 0-8-4 plus the side dressing of 200 pounds of nitrate of soda. In B they are on a plot which received 1000 pounds of 6-8-4 plus a side dressing with 200 pounds of nitrate of soda.

Figure 9 illustrates the difference obtained in yield at the second picking from plots which received 4-8-4 (left) and 6-8-4 fertilizer (right). The two fertilizers were applied at the rate of 1000 pounds per acre and each received the side dressing of 200 pounds of nitrate of soda to the acre.

The foregoing information on nitrogen for tomatoes indicates that for maximum production and greatest profits, approximately 92 pounds of actual nitrogen should be added to the soils in this area. The suggested amount of nitrogen is supplied in a 1000 pounds of complete fertilizer carrying 6 percent nitrogen plus a side dressing with 200 pounds of nitrate of soda to the acre.

Varying the Quantity of Phosphorus

The data in table 10 show that as the amount of phosphorus is increased the yield of tomatoes is increased. An application of 4 percent phosphorus (4-4-4) increased the yields by 36 field boxes per acre. For the next two additional 4 percent increases in phosphorus the yields are increased by approximately 8 field boxes each. As the level of phosphorus is increased above 12 percent (4-12-4) the increase in yield is so low that it is not of practical importance.

It is noted in table 3 that little response was obtained from varying the levels of phosphorus during the earlier years of the experiments. This is attributed to the heavy applications of complete fertilizer applied for commercial production during previous years. However, in 1941, 1942, and in the 4-year average, increased yields were obtained with the higher levels of phosphorus. The results obtained with phosphorus are somewhat similar to those obtained with nitrogen.

The data show that as the yields increase due to increased amounts of phosphorus the profits increase in a corresponding manner. As the proportion of phosphorus is increased from 0 (4-0-4) to 4 percent (4-4-4) the profit increases about $100.00. This increase is about two-thirds as much as that obtained with a similar increase of nitrogen. As the level of phosphorus is increased from 4 percent (4-4-4) to 8 percent (4-8-4) the profit increases about $20.00. It is noted that a similar increase in profit is made when phosphorus is increased to 12 percent (4-12-4). A further increase to 16 percent phosphorus shows an increase in yield over 4-12-4, but the increase is only about $10.00. This gives an increase of $143.00 in profit by the use of 4-12-4 in comparison with 4-0-4, which indicates that the phosphorus requirement for tomatoes on this soil is rather high.

From the above information the indications are that for highest yields and greatest profits about 120 pounds of phosphorus (P_2O_5) should be applied to the soils in this area for tomatoes.

Varying the Quantity of Potash

The results obtained with varied levels of potash, in a 1000-pound fertilizer mixture for tomatoes, show considerable variation in yield from the different amounts of potash in the fertilizer formula. In studying the 4-year average yields (table 10) it is noticed that plots receiving 4-8-0 (no potash) and plots receiving 4-8-4 (4 percent potash) produce the same yield. It is further noted that the yields from plots receiving 4-8-8 or 4-8-12 are identical. However, as the level of potash is increased from 4 percent to 8 percent the yield is increased by almost 12 field boxes.

The profits increase with increased levels of potash and increased yields. As the level of potash is increased from 4 percent (4-8-4) to 8 percent (4-8-8) the profits increase approximately $30.00. Therefore it is profitable to apply fertilizer carrying 60 to 80 pounds of actual potash (K_2O) to tomato land in this area.

Varying the Rate of 4-8-4

Presented in table 11 are the results obtained from varying the rates of applying 4-8-4 fertilizer from 500 to 3000 pounds to the acre upon the 4-year average yields, costs of production, and the profits received from tomatoes.

Yields were increased due to increased applications of 4-8-4 fertilizer up to 2000 pounds to the acre. As the rates of applying 4-8-4 were increased from 500 to 1000 pounds, the yields were increased 22 field boxes per acre. With 1500 pounds of fertilizer per acre, the yields were increased approximately another 15 field boxes. An additional increase of 500 pounds to a total of 2000 pounds of 4-8-4 to the acre shows another increase in yields of about 15 field boxes to the acre. The total increase in yields obtained by increasing the rate from 500 to 2000 pounds of 4-8-4 was 52 field boxes to the acre. The yield of tomatoes was not

Table 11. Effect of varying the rates of 4-8-4 from 500 to 3000 pounds to the acre upon yields, costs, and profits with marketable tomatoes.

Fertilizer[1] treatment lbs. 4-8-4	Yield, 4-yr. av. (field boxes)	Production[2] costs	Profits[3]
500	116.0	$52.62	$295.38
1000	138.4	61.75	353.45
1500	152.2	70.20	386.40
2000	168.3	78.82	426.08
2500	166.0	85.98	412.02
3000	155.6	92.49	374.31

[1]/All plots in this experiment received a side dressing with 200 pounds of nitrate of soda to the acre.

[2]/Production costs based on 1943 prices.

[3]/Profits based on tomatoes selling at $3.00 per field box.

increased by increasing the rate of 4-8-4 fertilizer above 2000 pounds to the acre.

It is noted that the profit (table 11) increases in a manner somewhat similar to the increase in yield. As the rate is increased from 500 to 1000 pounds to the acre the profit increases from $295.39 to $353.45, an increase of about $58.00 above costs. By increasing the rate from 1000 to 1500 pounds to the acre the profits increase approximately $33, or from $353.45 to $386.45. The profits are further increased about $40.00 by increasing the rate from 1500 to 2000 pounds of 4-8-4 to the acre. The application of rates above 2000 pounds of 4-8-4 to the acre results in reduced profits.

In reviewing the data presented in tables 10 and 11 it is noted that increases in yields were obtained by increasing the amounts of nitrogen, phosphorus, and potash applied to the soil. Inasmuch as the greatest response was obtained from applications of nitrogen, the increase in yields obtained from the increased rates can be misleading. It is the opinion that the higher yields obtained from 4-8-8 could be obtained from only 6 percent potash, or from 4-8-6.

Influence of Fertilizer Upon Percentage of Cull Tomatoes

Due to the fact that tomatoes are more or less graded in the field before they are carried to the packing sheds for marketing, it is of interest to note the effect of various amounts of nitrogen, phosphorus, and potash on the percentage of culls.

It is noted in table 12 that culls constitute about 35 percent of the total yield for each treatment. The highest percentage of culls (38 percent) is shown from the use of 8-8-4, while 0-8-4 produced the next highest percent of culls (36½ percent). It thus appears that neither of the nutrients increases or decreases the cull percentages to an appreciable extent. Differences in opinion exist among growers regarding the use of nitrogen in this area. Some have the opinion that high nitrogen encourages rough fruit and lowers the carrying quality of tomatoes. In that regard an observational test was made on the influence of nitrogen upon the carrying quality of tomatoes. Tomatoes from high-nitrogen and from low-nitrogen plots, packed in separate junior lugs, and subjected to identical storage conditions for 15 days, showed no appreciable differences in quality of fruit.

Summarizing, it appears that approximately 90 pounds of nitrogen (N), 120 pounds phosphorus (P_2O_5), and 60 to 80 pounds of potash (K_2O) should be applied to the soil to secure the highest yields and make the most profits from tomatoes in the Crystal Springs area. These amounts are supplied in approximately 1000 pounds of 6-12-6 plus 200 pounds of nitrate of soda per acre, or

Table 12. Effect of varying nitrogen, phosphorus, and potash in a 1000-pound fertilizer mixture upon yield—field boxes per acre.

Fertilizer[1/] treatment	Marketable fruit	Cull fruit	Total fruit	Culls
	lbs.	lbs.	lbs.	percent
0-8-4	118.2	68.3	186.5	36.6
4-8-4	173.4	94.3	267.7	35.2
6-8-4	185.3	101.7	287.0	35.4
8-8-4	173.5	107.7	281.2	38.3
4-0-4	129.1	66.5	195.6	34.0
4-4-4	165.0	81.4	246.4	33.0
4-12-4	180.1	91.5	271.6	33.7
4-16-4	185.1	89.5	274.6	32.6
4-8-0	173.5	92.6	266.1	34.8
4-8-8	185.2	90.6	275.8	32.8
4-8-12	185.2	94.0	279.2	33.7

[1/] All plots received a side dressing with 200 pounds of nitrate of soda to the acre.

Table 13. The residual effect of varying nitrogen, phosphorus, and potash upon yields of corn following cabbage, peas, and tomatoes.

Fertilizer[1/] treatment (1000 lbs. per acre)	Corn yield following cabbage 4-yr. av.	Corn yield following peas 3-yr. av.	Corn yield following tomatoes 2-yr. av.	Av. yield following all three crops
		Influence of nitrogen		
	bu.	bu.	bu.	bu.
0-8-4	31.4	18.7	5.1	18.4
4-8-4	38.6	27.6	8.9	25.0
6-8-4	33.4	31.9	10.0	25.1
8-8-4	32.2	36.9	9.8	26.3
		Influence of phosphorus		
4-0-4	31.0	28.9	7.8	22.6
4-4-4	27.5	24.9	6.8	19.7
4-8-4	38.6	27.6	8.9	25.0
4-12-4	33.8	31.0	9.4	24.7
4-16-4	37.5	27.6	7.3	24.1
		Influence of potash		
4-8-0	26.3	27.1	8.0	20.5
4-8-4	38.6	27.6	8.9	25.0
4-8-8	33.4	29.4	8.2	23.7
4-8-12	39.2	26.5	8.0	24.6

[1/]All plots received 200 pounds of nitrate of soda to the acre when corn was about knee high.

by 1200 pounds of 5-10-5 plus 200 pounds of nitrate of soda to the acre, or by 1500 pounds of 6-8-4 without the side dressing.

Experiments With Corn Following Truck Crops

It is a common practice among growers in the Copiah area to grow corn without additional fertilizer following cabbage, peas, and tomatoes. In some instances the growers side dress the corn with 200 pounds of nitrate of soda to the acre when the corn is about knee high. Corn was planted in these experiments following each crop without additional fertilizer, similar to common practice.

The yields of corn obtained from varying the levels of nitrogen, phosphorus, and potash applied to cabbage (table 13) are much alike. It is noted, however, from the 4-year average yields that greatest yields were obtained from plots which received a moderate supply of each of the nutrients. It is also noted that the yield of corn following cabbage is very good.

The yield of corn following peas increased when increased amounts of nitrogen were applied. As the proportions

Table 14. Influence upon the subsequent yield of corn of varying the rates of 4-8-4 from 500 to 3000 pounds to the acre with cabbage, peas, and tomatoes.

Fertilizer[1/] treatment	Corn yield following cabbage 4-yr. av.	Corn yield following peas 4-yr. av.	Corn yield following tomatoes 2-yr. av.	Av. yield following all three crops
lbs.	bu.	bu.	bu.	bu.
500	21.5	21.8	15.5	19.6
1000	23.7	24.5	16.0	21.4
1500	28.8	29.3	17.0	25.0
2000	33.4	33.3	19.8	28.8
2500	36.0	35.6	21.0	30.9
3000	34.5	38.0	21.6	31.4

[1/]Fertilizer was applied to the preceding crop. The corn received a uniform side dressing with 200 pounds of nitrate of soda to the acre.

of nitrogen were increased from 0 to 4 percent the yields were increased about 10 bushels to the acre. Varying the levels of phosphorus with peas did not influence the subsequent yield of corn.

Corn yields were also increased by increasing the amount of nitrogen in the fertilizer applied to tomatoes. As the nitrogen was increased from 0 to 6 percent, the yields of the following corn crop were doubled. Varying the amount of phosphorus and potash with tomatoes had little effect upon the subsequent corn yields.

The corn yields were gradually increased by increasing the rate of 4-8-4, applied to preceding crops of cabbage, peas, and tomatoes, but the increase in yields due to each 500 pounds increment of fertilizer is too small to be of practical importance; each 500-pound increment in fertilizer only increased the following corn yields about 2 or 3 bushels to the acre. When the increase in profits of cabbage, peas, or tomatoes is added to the increase in the corresponding corn yields, the increase in yields of corn due to increased fertilizer rates is not great enough to change the rates suggested for each of the three truck crops.

The results obtained with corn following tomatoes indicate that it is not an economical practice to grow corn after tomatoes in this area. During the 4-year period, yield data were recorded only 2 out of the 4 years. The yields obtained during the other 2 years were so poor that the corn was not worth harvesting. The ears from corn following tomatoes were short, poorly filled, and in most instances of no value. Therefore, it is suggested that tomatoes be followed with a summer cover crop rather than with corn.