it up to our committee." They look him over, they find out whether he is a worthy man, they look over his crop, whatever he has, and if they decide it's all right they say "You put up $50 in stock; you do not have to put up the cash; we will lend you the $50." In other words, when we make the loan, we will give you $950 and keep out $50 for stock. That's what we call B stock or voting stock. As soon as you have bought that, the Production Credit Corporation will subscribe for $200 worth of stock—A stock. Then there will be $250 in cash capital in your Production Credit Association. Then they can take your note for $1000 and take this $250 in capital up to the Intermediate Credit Bank and say "We want to borrow $1,000 on this," and the Intermediate Credit Association Bank lends the $1000,, keeps the $250 as additional security, and lends the $1000.

Now that's not the technical explanation. It's just putting it in a common horse-sense way of how it works, and that's the way we are getting the production credit to the farmers of America.

The fourth type is Co-operative Credit. There were also established twelve banks for co-operatives, one in each land bank district, and inasmuch as we have some nation-wide co-operation, requiring a great amount of credit there were established a sector bank, with five banks capitalized at five million each, and Congress put up the money. It was what was left from the Federal Farm Board Fund. This Co-operative Bank makes long-time loans on facilities, warehouses, packing plants, and so on.

Those are the four institutions that have been set up in the Farm Credit Administration to take care of the credit of America. We have been engaged in this work now since the 27th day of May. That's when the Act went into effect. All told, the four institutions by the 27th of this month will have loaned over a billion dollars to the American farmer. All told, that's about one-third of the applications that we have had on hand all the time, but I believe that during the coming twelve months these institutions will be able to take care of the credit needs of America. We have been doing a two-fold job; first, we have been taking care of an emergency. We have been an army of the administration that is absolutely essential to recovery. Second, we have been endeavoring to build a long-time mortgage system, a long-time credit system for agriculture on a co-operative basis, so soundly that down through the years agriculture need never again be so embarrassed by the denial of sound credit as we have been during the last three or four years.

INFLUENCE OF FERTILIZERS AND SOIL AMENDMENTS ON CITRUS TREES, FRUIT PRODUCTION AND QUALITY OF FRUIT

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INTRODUCTION

In the early fall of 1929 a series of soil fertility and fertilizer experiments with citrus were undertaken to study soil factors and fertilizer practices influencing citrus tree vitality, fruit production and quality of citrus fruits in Florida. At that time, many reports were received of the poor condition of citrus trees and of declining quality of fruit produced in many sections of the state. Since, many citrus problems have arisen. More recently the so-called "copper leaf disease" or bronzing of citrus attributed to nutritional deficiencies has been the forerunner in some affected groves of dropped leaves, die-back of twigs and loss of fruit in quality and yield.

Several lines of experiments pertaining to citrus problems, co-ordinated with work of the Florida Experiment Station and other Bureaus of the Department were undertaken. As a part of the attack this Bureau inaugurated experiments to study the effect of so-called minor essential plant foods on citrus in Florida soils and the effect of quickly available chemically pure fertilizers of high concentration which were made available by nitrogen fixation processes developed during the War and used considerably in Southern agriculture.

The soils of Florida are low in most of the common plant foods and in many regions the soils are deficient in the less common so-called minor essential plant foods. The addition of some of these, particularly copper to the Everglades soils[1] and manganese to the calcareous soils of the East Coast.[2] have stimulated growth and production of truck crops. The present report is primarily on the phase of the co-ordinated citrus work dealing with concentrated fertilizers and with the effects of minor essential plant foods, particularly manganese sulphate.

EXPERIMENTS WITH CONCENTRATED CHEMICAL FERTILIZERS

An experiment in a seedling orange grove was made from 1927 to 1933 on Norfolk fine sand at Orlando, Florida, comparing the effects of a chemical concentrated fertilizer containing ammonium phosphate, ammonium nitrate, urea and potassium sulphate with an ordinary analysis mixture containing superphosphate, potassium sulphate and nitrogen from sodium nitrate, bone meal and packing house tankage. The former was prepared so as to have three times the concentration of the latter, but the same amount of plant food was applied on a one-fourth acre plot receiving concentrated fertilizer and on a one-fourth acre receiving single strength fertilizer. The concentrated mixture was made from salts which are acid-forming, and the single strength fertilizer was compounded so as to be base-forming. The results recorded are given in Table 1.

The yields were lower from concentrated acid-forming fertilizer than from the single strength base-forming fertilizer. No records were made of the 1929-30 crop. The average yield per tree for five years is 127 pounds for the concentrated fertilizer against 154 pounds for the single strength fertilizer. Data secured in studying firmness, size and composition of the fruit on the 1930-31 and 1931-32 crops show slightly higher content of juice and slightly firmer fruit[3] for oranges grown with single strength fertilizer. The size of the fruit as determined by weight was variable. The two fertilizers differ (1) in concentration of salts or plant foods, (2) in source of salts and materials supplying the plant food and (3) in their acid and

[1]Allison, R. V., Bryan, O. C., and Hunter, J. H. The stimulation of plant response on the raw peat soils of the Florida Everglades through the use of copper sulphate and other chemicals. Bull. No. 190, Fla. Agr. Exp. Sta., 1927.

[2]Skinner, J. J., and Ruprecht, R. W. Fertilizer experiments with truck crops. Bull. 218, Florida Agr. Exp. Sta., 1930.

[3]The method used in determining firmness or rigidity of citrus fruit is described in a paper in these proceedings entitled "A Device for Measuring the Ability of Citrus Fruits to Withstand Pressure," by A. E. Hughes, see page 27.

TABLE I

EFFECT OF CONCENTRATED AND LOW ANALYSIS FERTILIZER ON SEEDLING ORANGES, ORLANDO, FLORIDA

Data Secured	1930-31 Crop		1931-32 Crop	
	Triple Strength Fertilizer	Single Strength Fertilizer	Triple Strength Fertilizer	Single Strength Fertilizer
Pressure required to crush (Lbs. per Sq. In.)	30.5	34.7	28.0	30.5
Rind (Per cent.)	23.0	23.5	25.6	25.9
Pulp (Per cent.)	26.4	23.7	29.9	25.4
Juice (Per cent.)	48.0	50.8	40.8	45.3
Reaction of juice (pH)	3.0	3.7	3.1	3.3
Aver. wt. of oranges (grams)	169.0	178.0	189.0	167.0
Aver. yield per tree (lbs.)	173.0	190.0	93.0	163.0
Aver. yield per tree (lbs.)	103[a]	109[a]	124[b]	137[b]
Aver. yield per tree (lbs.)	141[c]	170[c]		

[a]1927-28 crop [b]1928-29 crop [c]1932-33 crop

base-forming tendencies in the soil. The different results secured could be due in so far as the effects of fertilizers are concerned to any or all of these factors. The soil on which the experiments were made is acid, having a pH of approximately 5.9, although calcareous marl was applied a year preceding the inauguration of the experiment. No distinct change in the pH of the soils of the two plots was noted during the period of the experiment, except in 1929 when there was a slightly higher acidity or lower pH in the concentrated fertilizer plot. It is possible that the soil reaction may have changed temporarily for a period after the fertilizer applications, but this was not determined. Thirty pounds per tree of the single strength and 10 pounds of the concentrated mixture were used for each application made three times per year.

In an experiment near Lake Alfred, on Valencia oranges, made co-operatively with the Florida Experiment Station, eight concentrated fertilizers were used of various combinations of ammonium phosphate, ammonium nitrate, ammonium chloride, ammonium sulphate, urea, sodium nitrate, potassium sulphate, potassium nitrate and treble super-phosphate. Each fertilizer was used on blocks of 15 trees. Seven of the concentrated mixtures are acid-forming and one base-forming. The yields from the various mixtures containing different materials have not differed widely except the base-forming concentrated fertilizer which gave as an average for five years, 23 per cent. larger yields than the highest of the acid-forming fertilizers. Analyses made of the 1931-32 and 1932-33 oranges show a slightly higher per cent. of juice in oranges grown with the base-forming concentrated fertilizer. The rigidity of the fruit from this plot was greater than fruit grown with five of the acid-forming concentrated mixtures. Records were made of the condition of the 1931-32 oranges after shipping. These were picked April 5 and shipped to Washington, arriving on April 10. They were placed in storage until April 27. Two days after removal from storage, 91 per cent. of the oranges from the base-forming concentrated fertilizer plot were sufficiently firm to permit marketing, compared to 52 per cent. of firm fruit, the highest from the seven acid-forming fertilizer plots.

Further data with acid and base-forming fertilizer are available from experiments, including concentrated fertilizers, inaugurated in 1931 with

TABLE II

EFFECT OF ACID AND BASE-FORMING CONCENTRATED FERTILIZERS ON VALENCIA ORANGES ON THREE FLORIDA SOILS

Composition of Fertilizer	Acid or Base Forming	Av. Yield per Tree 1932-33 Pounds	Resistance of Fruit to Pressure Lbs. per Sq. Inch	Juice in Orange Per Cent.
Hammock Soil Underlain by Calcareous Rock, Mims, Florida				
Ammonium phosphate; Urea; Potassium sulphate	Acid	231	34.2	65
Treble super-phosphate; Calnitro; Potassium sulphate	Base	189	33.5	66
Neutral Palm Beach Soil, Vero Beach, Florida				
Ammonium phosphate; Urea; Potassium sulphate	Acid	96	38.2	57.6
Treble super-phosphate; Calnitro; Potassium sulphate	Base	181	42.7	61.3
Acid Norfolk Fine Sand, Winter Haven, Florida				
Ammonium phosphate; Urea; Potassium sulphate	Acid	119	32.5	55.0
Treble super-phosphate; Calnitro; Potassium sulphate	Base	122	36.3	58.0

Valencia oranges on Hammock soil underlain by calcareous rock near Mims, Florida; on neutral Prairie soil, underlain by calcareous material, near Vero Beach, Florida; and on acid Citrus Ridge Belt soil near Winter Haven, Florida. A concentrated fertilizer having acid-forming tendencies, containing ammonium phosphate, urea and potassium sulphate, and a concentrated fertilizer having base-forming tendencies, containing treble super-phosphate, Calnitro and potassium sulphate, were used on blocks of 15 trees each. The fertilizer applications had been made for less than two years when the 1932-33 data were secured, so the results, while indicative, should not be considered conclusive. The experiments are in progress and final conclusions from the work should await further data. The data are given in Table II.

On the Hammock soil, oranges grown with the two fertilizers contained approximately the same per cent. of juice and the degree of firmness did not vary widely. On the neutral Vero Beach soil and the acid Winter Haven soil, oranges grown with the acid-forming fertilizers required less pressure to crush and contained a smaller per cent. of juice than those grown with base-forming fertilizer. The yield was greater from the base-forming fertilizer.

The preliminary data secured in these experiments contribute to the evidence secured in other experiments that the less favorable results from certain types of concentrated fertilizers on citrus may be due to their acid-forming tendencies. However, the composition of the fertilizers used in some of the experiments, especially the last discussed, may be a possible factor in their effects on citrus fruits. It is not clear whether the more favorable results from base-forming fertilizers on some of the soils are due to its neutralizing quality or to the calcium supplied, although the Vero Beach soil which gave better results with base-forming fertilizer than acid-forming fertilizer is underlain with calcareous material, apparently supplying soluble calcium to the trees. The soil in the seedling grove at Orlando which gave better results from the base-forming fertilizer had, prior to the inauguration of the experiments, been supplied with calcareous, marly material, and some of the acid-forming concentrated fertilizers in the Lake Alfred experiment which gave less favorable results than base-forming fertilizer contained triple super-phosphate which supplies calcium.

EFFECT OF MANGANESE SULPHATE ON CITRUS TREES AND ON COMPOSITION AND QUALITY OF FRUIT

The effect of manganese sulphate on citrus was studied in experiments in various sections of Florida, which were started in 1929 and 1930 on different soil types having varying degrees of acidity and alkalinity. Three of the experiments are with tangerines, one with seedling oranges, five with Valencia oranges and three with grapefruit. Seven groves selected for the experiments were in poor condition, showed well developed stages of chlorosis and yields had declined. Five were healthy groves, showed but little chlorosis and yields were normal. In each experiment the plots comprised 15 to 30 trees.

The effects of manganese sulphate applied to the soil on the composition and quality of fruit and on tree foliage are given in Table III. The data were secured on fruit produced in 1932-33. Other data of this character were secured in some of the experiments in two of the preceding years. These were of the same trend as those secured in 1932-33, and are not given. One of the soils was highly calcareous and distinctly alkaline; one was neutral with a slightly acid subsoil; one neutral to slightly acid, and nine were acid, ranging in pH from 5.2 to 6.5.

The effects of manganese sulphate added to soils in the experiments reported, in general, were to increase the manganese content of the fruit, the firmness or rigidity of the fruit, the size or weight of the fruit, the intensity of color of the rind of fruit, and to improve the chlorotic condition of the foliage of the trees. The juice of the fruit was decreased in most of the experiments. A detailed analysis of the data follows: Fruit from eleven of the experiments contained more manganese where manganese was applied to the soil than fruit from the no manganese plots. In one experiment the reverse was true and this was on a neutral soil having a pH of 6.8 to 7.4. Fruit grown with manganese sulphate was firmer as indicated by resistance to pressure before crushing in nine experiments than fruit grown without manganese.

TABLE III[a]—EFFECT OF MANGANESE SULP

DATA RECORDED	Norfolk fine sand, DeCamp Grove, Eagle Lake, Tangerines, 13 years old 1933 — Citrus grown with: Fertilizer without manganese sulphate	Fertilizer with manganese sulphate	Norfolk f Phill O Tangerin — Citrus: Fertilize without manganes sulphate
Reaction of surface soil 0-8 inches (pH)	5.3	5.6	5.3
Reaction of subsoil 12-24 inches (pH)	4.7	5.0	5.2
Organic matter content of soil (per cent.)			
Manganese sulphate per tree annually (pounds)	0	6.0	0
Total manganese sulphate per tree 1929-1933 (pounds)	0	30.0	0[b]
Manganese content of fruit (p. p. m. Mn_3O_4)	1.398	3.539	1.011
Juice (per cent.)	52.3	44.4	40.5
Pulp (per cent.)	31.0	36.5	40.7
Rind (per cent.)	16.6	19.1	18.6
Total solids in juice (per cent. by Brix)	14.0	12.7	10.9
Acids in juice (per cent.)	1.3	1.4	1.3
Reaction of juice (pH)	3.0	3.0	3.1
Resistance of fruit to pressure before crushing (pounds per sq. in.)	22.8	26.3	18.0
Average weight of fruit (grams)	89.0	117.0	101.0
Color of fruit[a]	Orange Chrome	Cad. Orange	Flame Scarlet
Condition of foliage in fall (per cent. mottled)	50.0	0	18.0

[a]Colors according to R. Ridgeway, Color Standards and Nomenclature.
[b]Experiment started in 1930.
[c]Experiment started in 1931.

TABLE III[b]—EFFECT OF MANGANESE SULP

DATA RECORDED	Norfolk fine sand, Ard Grove, Sharpes Valencia oranges, 7 yrs. old 1933 — Citrus grown with: Fertilizer without manganese sulphate	Fertilizer with manganese sulphate	Blanton Philli O No. 1 Val 15 — Citrus: Fertilizer without manganes sulphate
Reaction of surface soil 0-8 inches (pH)	6.8	7.4	5.6
Reaction of subsoil 12-24 inches (pH)	6.4	6.7	5.4
Organic matter content of soil (per cent.)			
Manganese sulphate per tree annually (pounds)	0	9.0	0
Total manganese sulphate per tree 1929-1933 (pounds)	0[b]	27.0[b]	0
Manganese content of fruit (p. p. m. Mn_3O_4)	0.517	0.886	0.518
Juice (per cent.)	63.4	61.4	66.2
Pulp (per cent.)	18.7	20.7	15.0
Rind (per cent.)	17.8	17.8	19.4
Total solids in juice (per cent. by Brix)	12.8	12.6	14.3
Acids in juice (per cent.)	1.3	1.2	0.9
Reaction of juice (pH)	3.2	3.2	3.5
Resistance of fruit to pressure before crushing (pounds per sq. in.)	28.4	29.6	20.0
Average weight of fruit (grams)	202.0	219.0	209.0
Color of fruit[a]	Deep Yellow	Light Yellow	Deep Chrome
Condition of foliage in fall (per cent. mottled)	26.0	1.0	10.0

[a]Colors according to R. Ridgeway, Color Standards and Nomenclature.
[b]Experiment started in 1930.

PPLIED TO THE SOIL ON CITRUS IN FLORIDA

d No. 1, ove, rs. old	Norfolk fine sand No. 2, Phillips Grove, Orlando, Tangerines, 9 yrs. old 1933		Norfolk fine sand, Hubbell Grove, New Smyrna, Seedling Oranges, 25 yrs. old 1933		Norfolk fine sand, Rogers Grove, Orlando, Valencia Oranges, 9 yrs. old 1933		California Rock Soil Cook Grove, Homestead, Valencia Oranges, 4 yrs. old 1933	
with	Citrus grown with		Citrus grown with		Citrus grown with		Citrus grown with	
rtilizer with nganese lphate	Fertilizer without manganese sulphate	Fertilizer with manganese sulphate	Fertilizer without manganese sulphate	Fertilizer with manganese sulphate	Fertilizer without manganese sulphate	Fertilizer with manganese sulphate	Fertilizer without manganese sulphate	Fertilizer with manganese sulphate
5.3	5.2	5.2	6.1	6.0	5.3	5.7	8+	8+
5.2	5.2	5.3	5.1	4.7	5.2	5.3	8+	8+
6.0	0	6.0	0	6.0	0	18.0	0	3
24.0[b]	[b]	24.0[b]		30.0	0[c]	36.0[c]	0[c]	9[c]
2.315	1.011	2.315	0.957	3.098	1.014	1.821	0.457	1.455
42.4	46.0	43.8	41.7	36.9	60.4	55.4	53.7	51.9
38.9	36.4	38.2	39.5	41.8	19.9	24.5	25.6	25.9
18.3	16.9	17.4	19.0	21.5	19.8	19.9	20.7	22.1
11.4	11.4	11.4	13.4	13.2	11.7	12.9	11.1	11.0
1.3	1.4	1.3	1.2	1.1	1.2	1.1	1.0	1.0
3.1	3.0	3.1	3.4	3.6	3.4	3.5	3.5	3.5
18.2	17.2	20.0	17.3	22.3	36.8	35.3	50.8	52.8
99.0	102.0	100.0	199.0	243.0	195.0	198.0	234.0	238.0
rad. ed	Flame Scarlet	Grad. Red	Flame Scarlet	Grad. Red	Deep Yellow	Light Yellow		
5.0	12.0	5.0	23.0	0	10.0	10.0	26.0	6.0

PPLIED TO THE SOIL ON CITRUS IN FLORIDA

sand, ove, oranges, ld	Blanton fine sand, Phillips Grove, Orlando, No. 2 Valencia oranges, 15 yrs. old 1933		Norfolk fine sand, Ard Grove, Sharpes, Grapefruit, 7 yrs. old 1933		Norfolk fine sand, Hunt Bros. Grove, Lake Wales, Grapefruit 13 yrs. old 1933		Norfolk fine sand, Anderson Grove, Longwood, Grapefruit, 15 yrs. old 1933	
with	Citrus grown with		Citrus grown with		Citrus grown with		Citrus grown with	
rtilizer with nganese lphate	Fertilizer without manganese sulphate	Fertilizer with manganese sulphate	Fertilizer without manganese sulphate	Fertilizer with manganese sulphate	Fertilizer without manganese sulphate	Fertilizer with manganese sulphate	Fertilizer without manganese sulphate	Fertilizer with manganese sulphate
5.5	6.5	6.5	6.8	7.4	5.0	5.6	5.2	5.4
5.4	6.0	6.2	6.4	6.7	4.7	5.0	5.1	4.9
6.0	0	6.0	0	9.0	0	6.0	0	6.0
24.0	0[b]	24.0[b]	0[b]	27.0[b]	0	30.0	0	30.0
2.154	0.481	2.215	0.544	0.294	0.888	4.026	0.795	2.743
59.0	56.4	60.5	43.4	45.7	40.5	43.4	41.7	40.8
18.4	20.9	19.1	27.5	27.6	30.5	29.3	31.7	36.0
22.5	22.6	20.4	29.2	26.7	30.3	27.7	26.7	23.0
14.8	14.3	14.5	10.8	10.9	10.3	10.4	41.7	40.8
1.1	0.8	0.9	1.4	1.4	1.6	1.6	1.6	1.6
3.4	3.6	3.5	3.4	3.3	3.1	3.1	3.0	3.0
17.4	16.6	15.7	15.7	19.5	22.2	23.8	19.0	20.1
89.0	256.0	194.0	494.0	589.0	404.0	488.0	462.0	500.0
ad. range	Deep Chrome	Cad. Orange						
8.0	10.0	10.0	23.0	7.0	26.0	0	20.0	12.0

The differences in two of these cases were slight. The soils to which the addition of manganese did not increase the rigidity of the fruit are acid. The average weight of fruit was greater grown with manganese than without manganese in eight experiments. The four soils which gave heavier fruit without manganese are acid. The fruit from soil to which manganese was applied contained a smaller per cent. of juice in eight experiments. Two of the soils giving a higher per cent. of juice with manganese than without manganese were slightly acid and two were distinctly acid. The degree of acidity of the juice as determined by its hydrogen-ion concentration varied but slightly in fruit grown with and without manganese in all the experiments.

The condition of the foliage was much improved by the addition of manganese sulphate to the soil in most of the experiments. Some of the groves selected for the experiments showed marked chlorosis in the beginning. This condition was markedly improved, particularly in the groves on slightly acid, neutral and alkaline soils.

Plates 1 and 2 show typical trees in an experiment in the vicinity of Vero Beach. This grove showed severe chlorosis. Manganese sulphate was applied semi-annually at the rate of 10 pounds per tree at each application for two years on one plot of the grove. Plate 1 shows a typical tree from the no manganese plot and Plate 2 a typical tree from the manganese plot after two years. Note the healthy and thick foliage of the tree shown in Plate 2 as compared to the scant foliage of the tree shown in Plate 1 which received no manganese. All the trees received a complete commercial fertilizer applied three times per year. Plate 3 shows typical chlorotic leaves from the trees receiving no manganese as compared to the typical green leaves from the trees receiving manganese in experiment on a neutral soil near Sharpes, Florida. Plate 4 shows a tangerine grove on Norfolk fine said, a typical acid Citrus Ridge Belt soil having a pH of 5.3 at Eagle Lake, Florida. In 1929 this entire grove showed advanced stages of chlorosis, the trees in general were in a poor condition and produced but little fruit. The entire grove has since been fertilized three times annually with a standard commercial mixture, and one block of about half an acre received in addition six pounds of manganese sulphate per tree annually. The photographic record made in 1932 shows healthy trees on the left which have received manganese sulphate and chlorotic trees with scant foliage, which received no manganese on the right. A close view of a typical tree from the no manganese plot showing its scant foliage is shown in Plate 5.

The color of the fruit before and at the time of picking seemed strikingly influenced by the addition of manganese sulphate to the soils. The color of the rind of the fruit was intensified in all the experiments, regardless of the soil type or its reaction.

EFFECT OF MANGANESE SULPHATE ON YIELDS

The influence of manganese sulphate on yields of citrus in twelve experiments in various parts of Florida are given in Table IV. Plots in these experiments consist of from 15 to 30 trees. The data showing influence of manganese sulphate on the fruit and trees are given in preceding tables and previously discussed.

In a three-year experiment on Norfolk fine sand, underlain with Coquina shells near Sharpes, Florida, manganese sulphate increased the yield of Valencia oranges the third year, but no gain was noted the second year of the experiment. The yields of tangerines and grapefruit were increased each year the yields were recorded. The soil is practically neutral, having a pH of 6.4 to 6.8. On acid Norfolk fine sand near New Smyrna manganese sulphate slightly increased the yields of seedling oranges the two years yields were recorded. On an acid Norfolk fine sand near Longwood, Florida, manganese sulphate increased the yields of grapefruit two years the yields were recorded. On an acid Norfolk fine sand at Winter

TABLE IV

EFFECT OF MANGANESE SULPHATE ON YIELD OF CITRUS ON FLORIDA SOIL

Character of Soil	Location	Reaction of: Surface Soil	Reaction of: Sub-Soil	Crop	Manganese Sulphate per Tree Annually	Experiment Started	Average Yield per Tree Annually: Year	Fertilizer Only	Fertilizer Plus Manganese
		pH	pH		Pounds			Pounds	Pounds
Norfolk fine sand underlain with Coquina shells	Sharpes	6.8	6.4	Valencia Oranges	9	1930	32-33	28	26
							33-34	18	56
Norfolk fine sand underlain with Coquina shells	Sharpes	6.8	6.4	Tangerines	9	1930	32-33	62	70
Norfolk fine sand underlain with Coquina shells	Sharpes	6.8	6.4	Grapefruit	9	1930	32-33	46	81
							33-34	118	176
Norfolk fine sand	New Smyrna	5.9	4.7	Seedling Oranges	6	1929	31-32	95	98
							32-33	88	89
Norfolk fine sand	Longwood	5.2	5.1	Grapefruit	6	1929	31-32	64	92
							32-33	100	199
Norfolk fine sand	Winter Haven	5.3	5.2	Valencia Oranges	18	1932	33-34	76	80
Norfolk sand	Eagle Lake	5.3	4.7	Tangerines	6	1929	31-32	138	166
							33-34	65	56
Calcareous Rock, No. 1, Soil	Homestead	8.0	8.0	Valencia Oranges	3	1930	31-32	16	22
							32-33	17	41
							33-34	21	43
Calcareous Rock, No. 2, Soil	Homestead	8.0	8.0	Valencia Oranges	1.5	1930	33-34	8	13
Low Hammock Soils underlain with marl	Mims	6.2	7.1	Valencia Oranges	6	1931	32-33	170	291
Norfolk fine sand	Winter Haven	5.2	5.5	Valencia Oranges	6	1931	32-33	120	105
Palm Beach sand	Vero Beach	5.1	8.0	Valencia Oranges	6	1931	32-33	165	172

TABLE V

EFFECT OF MANGANESE SULPHATE ON YIELD OF CITRUS ON FLORIDA SOIL

Character of Soil	Location	Reaction of Surface Soil	Reaction of Sub-Soil	Crop	Manganese Sulphate per Tree Annually	Experiment Started	Average Yield per Tree Annually: Year	Fertilizer Only	Fertilizer +M'g'nese
		pH	pH		Pounds			Pounds	Pounds
Norfolk fine sand........	Orlando	5.3	5.2	Tangerines	6	1929	30-31	44	160
							31-32	257	290
							32-33	400	464
							33-34	112	121
Norfolk fine sand........	Orlando	5.3	5.2	Tangerines	6	1929	30-31	102	121
							31-32	273	291
							32-33	340	377
							33-34	210	151
Blanton fine sand........	Orlando	5.6	5.4	Valencia Oranges	6	1929	30-31		
							31-32	331	226
							32-33	161	200
							33-34	108	104
Blanton fine sand........	Orlando	6.5	6.2	Valencia Oranges	6	1929	30-31		
							31-32	73	187
							32-33	169	172
							33-34	43	119

Haven manganese slightly increased the yields of Valencia oranges the first year of the experiment. On a very acid soil at Eagle Lake manganese increased the yields of tangerines the third year of the experiment, but no increase was noted the fourth year. Yields were not recorded the first and second years. The general condition of the trees was markedly improved by manganese sulphate. In two experiments with Valencia oranges on calcareous rock soil near Homestead, Florida, manganese increased the yields each year. On low Hammock soil underlain with marl at considerable depth manganese markedly increased the yields of Valencia oranges the first year after application was made, and on Palm Beach sand containing particles of marl and shell and underlain by calcareous rock at Vero Beach manganese slightly increased the yield of Valencia oranges. On acid Norfolk fine sand at Winter Haven manganese decreased the yield of Valencia oranges the first year of the experiment.

In Table V are given the results of a four-year experiment on two tangerine groves with manganese sulphate on Norfolk fine sand at Orlando, Florida, and with Valencia oranges on two groves on Blanton fine sand. Both soils are acid, the Norfolk fine sand having a pH of 5.2 to 5.3 and the groves on Blanton fine sand, having a pH of 5.6 in one case and 6.5 in another.

In one experiment with tangerines the yields were increased each year by manganese sulphate, the average yield being 203 pounds per tree for the no manganese plots and 259 pounds per tree for the manganese plots. In the second experiment yields were increased slightly by manganese sulphate each year except in 1933-34. The average yield per tree for four years is 231 pounds for the no manganese plots and 235 pounds for the manganese plots.

In the experiment with Valencia oranges in the grove with the soil having a pH of 5.4 to 5.6, yields were less for two years from the manganese sulphate plots, and larger for one year. In the grove where the soil had a pH of 6.2 to 6.5 yields were larger each year from the manganese sulphate plot. The average yield for no manganese is 95 pounds per tree against 159 pounds per tree for the manganese plot. The effect of manganese sulphate in the 16 experiments reported was to increase yield in all except two. Increased production was small in some cases, but in most cases the difference in yield appeared significant.

INFLUENCE OF MANGANESE SULPHATE WITH ACID AND BASE FORMING FERTILIZERS

A study is being made of the effect of manganese sulphate on alkaline and acid soils when used with acid-forming and base-forming fertilizers. The preliminary results of an experiment at Mims and Winter Haven with Valencia oranges are given in Table VI. Manganese sulphate was applied in the summer of 1931 and in 1932 at the rate of three pounds per tree annually in these experiments on which data were recorded of the 1932-33 crop.

On hammock soil which is underlain by calcareous rock, the use of manganese sulphate in conjunction with the use of acid-forming concentrated and single strength fertilizers increased the yields approximately 9 and 15 per cent., respectively, while its use in conjunction with base-forming concentrated and single strength fertilizer increased the yield approximately 83 and 71 per cent., respectively. On acid Norfolk fine sand manganese sulphate decreased the yields of oranges when used in conjunction with both acid-forming and base-forming fertilizers. Manganese content of oranges was increased by the addition of manganese sulphate to the soil, which was more marked on the acid Norfolk fine sand than on the Hammock soil.

SUMMARY

Orange trees on acid soils fertilized with concentrated acid-forming fertilizers generally did not give as good yields, nor as heavy and firm fruit as with base-forming fertilizers. While base-forming fertilizers gave larger yields and firmer fruit on acid soils, its superiority was not as marked on neutral to alkaline soils.

The effects of manganese sulphate added to Florida soils of acid and alkaline reactions were, in general, to increase the manganese content, the firmness and weight of the fruit, and color intensity of the rind of the fruit. The per cent. of juice in the ripe fruit was in most of the experi-

ments decreased, but the degree of acidity was apparently not affected.

Manganese sulphate applied to soils of chlorotic groves improved the condition of the trees, and in many experiments chlorosis was reduced. This effect was most marked on neutral and alkaline soils, and frequently noted on acid soils.

Manganese sulphate applied to the soil in conjunction with commercial fertilizers containing nitrogen, phosphoric acid, and potash increased the yield of citrus over that produced by fertilizers on most of the soils in which experiments were made. On two soils, no increase in yield resulted and in some experiments increases were small. The experiments were made on acid, neutral and alkaline soils in various parts of *Florida.* Manganese sulphate applied periodically for four years to tangerines on acid soils gave increased yields. While the effect of manganese sulphate on yield was variable, depending probably on the character of the soil, there was an improvement in the firmness, weight, size, and color of the fruit regardless of the character of the soil.

TABLE VI

EFFECT OF MANGANESE SULPHATE ON VALENCIA ORANGES ON ALKALINE AND ACID SOILS. (Data secured on 1932-1933 crop. Manganese Sulphate applied at the rate of 3 pounds per tree in 1931 and in 1932.)

Composition of Fertilizer	Hammock Soil, Mims, Florida, underlain by Calcareous rock Subsoil pH 7.2		Citrus Ridge Belt Soil Winter Haven, Florida, Soil Acid pH 5.2	
	Average Yield per tree	Manganese in Oranges	Average Yield per tree	Manganese in Oranges
	Pounds	p.p.m.Mn_3O_4	Pounds	p.p.m.Mn_3O_4
Double strength, acid forming fertilizer containing Ammo-phos and Synthetic N.	231	1.086	120	1.641
Same—plus Manganese sulphate	251	0.904	105	3.908
Single strength, acid forming fertilizer containing Super-phosphate, inorganic and organic nitrogen	181	0.442	123	1.680
Same—plus Manganese sulphate	209	0.742	125	3.892
Double strength, base forming fertilizer containing Treble Superphosphate and Synthetic Nitrogen	190	0.810	122	1.656
Same—plus Manganese sulphate	349	0.889	89	6.395
Single strength, base forming fertilizer containing Super-phosphate and inorganic nitrogen	170	1.067	97	1.665
Same—plus Manganese sulphate	291	1.423	59	6.565