THE EFFECT OF A TRACE ELEMENT CONCENTRATE ON THE YIELD AND CHEMICAL CONTENT OF CORN

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Alfred Robertson

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ABSTRACT

A trace element concentrate developed by Dixie Chemical Company from sea water was believed to be valuable as a fertilizer additive. Varying rates of 100, 200, and 400 pounds of this concentrate were added to 400 pounds of Olin Mathieson Chemical Corporation 12-24-12 fertilizer. Nitrogen was added as a side dressing to the fertilizer treatment at the rate of 60 pounds per acre. The trace element-fertilizer mixture was applied at planting in bands just below and to the side of the corn seed. One treatment, a calcium-magnesium equivalent to the 200 pound trace element concentrate, was used to check the high calcium and magnesium in the trace element concentrate. Plots with no treatment and plots with fertilizer alone were used as additional comparisons with the trace element concentrate.

Samples were taken of both leaves and grain at a recommended growth stage. Analysises were made of the leaves at the full silk and tassel stage and of the grain at the hard dough stage. Tests showed that the protein content of the leaves and grain were increased by the fertilizer application. Effects of the trace element concentrate on the protein content of the leaves and grain were not detected.

Samples of the mature grain from the following four treatments were analyzed spectographically for trace elements, untreated,

400 pounds 12-24-12 with nitrogen, 400 pounds 12-24-12 with nitrogen plus 200 pounds trace element concentrate, and 400 pounds calcium-magnesium equivalent to that in the 200 pounds trace element concentrate. Effects of the trace element concentrate as a fertilizer additive could not be detected spectographically on the mature corn grain.

ACKNOWLEDGEMENT

This is to express sincere appreciation to all those who have aided in making the outcome of this project a success: to Dr. John S. Williams, Agriculture Department, University of Houston for the idea, opportunity, and encouragement; to Miss Jo Ann Corey of Uncle Johnny Feed Mills for the chemical analysis; to Mr. Gail Whitcomb for the experimental area; to the Stock and Stolen Club for labor; and lastly to Dixie Chemical Company, Houston, Texas without whose financial assistance and product this study would not have been completed.

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INTRODUCTION

In early times it was difficult to determine the exact cause of many crop and livestock disorders. Lack of refined chemical techniques and often-misguided views of early investigators added to the complexity of the problems. With the development of new and improved techniques in chemical analysis, particularly in the field of agricultural chemistry, a much greater importance is now given to minor or trace elements in plant and animal nutrition. Many present day soil and crop scientists are now searching for the role of these traces of chemical nutrients for plant and animal health.

Seven trace elements have been proven necessary growth stimulants in plant and animal nutrition. Copper, manganese, and zinc have been proven essential for the proper growth of both plant and animal life. Boron and Molybdenum are necessary only to plants, while cobalt and iodine are necessary to animals but have never been proven essential to plants. Several others are of questionable necessity for either. In many instances the proper chemical combination and exact amounts of trace elements are yet to be proven essential as micronutrients. Many studies today report the effects of definite compounds of trace elements, mostly sulphates, on plant growth. Sea water is known to contain important micronutrients leached from the soil. However, as a source for plant and animal needs, little information is available on processed sea water as a supplier of growth minerals.

The present study reports on the effect of a trace element concentrate obtained from sea water on the yield and chemical content of corn. An important objective of this investigation was to obtain information on the value of this trace element concentrate as an additive to fertilizers.

REVIEW OF LITERATURE

The number of recent publications relating to trace elements in crops is extensive and there are many excellent reviews concerning the subject. By far the most comprehensive review is that assembled by Brewer (3) 1/. His publications compiled by the Chilean Nitrate Educational Bureau give the most complete picture of the world's literature on studies in this field of research. The present study is related to a wide field of investigation; however, only those researches conducted with corn and five micronutrients generally believed essential by most physiologists will be discussed and evaluated. These five nutrients are boron, copper, manganese, zinc, and molybdenum.

BORON

Boron has been studied to a greater extent than any other trace element. The boron content of plants ranges between twenty and two hundred parts per million dry matter. Marked increases in yield from most crops resulted from applications of ten to forty pounds of borax (11.34 percent boron) per acre. Despite the work done with boron, Brewer (3) lists only two studies concerning corn.

1/ Figures in parenthesis refer to literature cited, pages 30 and 31.

Menagarishvili and Laghava's work with corn (5) on the effect of boron and manganese in combination with a chemical fertilizer showed that a beneficial effect in yield resulted. The same yield effect was more pronounced in the second year of application. They further observed, that compared to other crops studied, corn responded less when a chemical fertilizer was used. Otting (7) determined the boron content of the tissues of the roots, stems, leaves, and seed of corn. He found that boron was more concentrated in the corn leaves compared to the roots and grain. Moreover, it was noticed that within the leaves there was a concentration of boron in the chloroplasts. Although somewhat unrelated to corn, he found that salt water algeae can accumulate boron from sea water.

COPPER

Most experiments have shown that copper works well as a fertilizer additive. Berger and Truog (2) working with sweet corn recorded that five to ten pounds of copper sulphate in combination with applications of 3-18-9 fertilizer increased the yield of useable ears of corn five to forty percent. Increases in yield were not obtained in similar experiments on a more productive prairie silt loam soil higher in organic matter. Okuntsov (8) sprayed corn leaves five times within a sixteen day period with a .001M copper sulphate solution which resulted in an increase of 60.6% of chlorophyl in the leaf tissue. In other experiments, Okuntsov (8) with the same treatments above, increased the respiration intensity of corn by 0.9 mg. of carbon-dioxide per square dimension of leaf blade. However, no effect on the photosynthesis intensity could be detected. Brown and Harmer (4) studied the influence of copper compounds on the yield and growth pattern of corn grown on an organic soil. They found that the absorbtion of copper by plants affected the assimilation of nitrogen, phosphorous, potassium, calcium, iron, magnesium and silicon. Omission of copper resulted in very large concentrations of nitrogen, phosphorous, and potassium and considerable increases in calcium, magnesium, silicon, and iron. Most plants contain less than ten parts per million copper, on a dry matter basis, and they normally show copper toxicity at thirty parts per million or more.

MANGANESE

The manganese content of plants may vary between five parts per million dry weight and several thousand parts. Soils in the West were found to have a less amount of available manganese than the more acid soils of the East and South. Thomas and Winant (10) working with crop response from Maryland soils reports that over a twelve year period the highest corn yields were obtained from soils of medium fertility. They suggest that the physical structure of the soil and its effect on root growth may be the most important factor governing the growth of corn. They further noted that the exchangeable manganese content of the soil was greatly influenced by soil treatments, being reduced by lime and increased by manure and commercial fertilizers.

ZINC

Plants vary considerably in their zinc requirements. The usual range is between twenty-five and seventy-five parts per million. Berger and Truog (2) stated that zinc sulphate increased the yield of useable ears ten to forty-five percent in three of five experiments on a Miami silt loam. Increases in yield with applications of zinc were not obtained on a Carrington silt loam, a prairie soil high in organic matter. Acute deficiencies of zinc were found by Viets (14) where the top soil had been removed. Foliar applications of zinc sulphate rapidly corrected these deficiencies. Samples of Newberg loamy sand receiving basal treatments of nitrogen, phosphorous and potassium and varying amounts of zinc beginning with twenty parts per million and increasing to 160 parts per million were studied by Powers and Pang (9). The samples were analyzed for water-soluble, replaceable, and total zinc. The water-soluble zinc varied from 0.0 in the check sample to 0.3 micrograms per gram in the sample receiving 160 parts per million. The replaceable zinc varied, respectively, in the same two samples from 3.6 to 10 micrograms per gram, while the total zinc increased from 50 to 190 micrograms per gram. Analysis of the check plant of corn grown on Newberg loamy sand showed that the leaves, stems, and roots contained, respectively 10, 30, and 30 micrograms of zinc per gram. The amounts of zinc in the leaves, stems, and roots of plants receiving a treatment of nitrogen, phosphorous and potassium plus 160 parts per million of zinc were 90, 35, and 50 micrograms per gram. The zinc content of flowers, leaves, and stems of sunflowers was found to increase with additions of forty pounds of zinc to the nitrogen, phosphorous, and potassium basal treatments.

MOLYBDENUM

Molybdenum deficiencies have only recently come into notice. Recent work by Mulder (6) reports that this element acts as a catalyst in the reduction of atmospheric nitrogen to ammonia by the bacteria in the nodules on the roots of legumes. Mulder (6) further reported that molybdenum is also essential in the reduction of nitrates to ammonia in the non-legume plants. However, fertile soils contain only between 0.2 and 0.6 pounds of the total molybdenum in the plow depth of an acre. Vanselow and Datta (13), using the spectrographic method, studied the molybdenum requirements of lemons and found that leaves containing 0.01 p.p.m. molybdenum were deficient but those containing concentrations greater than 0.024 parts per million were normal. Most forage plants contain between one to two parts per million molybdenum on a dry weight basis. Molybdenum differs from other trace elements, as stated by Bear (1), in that liming increases its solubility. He further states that there is reason to believe that one of the most important effects of liming is that of making soil molybdenum available. No substantial work has been done in relation to molybdenum effects on corn.

EXPERIMENTAL PROCEDURE

In the present study corn was chosen to determine the effect of a trace element concentrate on plant growth and yield because of the natural adaptability of corn to the climate, the size of the plant and grain, the length of growing season, and the economic importance in human and animal consumption. Experimental plots were set up on the Gail Whitcomb Clear Creek Farms twenty-five miles south of Houston, Texas (Plates 1 and 2). The soil type was Lake Charles clay loam which for the last seven years has lain idle growing native and introduced pasture grasses. The particular area under study is almost flat; the drainage is good.

The gross experimental area after land preparation was divided into 18 plots, 23 feet by 27 feet, which includes 11,178 square feet (Plates 3 and 4). The experimental design was a randomly chosen block consisting of three replications of six treatments. The treatments shown in figure 2 were as follows: (1) no treatment, (2) 400 pounds Olin Mathieson 12-24-12 plus 60 pounds of nitrogen from ammonium sulphate, (3) 400 pounds of the above 12-24-12 plus 60 pounds of nitrogen plus 100 pounds of trace element concentrate, (4) 400 pounds of the above 12-24-12 plus 60 pounds of nitrogen plus 200 pounds trace element concentrate, (5) 400 pounds of the above 12-24-12 plus 60 pounds of nitrogen

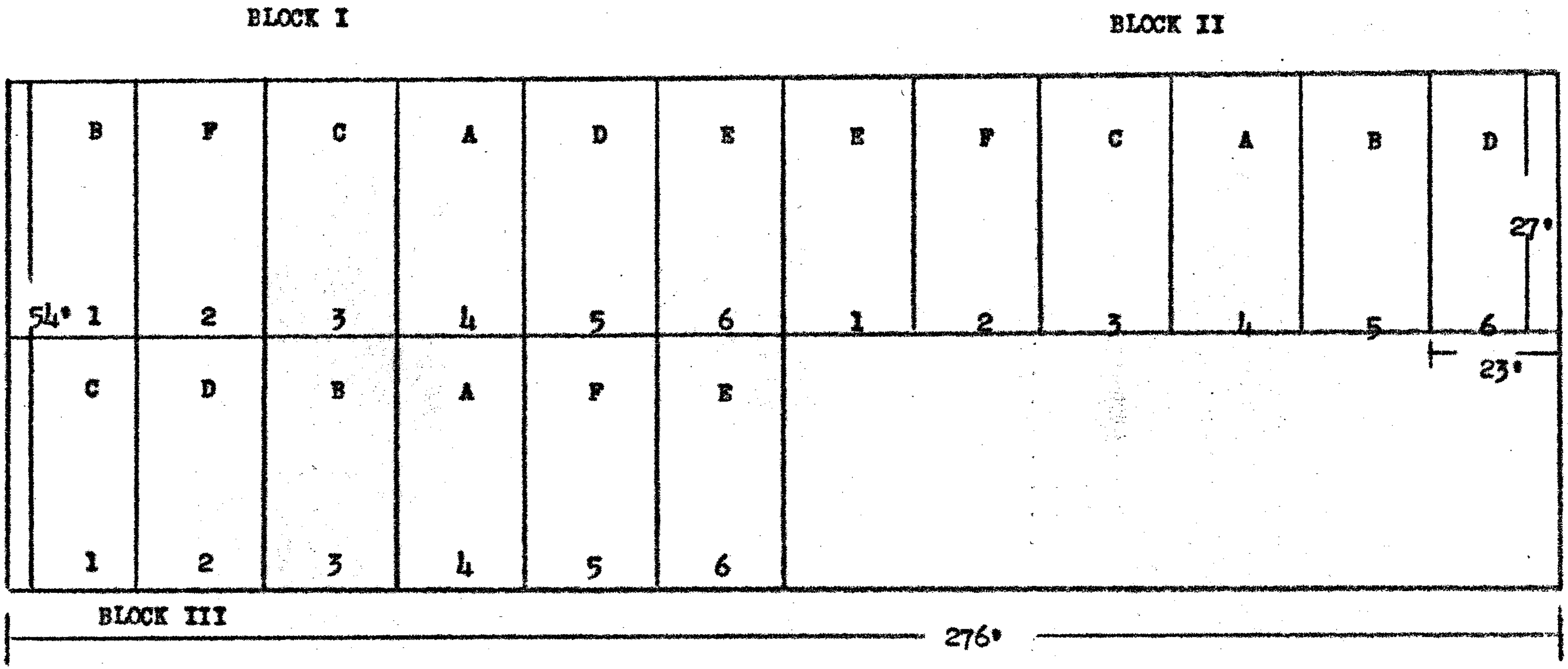
FIGURE 1 Trace Element Fertilizer Additive 1/

Magnesium	33. %
Sodium	.5 %
Calcium	8. %
Aluminum	.6 % = 600 PPM*
Barium	Trace
Boron	.05 % = 500 PPM
Strontium	.5 % = 5000PPM
Chronium	.001% = 1 PPM
Nickel	.003% = 30 PPM
Copper	.002% = 20 PPM
Iron	.04 % = 400 PPM
Manganese	.004% = 40 PPM
Silicon	.2 % = 2000 PPM
Zinc	Not detected

1/ Anions of the above elements are mostly hydroxides and carbonates.

* Parts per million

FIGURE 2. **EXPERIMENTAL DESIGN**



Treatments

A. No treatment
B. 400# 12-24-12 ≠ 60# N
C. 400# 12-24-12 ≠ 100# trace element concentrate
D. 400# 12-24-12 ≠ 200# trace element concentrate
E. 400# 12-24-12 ≠ 400# trace element concentrate
F. 400# 12-24-12 ≠ Ca. ≠ Mg. equivalent to 200# concentrate

plus 400 pounds trace element concentrate, and (6) 400 pounds of the above 12-24-12 plus 60 pounds of nitrogen plus the calcium and magnesium equivalent to 200 pounds trace element concentrate. The calcium-magnesium equivalent to the 200 pounds trace element concentrate treatment was applied as a control measure equaling the amount of calcium and magnesium in the concentrate. The fertilizer and the concentrate were throughly mixed before being applied in bands one and one-half inches below and two and one-half inches to the side of the seed at planting.

Soil samples taken prior to land preparation consisted of approximately sixty randomized borings zero to six inches deep. The analysis showed the soil to have a pH of 6.9. Figure 3 is a report of this soil analysis which also shows the routine major plant nutrient status.

The corn was planted March 29, 1954 in rows thirty-six inches apart and thinned to approximately 16,000 plants per acre. The crop was cultivated and hand-hoed to control weeds. Olin Mathieson Chemical Corporation's 75% DDT Dust was used to control insects, mainly army worms and cut ants. The corn was side-dressed in May with ammonium sulphate at the rate of sixty pounds of nitrogen per acre. This nitrogen was applied in bands about ten inches from the corn rows.

Leaf samples taken for spectographical analysis in early June

FIGURE 3. Soil Analysis Report 1/

Treatment	pH	Organic Matter %	Nitrate Nitrogen PPM	P_2O_5 PPM	K_2O PPM	Ca PPM	Mg PPM	Ca-Mg Ratio
A	6.80	1.80	10	26	65	1390	383	3.6
	6.75	2.0	12.5	29.5	80	1320	413	3.2
	6.9	2.2	10	14	65	1280	317	3.4
B	6.4	2.0	22.5	49	90	1490	438	3.4
	6.5	2.5	22.5	39.5	95	1520	438	3.4
	6.5	2.1	20	21.5	67.5	1270	487	2.6
C	6.45	2.2	20	34	65	1428	372	3.8
	6.45	1.65	10	31	60	1060	195	5.5
	6.6	1.45	7.5	78	50	950	201	4.7
D	6.6	1.90	25	31	67.5	1390	383	3.6
	6.7	1.45	15	45	65	1360	304	4.4
	6.65	1.50	7.5	26	45	1080	201	5.3
E	6.64	2.2	20	29	90	1660	367	4.6
	6.6	2.45	30	72	95	1300	181	1.9
	6.4	2.7	20	55	102.5	1450	334	4.3
F	6.35	1.50	30	66.5	84	1460	401	3.6
	6.4	2.45	15	34	80	1350	292	4.6
	6.65	1.75	7.5	34	55	1420	134	10.6

1/ Shows treatment and replication as tested by Wharton County Soil Testing Laboratory.

consisted of thirty leaves selected randomly from thirty plants from two rows in each of the eighteen plots. The sixth leaf from the base of the plant was chosen as the sample leaf when the plants were in full silk and tassel as described by Tyner (12). The samples were then oven dried, ground and analyzed spectographically by Dixie Chemical Company.

The second leaf sampling (June 16), consisting of twenty leaves harvested as above, was for protein analysis. Only those leaves in the healthiest condition were selected. The samples were air dried and ground for analysis. Protein analysis as shown in figure 4 was made by Uncle Johnny Mills, Houston, Texas.

Ear samples were also taken for spectographical analysis. These samples were taken June 21 thirteen days after the first leaf sample. Each ear sample consisted of ten ears from ten plants selected from two rows in each of the eighteen plots. These samples were taken at the soft-dough stage as reported by Tregdon (11) to be the optimum time for maximum nutrient concentration in the ears. The ears were shucked, oven dried, and ground in preparation for spectographical analysis.

For estimating corn yields (August 11) the ears were taken from three rows in each plot of 153 square feet. Bushels per acre were calculated from these weights. For protein analysis fifteen of the best ears were selected from a composite of the

FIGURE 4. Protein Analysis of Corn Leaves Soft-Dough Stage

Treatment	Replication Number	Protein Analysis	Moisture	Moisture Free Protein	Group Range
A	1	14.8	9.2	16.3	13.1 - 16.3
	2	11.9	8.6	13.0	
	3	14.1	9.8	15.6	
B	1	14.3	9.6	15.8	15.4 - 16.1
	2	13.9	9.7	15.4	
	3	14.6	9.3	16.1	
C	1	14.4	9.4	15.9	15.2 - 16.0
	2	14.2	10.4	15.8	
	3	14.5	8.9	15.9	
D	1	14.3	8.7	15.7	15.3 - 15.6
	2	13.9	9.4	15.3	
	3	13.9	9.4	15.3	
E	1	14.2	9.8	15.7	15.7 - 16.7
	2	15.0	9.4	16.6	
	3	14.7	8.7	16.1	
F	1	14.3	8.6	15.6	15.7 - 17.2
	2	15.9	8.0	17.3	
	3	14.6	8.7	16.0	

same treatment from each replication. The grain was shelled, ground and analyzed by the conventional Kjeldehl method.

The final ear samples for spectographied analysis included ten ears from ten plants selected at random from two rows in each of the eighteen plots. Samples were taken August 12 when the ears were fully matured for analysis by Dixie Chemical Company.

RESULTS AND DISCUSSION

The growing season of 1954 in the Gulf Coast area was unfavorable for experimental corn growing. Rainfall was markedly deficient and temperatures were slightly higher than usual as shown in figures 5 and 6. The corn was irrigated by lawn sprinklers to bring about germination. Germination was not uniform and replanting was necessary in certain places. The plants were yellowish and somewhat stunted during the first ten inches of growth. It remained this light yellow color until warm weather and rain prevailed.

Subsequent lack of rainfall severely curtailed normal growth of the corn, especially from the tasselling stage until maturity. This resulted in a number of irregularly pollinated and undeveloped ears. Soon after the soft-dough stage certain plots showed signs of burning. This was evident in plots 5 and 6 of block I and plots 5 and 6 of block III (figure 2). The burning effect was recorded photographically in plates 13, 14, and 15. The yield in these plots was low and the plants showed a marked effect of the dry season (Plate 15). Low corn yields can partially be explained by the tilth of the respective plots. The soil was compacted and slowly permeable to water. Two of the above plots showing burning received 400 pounds trace element concentrate. Another received 200 pounds trace element concentrate, while a third received a calcium-magnesium equivalent to that found in

FIGURE 5. Rainfall During the Growing Season 1/

Month	Total Moisture	Normal Mean	Maximum in 24 hours	Deviation From Normal
March	.86	3.17	.76	-2.31
April	5.36	3.83	4.39	+1.53
May	6.30	5.05	2.04	+1.25
June	.87	4.45	.57	-3.58
July	2.75	3.98	1.33	-1.23
August	2.20	2.11	.77	+ .09

1/ As recorded in inches at nearby Air Force Base.

FIGURE 6. Temperature During the Growing Season 1/

Month	Average Maximum	Maximum	Minimum	Normal Maximum	Normal Minimum
March	70.9°F	84°F	35°F	91°F	23°F
April	80.2	87	46	92	34
May	81.4	89	46	98	45
June	91.1	98	62	103	55
July	94.9	104	73	104	55
August	94.0	100	72	108	54

1/ As recorded in degrees Fahrenheit at nearby Air Force Base.

the 200 pound trace element concentrate. Hence, it is believed that the high rate of trace element concentrate was not the only factor influencing the burning of the leaves and reduced yields.

Grain Yield Results

Grain yields were calculated from the weights recorded at harvest time from three rows in each plot. The plots with no fertilizer produced 88, 75, and 54 bushels per acre per plot. The range of variation was 34 bushels per acre per plot. Plants in these untreated plots stayed green longer. These plots had very similar soil tilth, permeability, and structure. The location of these untreated plots in the respective blocks is shown in figure 2. The 400 pounds 12-24-12 plus 60 pounds nitrogen plots produced yields with the lowest range of variation of the entire experiment. Yields here were 83, 109, and 105 bushels per acre. The range of variation was 22 bushels per acre per plot. The plots treated with 100 pounds of trace element concentrate showed a variation in yield of 27 bushels per acre per plot. Individual plots produced 101, 70, and 72 bushels per acre per plot. This 100 pound trace element treatment produced some of the highest yields in the entire experiment. The 200 pound trace element concentrate treatment showed a marked interplot variation of 70 bushels per acre. The yields were 20, 90, and 87 bushels per acre. This high range in variation among plots receiving the same treatment may partially be explained by the condition of the soil structure in the plot 6 of block III. This particular plot due to the highly compacted slowly permeable soil produced the smallest yield of any plot in the experiment. The 400 pound trace element concentrate treatment likewise showed a wide interplot variation. The range of variation was 42 bushels per acre per plot. This wide range in variation may also be explained by the poor tilth of one of the plots. Here as above, the soil was dry, compacted, and slowly permeable to water. Yields per plot were 75, 78, and 33 bushels per acre. The soil receiving the calcium-magnesium equivalent in the 200 pound trace element concentrate showed the highest yield in the study. However, this high yield was found among plots having the highest range of variation, 72 bushels per acre per plot. This calcium-magnesium additive indicated that the yields from the trace element treatments were not wholly influenced by the high amount of calcium and magnesium in the concentrate. The yield per plot was 112, 76, and 40 bushels per acre.

Protein Analysis

Corn leaves for protein analysis were taken June 16, 1954 when the plants were at full silk and tassel as described by Tyner (12). Corn leaves showed much less variation in protein content than did the grain in yields per acre. Crude protein analysis of corn leaves are shown in figure 4. Analysis by the conventional Kjeldahl method showed a variation from 13.1 to 17.2 per cent crude protein on a moisture free basis. The untreated plots showed the widest variation, 13.1 to 16.3 per cent crude protein. Leaves from fertilized plots showed very little variation; 15.4 to 16.1 per cent crude protein. The samples of the 100 pound trace element treatment had a range of 15.7 to 16.0 per cent crude protein. Samples of the 200 pound trace element treatment varied from 15.7 to 16.3 per cent crude protein. Leaves receiving the 400 pound trace element treatment had a one per cent difference with a range of 15.7 to 16.7 per cent crude protein. The calcium-magnesium plots showed the highest amount of crude protein, 17.2, with a range of 15.7 to 17.2.

Leaf analysis revealed that fertilization in the study increased the protein content of the leaves. The wide range of variation masks any influence that the trace element concentrate may have had. Here again, as with grain yields, this wide range of variation in the protein content occurred in the highly compacted, slowly permeable plots in blocks I and III. Protein analysis was also run on grain samples. Samples for analysis consisted of a composite of each treatment from the three replications. The samples were analyzed for nitrogen and ammonia as well as protein. Figure 7 shows the nitrogen, ammonia, and protein content of the corn grain. The per cent nitrogen ranged from 1.48 in the untreated plots to 1.65 in the 400 pound trace element treated plots. The ammonia content varied from 1.80 per cent in the untreated plots to 2.0 per cent in the 400 pound trace element treated plots. The per cent protein ranged from 9.25 in the untreated plots to 10.28 in the 400 pound trace element plots. The 200 pound trace element treated plots had the same percentage of nitrogen, ammonia, and protein as did the untreated plots.

These data then indicate that neither the fertilizer nor the trace element concentrate influenced the protein content of the grain. Here again, it is believed that drought prevented the expression that nitrogen and/or the trace element concentrate might have had on the grain.

Trace Element Analysis

Spectrographical analysis was made of four samples of the corn grain at the hard-dough stage. Samples were taken from no treatment plots, plots with 400 pounds 12-24-12 plus 60 pounds nitrogen, plots with 400 pounds 12-24-12 plus 60 pounds nitrogen plus 200 pounds trace element concentrate, and 400 pounds 12-24-12 plus 60 pounds nitrogen plus a calcium-magnesium equivalent to the 200 pound concentrate treatment. Spectrographical analysis for sixteen elements may be found in figure 8. A comparison of the orginal concentrate with the analyzed grain is given in figure 9. Leaf

FIGURE 7. Protein Analysis of Mature Corn Grain

Sample	Nitrogen	Ammonia	Protein
A	1.48	1.80	9.25
B	1.59	1.93	9.94
C	1.73	1.98	10.19
D	1.48	1.80	9.25
E	1.65	2.00	10.28
F	1.52	1.85	9.50

samples for spectrographical analysis were harvested but determinations were not run. It is thought that these leaf samples will show more effect of the trace element concentrate than that indicated by the grain.

FIGURE 8. Spectrographical Analysis Mature Corn Grain 1/

Sample	#1	#2	#3	#4
Magnesium	16.0	12.0	14.0	16.0
Sodium	3.0	2.0	0.5	2.0
Calcium	6.0	2.0	2.0	4.0
Potassium	20.0	21.0	20.0	22.0
Copper	0.02	0.02	0.01	0.01
Tin	0.7	2.0	0.6	0.8
Aluminum	0.07	0.2	0.05	0.08
Iron	0.4	1.0	0.3	2.0
Silicon	0.7	0.3	2.0	1.0
Phosphorus	14.0	20.0	20.0	15.0
Boron	0.006	0.01	0.02	0.01
Manganese	0.1	0.1	0.1	0.06
Chromium	Trace	Trace	Trace	Trace
Titanium	N.D.	N.D.	N.D.	N.D.
Barium	Trace	Trace	Trace	Trace
Strontium	Trace	Trace	Trace	Trace

1/ Sample #1, no treatment; Sample #2, 400# 12-24-12 plus 60# nitrogen; Sample #3, 400# 12-24-12 plus 60# nitrogen plus 200# trace element concentrate; Sample #4, 400# 12-24-12 plus calcium and magnesium equivalent to 200# trace element concentrate.

FIGURE 9. Comparison of Spectographic Analysis of Mature Corn with Original Concentrate

Sample	#1	#2	#3	#4	Original Concentrate
Magnesium	16.	12.	14.	16.	33.
Sodium	3.	2.	0.5	2.	.5
Calcium	6.	2.	2.	4.	8.
Potassium	20.	21.	20.	22.	
Copper	0.2	0.02	0.01	0.01	.002
Tin	0.7	2.	0.6	0.8	
Aluminum	0.07	0.2	0.05	0.08	.06
Iron	0.4	1.	0.3	2.	.04
Silicon	0.7	0.3	2.	1.	.2
Phosphorus	14.	20.	20.	15.	
Boron	0.006	0.01	0.02	0.01	.05
Manganese	0.1	0.1	0.1	0.06	.004
Chromium	Trace	Trace	Trace	Trace	.003
Titanium	N.D.	N.D.	N.D.	N.D.	
Barium	Trace	Trace	Trace	Trace	Trace
Strontium	Trace	Trace	Trace	Trace	.5

SUMMARY AND CONCLUSIONS

The effect of a trace element concentrate on the yield and chemical content of corn was studied on Lake Charles clay loam at Gail Whitcomb's Clear Creek Farm twenty-five miles south of Houston, Texas in 1954. The concentrate, produced by Dixie Chemical Company, Houston, Texas, was mixed with Olin Mathieson Chemical Corporation's 12-24-12 fertilizer and applied at planting. Six treatments were used with three replications each.

The growing season was unfavorable for experimental corn growing. At the silk and tassel stage the plants began to show signs of burning and continued until maturity. The burning was found particularly in four plots. This can be explained by the poor tilth of the plots. The soil was compacted and slowly permeable especially during a drought. Such conditions produced low yields and wide ranges of variation.

Samples were taken of both leaves and grain at the soft-dough stage and grain only at the hard-dough stage. The samples were analyzed for protein content by the conventional Kjeldahl method. Grain samples of the hard-dough stage were spectographically analyzed for the sixteen elements of the orginal concentrate.

Leaf analysis revealed that fertilization in the study increased the protein content of the leaves. Other data indicated that neither the fertilizer nor the trace element concentrate influenced the protein content of the grain. It is believed that drought prevented any expression that fertilizer and/or trace element concentrate could have had on the mature grain. Leaf samples were harvested but not analysed. It is thought that these leaf samples will show a greater effect of the trace element concentrate than that indicated by the grain.

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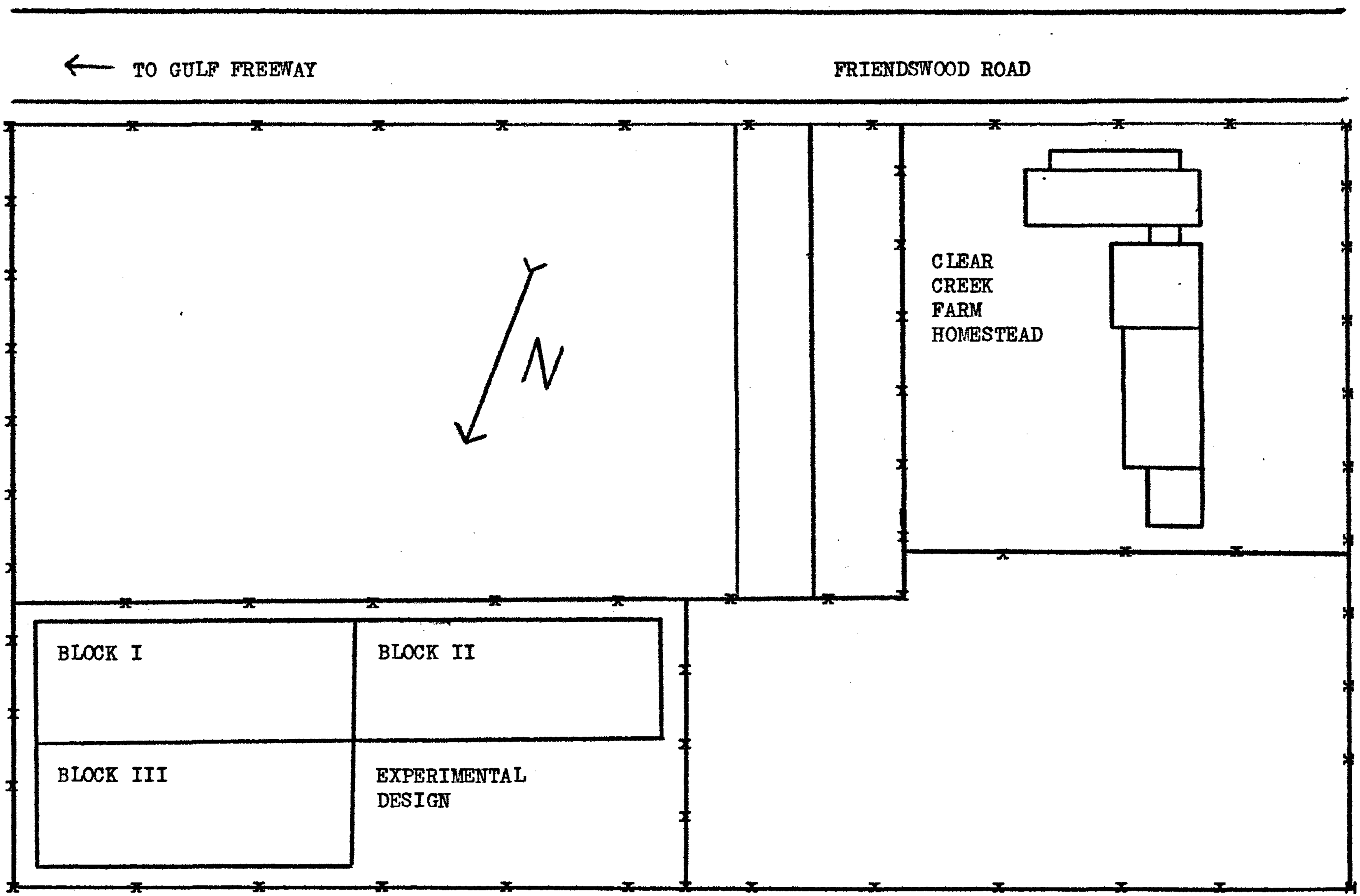
PLATE 1. LOCATION OF EXPERIMENTAL PLOTS



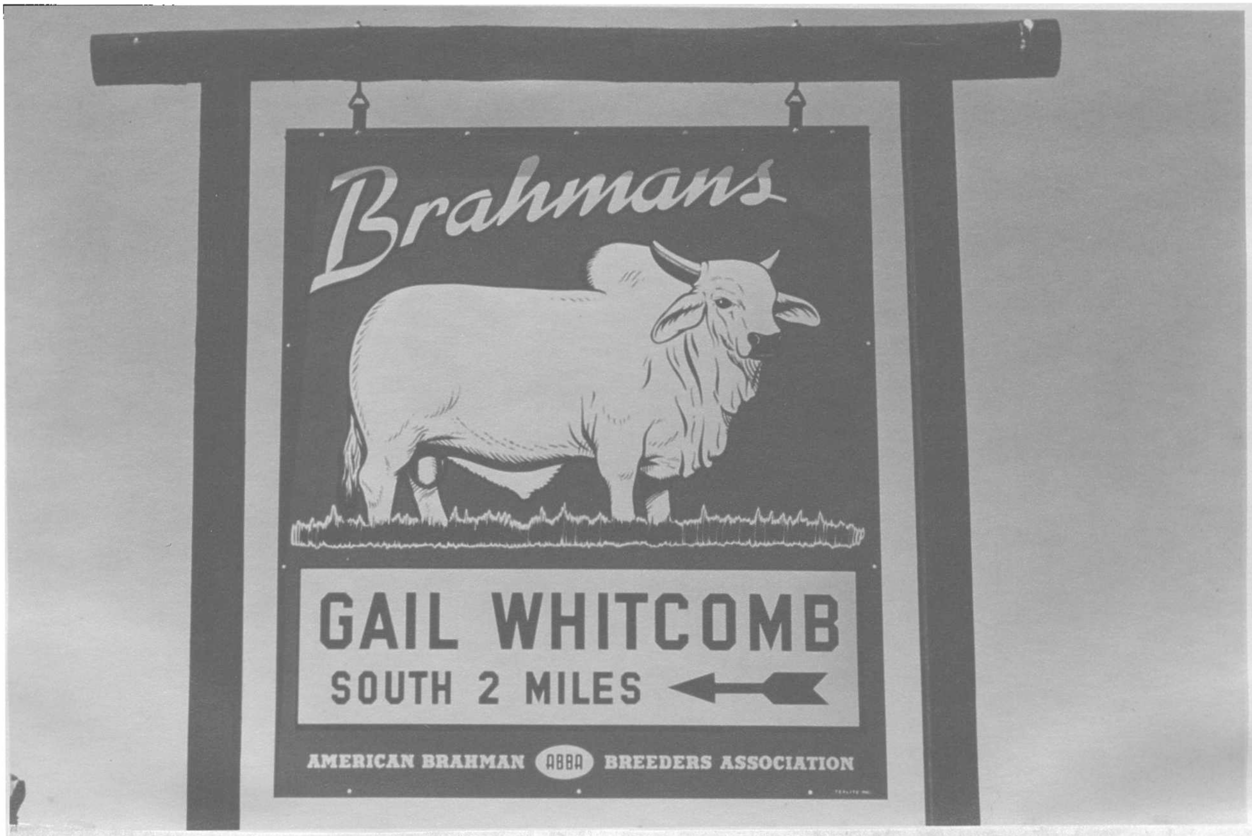


PLATE 2. SIGN AT GULF FREEWAY AND FRIENDSWOOD ROAD APPROXIMATELY 25 MILES SOUTH OF HOUSTON, TEXAS

PLATE 3. EXPERIMENTAL SITE AFTER SEED BED PREPARATION

PLATE 4. EXPERIMENTAL AREA SHOWING STAKED PLOTS

PLATE 5. OPENING THE FURROWS IN 36" ROWS

PLATE 6. APPLICATION OF FERTILIZER AND THE TRACE ELEMENT CONCENTRATE IN BANDS $2\frac{1}{2}$" ON EACH SIDE AND $1\frac{1}{2}$" BELOW EACH CORN ROW

PLATE 7. A BLOCK OF CORN JUST PRIOR TO THE TASSELING STAGE

PLATE 8. SIDE VIEW OF PLOTS AT TASSELLING STAGE

PLATE 9. A TYPICAL LEAF FOR SAMPLING

PLATE 10. TOP VIEW OF PLOTS AT FULL SILK AND TASSEL STAGE

PLATE 11. PLANTS BEGINNING TO SHOW A BURNING EFFECT OF DROUGHT, POOR SOIL TILTH

PLATE 12. BURNING OF PLANTS BROUGHT ON BY CONTINUED DROUGHT, POOR SOIL STRUCTURE

PLATE 13. EXTREME EFFECT OF DROUGHT, POOR SOIL TILTH

PLATE 14. CORN FROM NO TREATMENT PLOTS AND TRACE ELEMENT CONCENTRATE PLOTS

PLATE 15. CORN FROM NO TREATMENT PLOTS AND 100 POUNDS TRACE ELEMENT CONCENTRATE PLOTS

PLATE 16. CORN FROM 200 POUND TRACE ELEMENT CONCENTRATE PLOTS AND 400 POUND TRACE ELEMENT CONCENTRATE PLOTS