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Fertilizer Studies as Conducted on the Carbon County Experimental Farm with Special Reference to Treble-Superphosphate

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FERTILIZER STUDIES AS CONDUCTED ON THE CARBON COUNTY EXPERIMENTAL FARM WITH SPECIAL REFERENCE TO TREBLE-SUPERPHOSPHATE.

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Delos Zobell

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TABLE OF CONTENT

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Location and Description of Farm

In 1927 an experimental farm was established in Carbon County, Utah. The farm is on a new irrigation tract south of the Price River and about four miles south of Price. The agricultural problems of the Carbon County Experimental Farm and the locality which it serves are distinctly different from those of most of the farming sections in Utah. The soil of this region is of a sandy, silty nature apparently with deflocculated colloids which make it somewhat difficult to manage. There is a low percentage of organic matter in this soil, and because of this and its impervious condition the soil absorbs water slowly. The range in moisture content at which the soil may be tilled is rather narrow.

History of Fertilizer Plats

The farm was broken from native vegetation in 1918 and alfalfa was the only crop grown until 1927 when the Experimental Farm was established. In 1928 a portion of this experimental farm was set aside for fertilizer studies. The different combinations of nitrogen, phosphorus, and potassium (commercial fertilizers) were used alone and in combination with barnyard manure. Not knowing the past history of the farm it so happened that the fertilizer plats were located on a section of the farm which developed into a "seep" area. Formerly alfalfa hay had been

grown on this land and because of the inferior yields it was thought this would be a desirable location for fertilizer studies. Barley and Sugar-beets were grown on this tract of land the first year of the experiment, but because of the high salt content of the soil the fertilizers did not show any marked effect. The barley was harvested, but owing to the heavy fall storms it was impossible to harvest any of the sugar-beets. In this part of the farm the under-ground water came within a few inches of the surface. The following year the fertilizer plats were relocated in a more desirable section, and it is on this new location where further studies were made. It was for this reason that the results of 1928 are not included.

Review of Work Done by Others

There is a large amount of literature on the use of the different fertilizers and their effect upon crop yields. However, only a limited amount of work has been done in the arid and irrigated sections of the world. It has been the opinion of many of the agricultural workers that the arid region would not need commercial fertilizers for many years to come. In the last few years considerable attention has been given to the addition of the phosphate fertilizers for sugar-beets and alfalfa. Bartels (2) in Victoria, South Australia, reports that treble-superphosphate increased the yield of alfalfa up to 200 per cent. The vigor, growth, and stand of alfalfa, so treated, which was ten years old was as good as an ordinary three-year -old stand. He thought that phosphorus could be used to rejuvenate the partly exhausted soil of Southeast Australia. The results of the use of 400 pounds of superphosphate on alfalfa continued to show six years after the application. McGeorge and Breazeale in Arizona (9) report that soils , especially the calcareous types, rarely contain more than traces of phosphate in the soil solution, the phosphate being

largely unavailable to the plants. Dr. Oscar Loew of the Bureau of Plant Industry, U.S.D.A. (7) reports that the yield of grain is generally increased to a far greater extent by phosphoric acid than by nitrogen or potassium compounds. Charles Mathews (11) reports at Gaylord, Minnesota, that the application of 155 pounds of 45 per cent treble-superphosphate increased the acre-yield of sugar-beets from 10.6 tons to 12.4 tons. Sackett and Stewart (12) of Colorado report: "With the application of 200 pounds of treble-superphosphate per acre the yield of sugar-beets was increased 15.95 per cent over the unfertilized check." An anonymous writer in Facts About Sugar(1) reports that the addition of treble-superphosphate in many parts of Colorado increased the acre-yield of sugar-beets from a fraction of a ton to as high as 10 to 11 tons, the average increas being about 2 tons. It was also reported that phosphate fertilizers may increase the sugar content, but in many cases where there is an increase in yield of beets there is no increase in the sugar content. There are many articles in the more popular magazines and newspapers telling of the response of different crops to phosphorus fertilizers. Many of these articles are apparently not based on scientifically conducted fertilizer tests.

Method of Procedure

Two series of plats 20 feet 6.5 inches wide and 126 feet long were used in the experiment. One series received barnyard manure at the rate of 10 tons to the acre. The plats were so arranged that the irrigation water would not carry any of the manure onto the unmanured plats. There were no allyways between the plats, thus eliminating the border effect except on the end plats. The same amount of fertilizer was distributed on the manured as on the unmanured plats. The relative

Fig. #1.

North

NPK	NPK & M
Check	Manure
K	K & M
NP	NP & M
NK	NK & M
Check	Manure
P	P & M
N	N & M
PK	PK & M
Check	Manure
NPK	NPK & M
K	K & M
NP	NP & M
Check	Manure
NK	NK & M
P	P & M
N	N & M
Check	Manure
PK	PK & M
NPK	NPK & M
K	K & M
Check	Manure
NP	NP & M
NK	NK & M
P	P & M
Check	Manure
N	N & M
PK	PK & M

West

Map of the fertilizer plats showing the relative position of the different treatments. Each plat is 20 feet 6.5 inches wide and 126 feet long. The lower (east) half of each strip is the same size as the opposite and has the same fertilizer treatments with the addition of barnyard manure applied at the rate of ten tons to the acre.

The irrigation water is applied at the west end and runs toward the east.

position of the fertilizer plats are shown in Figure 1.

The fertilizers were applied with a beet drill with a fertilizer attachment, except for the year 1929 when the fertilizers were broadcast. The fertilizer was drilled into the soil at the time the seed was sown, thus both seed and fertilizer were in the same relative place in the soil. Immediately after planting the land was irrigated in order to assure germination.

Fertilizer materials used were as follows: The phosphorus was in the form of Treble-superphosphate applied at the rate of 125 pounds to the acre. The nitrogen was in the form of ammonium sulfate applied at the rate of 150 pounds to the acre. The potassium was in the form of potassium chloride and was applied at the rate of 125 pounds to the acre. These fertilizers were used separately and in all combinations of two and all three materials together. All treatment was replicated three times.

Studies with Sugar-Beets

Table 1. Yield of sugar-beets with different fertilizer treatments, 1929. (Average of 3 plats)

Treatment	Acre-yield(tons)	P.E.%	P.E.(tons)	Diff./P.E.
P	23.89		1.51	1.78
K	22.63		1.43	1.18
N	19.46		1.23	-0.51
Check (nofertilizer)	20.36	6.34	1.29	
PK	24.77		1.57	2.17
NP	25.86		1.64	2.64
NK	25.13		1.59	2.33
NPK	22.24		1.41	0.98
P, Manure	23.07		1.85	0.41
K, Manure	26.11		2.10	0.68
N, Manure	22.81		1.83	-0.52
Manure (check)	24.17	8.04	1.94	
PK, Manure	23.94		1.92	-0.86
NP, Manure	25.86		2.08	0.60
NK, Manure	26.81		2.15	0.58
NPK, Manure	25.30		2.03	0.40

The yield data for 1929 is given in table 1. The probable error was obtained by the use of the "deviation of the mean" method (6). When the difference between the means of two treatments divided by the probable error of that difference is three or more, the odds are high enough so that the difference between the two means is probably significant.

For 1929 the probable error of a single treatment for the entire experiment where no manure had been applied was 6.34 per cent, while the probable error for the manured plats was 8.04 per cent.

An analysis of the data in table 1 does not show that any of the treatments were significantly better than any of the others. Therefore, it is logical to assume that the addition of commercial fertilizers did not give any significant increase in yield.

Table 2 gives the sugar content and acre-yield of sugar which was obtained from the same plats in 1929.

Table 2 . Sugar content of beets and acre-yield of sugar with different fertilizer treatments in 1929 (Average of 3 Plats)*

Treatment	Sugar Percentage	Acre-Yield Sugar(lbs)	P.E.%	P.E. of Acre-Yield	Diff./ P.E.
P	16.0	7664		208.4	.99
K	17.0	7582		206.2	.69
N	16.1	6288		171.1	-.44
Check	16.5	6395	2.72	173.9	--
PK	16.7	8259		224.6	3.04
NP	16.9	8728		237.4	7.96
NK	15.7	7866		214.0	.53
NPK	17.0	7573		206.0	4.37
P, Manure	18.0	8322		763.9	.45
K, Manure	17.5	8622		791.5	.71
N, Manure	17.2	7855		721.0	.00
Manure	18.1	7817	9.18	800.4	--
PK, Manure	17.8	7407		771.7	.53
NP, Manure	18.3	6005		551.5	1.86
NK, Manure	17.5	9332		856.6	1.29
NPK, Manure	18.3	9253		849.4	1.13

* The analytical work for sugar content was done by the chemists of the Holly Sugar Company, Grand Junction, Colorado.

The probable error was calculated for the yield in tons as shown above. A study of Table indicates that the addition of phosphorus without manure increased the sugar content and acre-yield of sugar. Wherever phosphorus was used in combination with other fertilizers, the sugar yield was more than three times the probable error. It is to be noted that where nitrogen was used the acre-yield of sugar was decreased, and where applied alone the yield was less than the check. From these results it is concluded that nitrogen had a retarding effect on the sugar content and acre-yield of sugar and that phosphorus had an increasing effect on the sugar content and acre-yield of sugar. The probable error for the treatments without manure is 2.72 per cent.

Results of the application of barnyard manure in addition to the other fertilizers show that there is no one fertilizer which stimulates the yield of sugar more than any other. However, nitrogen gave a slightly higher acre-yield of sugar than did the manure. Phosphorus gave some increase over nitrogen but did not give any more increase than did potassium. From these results, apparently none of the fertilizers when used in connection with manure gave a significant increase in either yield or sugar content over the manure alone. The probable error for this series was 9.18 per cent.

Table 3. Yield of sugar-beets with different fertilizer treatments in 1930 (Average of 3 Plats)

Treatment	Acre-yield(tons)	P.E. %	P.E. (tons)	Diff./P.E.
P	23.69		1.66	4.4
K	17.35		1.22	1.2
N	12.91		0.91	-0.49
Check	15.95	7.02	1.20	—
PK	21.66		1.52	3.1
NP	21.69		1.52	3.1
NK	16.30		1.14	0.47
NPK	17.83		1.25	1.3
P, Manure	27.87		1.96	3.4
K, Manure	20.53		1.45	0.43
N, Manure	15.69		1.10	-2.57
Manure	19.71	7.03	1.39	—
PK, Manure	26.26		1.85	2.85
NP, Manure	28.59		2.00	3.65
NK, Manure	21.03		1.48	0.65
NPK, Manure	23.25		1.63	1.66

The yields obtained in 1930 are given in table No.3. The probable error for the unmanured treatments is 7.02 per cent. It is evident that the yield of beets on the plats to which phosphorus was applied without the addition of barnyard manure is enough larger than the untreated plats to be significantly important. From the beginning of the season the beets grown on the plats to which phosphorus was applied were more thrifty and made a better growth than the beets grown on the other treatments. During the summer when the beet leafhoppers or white flies (Eutettix tenellus, Baker) attacked the beets, those having phosphorus seemed to withstand the attack much better than did the other plats. It is also evident that phosphorus was the fertilizer needed on this soil type for an increase in sugar-beet yield. Where the nitrogen fertilizer was used, the yield was actually decreased over the check. Too much ammonium sulphate in close contact with the seed seems to have reduced germination. The application of potassium did not reduce nor give any

significant increase in yield. The addition of phosphorus gave an increase of 48.52 per cent over the check.

When used in connection with barnyard manure, none of the fertilizers gave an increased yield except the phosphorus. It will be noted that nitrogen decreased the yield below the check and that potassium gave a slight increase although not enough to be significant. The probable error for the manured series of the test is 7.03 per cent. When the three fertilizers (nitrogen, phosphorus, and potassium) were used in combination with each other, the yields were only slightly better than the check. Apparently, the addition of the nitrogen fertilizers drilled with the seed had a retarding effect on the growth of the beets, especially during the seedling stage. The average weight of the beets from the phosphated plats was 2.84 pounds as compared to 2.67 pounds for the nitrogen. The plats on which phosphorus had been applied produced 71.3 beets to the 100 feet as compared to 47.6 for nitrogen, 64 for potassium, and 62.9 for the manure alone. Thus, it will be noted that the phosphorus not only gave an increase in yield, but that this increase was largely due to the fact that the beets were heavier and that there were more beets to the acre. The use of phosphorus and manure together gave an increase of 41.40 per cent more than for manure alone.

Table 4. Percentage of sugar and yield of sugar with different fertilizer treatments, 1930.

Treatment	Per Cent Sugar	Acre-yield Sugar (lbs.)	P.E. %	P.E. of acre-yield	Diff./ P.E.
P	16.3	7733		697.5	3.35
K	14.8	5221		470.9	.403
N	15.3	3950		356.2	-1.76
Check	15.3	4958	9.02	447.2	—
PK	15.6	6796		613.0	2.42
NP	15.7	6841		617.0	2.47
NK	15.9	5214		470.3	.39
NPK	14.0	5018		452.6	.094
P, Manure	17.1	9535		677.9	3.37
K, Manure	16.2	6627		471.2	.147
N, Manure	17.0	4406		313.3	-4.07
Manure	16.2	6737	7.11	479.0	—
PK, Manure	16.8	8798		625.5	2.61
NP, Manure	17.0	9740		692.6	3.57
NK, Manure	16.6	7050		501.3	.30
NPK, Manure	16.8	7820		556.0	1.43

The acre-yield of sugar for 1930 is given in Table 4. The probable error in percentage for the treatments without manure is 9.02 per cent. From Table 4 it is evident that the phosphorus fertilizer gave a significant increase in sugar content of the beets as well as in the yield of sugar per acre. It was noted that the plats on which phosphorus had been applied ripened several days earlier in the fall than did the others. The plats which received nitrogen were much later in ripening than were the others. The date of maturity seemed to have a direct effect upon the sugar content of the beets. Beets which had received phosphorus were ready for harvest when the nitrogen plats did not show appreciable signs of rippening. The acre-yield of sugar was influenced by the low sugar content and acre-tonnage of beets in those plats receiving nitrogen, while the plats receiving the phosphorus not only produced more tons of beets to the acre but also had a higher sugar content.

The addition of barnyard manure and phosphorus to the soil gave the largest yield, both of beets and sugar. The nitrogen fertilizer decreased the sugar content and the potassium gave a slight increase in acre-yield of sugar. However, these figures are not especially significant. The addition of manure increased the acre-yield of sugar from 4958 to 6737 pounds, 35.96 per cent increase. The phosphorus gave an increase of 41.53 per cent and nitrogen a decrease of 34.59 per cent in acre-yield over the manured check plat. The combination of manure and phosphorus increased the acre-yield of sugar 92.31 per cent.

The 1931 yield of sugar-beets are given in Table 5. The fertilizer treatments were a repetition of 1930. The extreme drough of 1931 so greatly reduced the yields that it seems unwise to compare the results of that year with those of 1929 and 1930.

Table 5. Yield of beets with different fertilizer treatments 1931

Treatment	Acre-Yield(tons)	P.E.%	P.E. Tons	Diff./P.E.
P	8.24		0.39	4.58
K	6.99		0.33	2.11
N	4.91		0.23	-2.86
Check	6.04	4.77	0.28	---
PK	6.95		0.33	2.11
NP	8.18		0.39	4.45
NK	7.31		0.35	2.82
NPK	7.58		0.36	3.34
P, Manure	10.47		0.51	2.46
K, Manure	9.06		0.26	-1.05
N, Manure	8.75		0.26	-1.76
Manure	9.46	2.92	0.28	---
PK, Manure	10.28		0.30	2.0
NP, Manure	10.29		0.30	2.01
NK, Manure	9.27		0.27	-0.50
NPK, Manure	10.10		0.29	1.35

From Table 5 it is evident that the phosphorus fertilizers were the only ones which gave significant increases in yield. The phosphorus increased the yields of beets 36.42 per cent over the check, which is a significant increase. The potassium fertilizers gave a slight increase but

not enough to be significant. Again, the nitrogen caused a decrease in yield, of 18.70 per cent. The phosphorus fertilizers gave an early stimulation to the beet seedlings; consequently, giving them a much better start in the early season than that of the beet seedlings on adjoining plats. The nitrogen fertilizers seemed to retard the growth of the beet seedlings. The plants did not overcome this handicap at any time during the season.

The probable error (in percentage) of the treatments having manure in addition to the fertilizers was 2.92. Phosphorus gave the highest yields, although this difference was not enough to be significant. The use of phosphorus in addition to manure gave an increase of 10.67 per cent over the manured checks while the addition of phosphorus and barn-yard manure gave an increase of 73.34 per cent over the unmanured plats.

The low yields of the beets in 1931 was due largely to the lack of irrigation water and the excessively hot weather during the months of July and August. The beets on the phosphorus plats seemed to withstand the drough better than those on the other plats because they had more leaves to shade the soil and thus conserved the moisture.

Fig. A showing the results of phosphorus and nitrogen fertilizers on sugar-beets. The picture was taken September 1, 1931. The right side of the picture is the phosphate treated and the left side the nitrogen fertilizer. The front of the picture shows the effect of unmanured land while the rear view is manured.

Table 6. Sugar content of beets and acre-yield of sugar with different fertilizer treatments, 1931

Treatment	Per cent sugar	Acre-Yield sugar (lbs)	P.E.%	P.E. of Acre-Yield	Diff./ P.E.
P	15.9	2606		131.4	4.40
K	14.4	2056		103.7	1.15
N	15.0	1517		76.4	-5.05
Check	15.1	1893	5.04	95.7	--
PK	15.5	2114		106.5	1.55
NP	15.4	2535		127.7	4.03
NK	15.2	2245		113.1	2.39
NPK	15.4	2379		119.9	3.17
P					
P, Manure	16.6	3479		122.1	2.49
M, Manure	16.0	2868		100.7	-1.40
N, Manure	16.5	2800		98.2	-1.89
Manure	15.7	3075	3.51	107.9	--
PK, Manure	16.5	3357		117.8	1.77
NP, Manure	16.5	3297		115.7	1.40
NK, Manure	16.0	3041		106.7	-.22
NPK, Manure	16.4	3147		110.5	.46

The sugar content and acre-yield in 1931 is given in Table 6. The probable error in percentage of the yield of sugar for the different treatments without manure was 5.04 per cent. The increase which phosphorus gave in the yield of sugar per acre is noticeable. In each case where phosphorus was used, the yield of sugar was materially increased; where the nitrogen was used alone there was a decided decrease in yield over the check. The use of the potassium fertilizer gave a small increase in yield.

The probable error in percentage for the treatments with manure was 3.51 per cent. Phosphorus was the only fertilizer which gave an increase in yield, but this was not significantly higher than the other fertilizers. The addition of potassium and nitrogen gave a decided decrease in the yield of sugar. Again, it will be noted that the use of phosphorus and barnyard manure gave the highest yield of sugar, but the increase in

yield was not significantly better than the check. The addition of phosphorus and barnyard manure gave an increase of 83.78 per cent in sugar above the yield of the unmanured check plats.

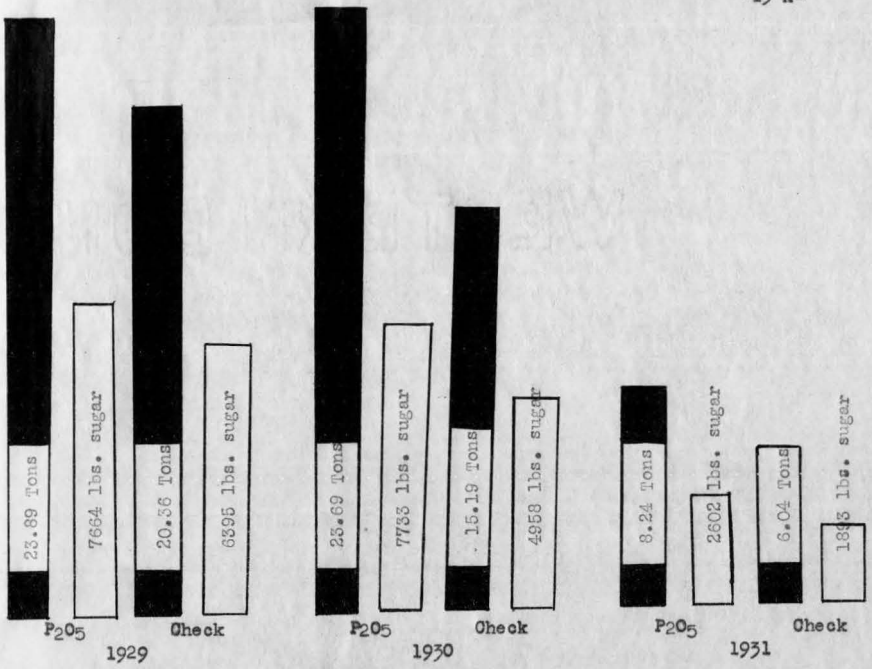
Phosphorus did not cause any material increase in the per cent of sugar in any instance and the increase in acre-yield of sugar was due to the increase in tonnage of beets. It will be observed that the phosphorus did give a slight increase in per cent of sugar but this increase was not enough to be significant when calculated statistically. Where the barnyard manure was applied the per cent of sugar was increased as well as the acre-yield of sugar.

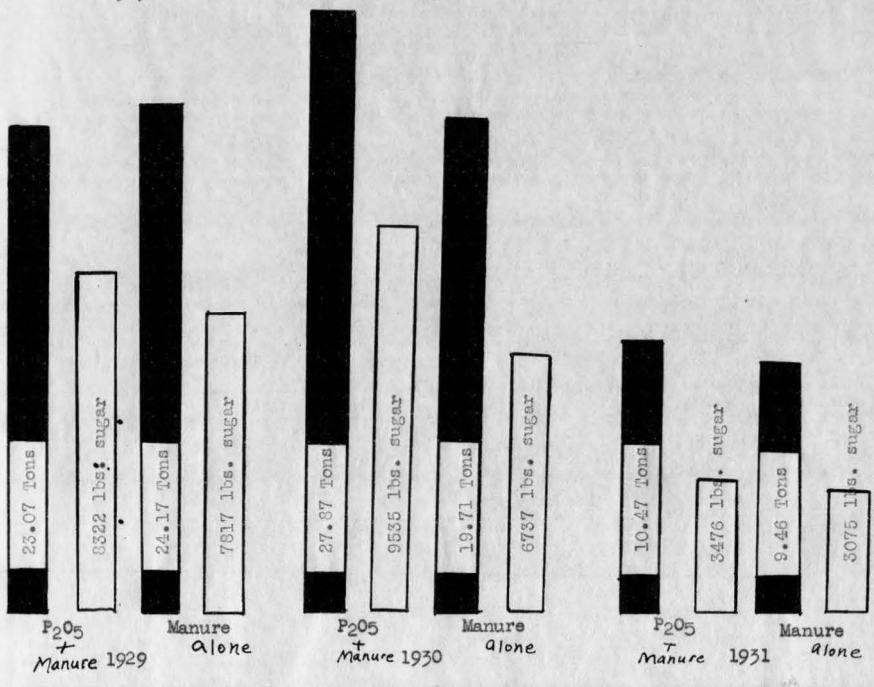
FIGURE +2

This figure shows the comparative effect of phosphorus and checks in yields per acre of beets and sugar as calculated from tests made from samples of beets. The yield for each year is indicated on the graph.

The lower half of the graph shows the comparison of the phosphorus and barnyard manure also the effect of the phosphorus on the yield of sugar.

Fig. #2.


23.89 Tons
7664 lbs. sugar
20.36 Tons
6396 lbs. sugar
P2O5
Check
1929
25.69 Tons
7733 lbs. sugar
15.19 Tons
4958 lbs. sugar
P2O5
Check
1930
8.24 Tons
2602 lbs. sugar
6.04 Tons
1943 lbs. sugar
P2O5
Check
1931


23.07 Tons
8322 lbs. sugar
24.17 Tons
7817 lbs. sugar
P2O5 + Manure
Manure alone
1929
27.87 Tons
9535 lbs. sugar
19.71 Tons
6737 lbs. sugar
P2O5 + Manure
Manure alone
1930
10.47 Tons
3476 lbs. sugar
9.46 Tons
3075 lbs. sugar
P2O5 + Manure
Manure alone
1931

STUDIES WITH ALFALFA

In 1929 a series of three plats were established in an alfalfa field on the Carbon County Experimental Farm which had been planted the preceding year. On each plat treble-superphosphate was applied at the rate of 125 pounds to the acre and no additional applications were made during the following two years. The phosphorus was applied broadcast immediately following the removal of the first crop. After the phosphorus had been applied a light rain fell and the land was then irrigated. Shortly after the application of the phosphorus the effect of the fertilizer began to be noticeable. Both check and treated plats were 50 feet square and replicated three times. The hay from the fertilized and check plats was cut, cured, and weighed separately. The acre-yields were then calculated from the areas harvested.

In 1929 the second crop of hay harvested during the season and the first crop harvested after the application of the fertilizer gave an acre-yield of 1.5 tons for the phosphated plats and 1.0 ton for the check plat. The hay from the phosphorus plats had more leaves and finer stems than did the check plats. The blooming period was retarded on the phosphorus plats, while on the check plats about half of the plants were in bloom.

In the third or last crop harvested in 1929 the phosphorus plats gave an acre-yield of 0.9 ton, while the check plats yielded 0.6 ton, an increase of 50 per cent for the phosphorus-treated plats. Again, the hay from the phosphated plats was of higher quality than the hay from the check plats. After this crop was harvested many new shoots started to appear

from the phosphated plats, while there were few shoots on the check plats.

In the spring of 1930 the alfalfa plants on the plats on which phosphorus had been applied the preceding year began to grow ten days sooner than those on the check plats. The first crop of alfalfa from the phosphated plats yielded 0.7 ton and the check plats yielded 0.4 tons, or an increase of 75 per cent. The alfalfa weevil retarded the growth on all the plats.

The plats on which phosphorus had been applied yielded 1.6 tons for the second crop as compared to 1.0 tons for the check, or an increase of 60 per cent. The third crop was not as high in yield. The phosphated plats yielded 0.75 ton as compared to 0.5 ton for the check plats, which represents an increase of 50 per cent.

The total yield for the phosphorus plats was 3.05 tons, while the check plats yielded 1.90 tons, an increase of 60.5 per cent, which is highly significant. The yield of the hay was not only increased, but the quality was also improved.

In 1931 the effect of the phosphorus continued to carry over from the 1929 application. The plats yielding 1.13 tons for the first crop as compared to 0.75 ton for the check, an increase of 49.2 per cent. Alfalfa on the phosphated plats began to grow several days earlier in the spring than did that on the check plats. The acre-yield of hay for the phosphorus plats for the second crop was 1.37 tons as compared to 0.76 ton for the check. The phosphorus gave an increase of 79.7 per cent. Phosphated plats yielded 1.06 tons for the third crop as compared to 0.63 ton for the checks, representing an increase of 68.1 per cent. The annual yield of the phosphated plats was 3.57 tons as compared to 2.156 tons for the checks, an increase of 65.58 per cent.

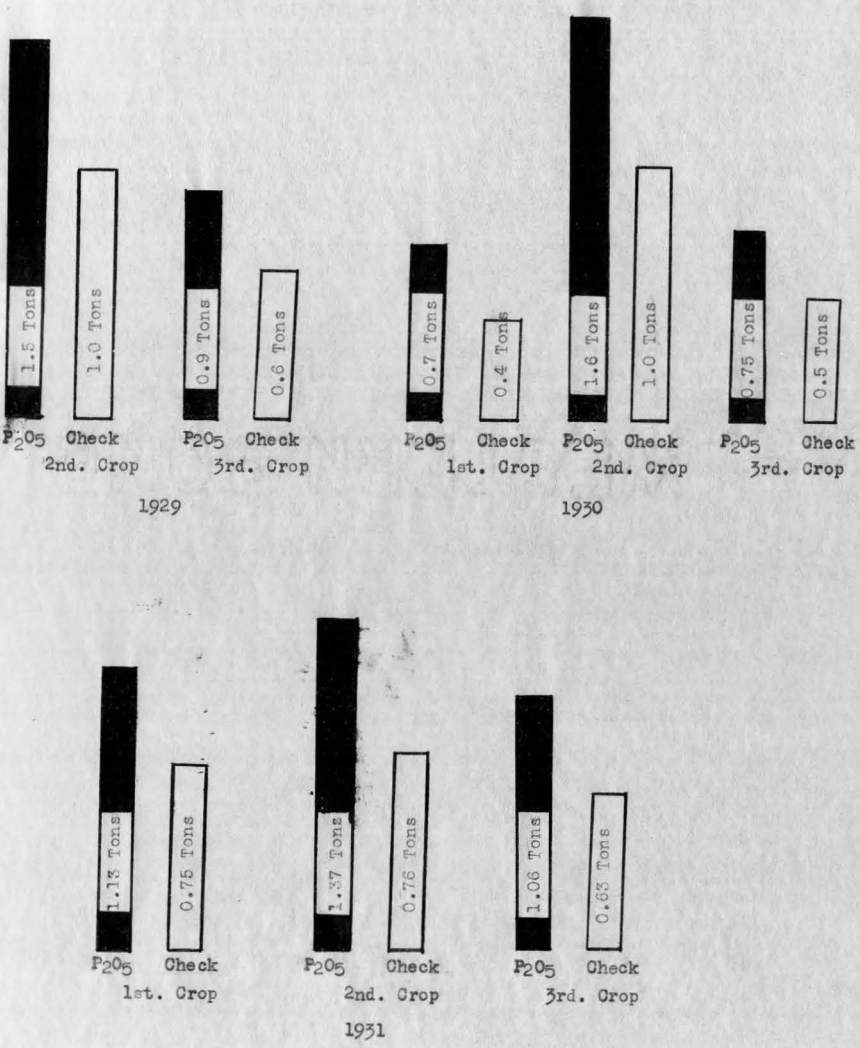
The fact that the hay from the phosphated plats had more leaves and finer stems suggested the question as to whether this alfalfa would

have a higher feed value than the checks. A series of samples from the first and second crops of 1931 were tested in the laboratory for nitrogen by the Kjeldahl method. The amount of nitrogen was multiplied by the factor 6.25 to find the amount of crude protein. The hay harvested in 1931 from the check plats contained 15.62 per cent crude protein for the first crop and 15.12 per cent for the second crop. The hay from the phosphated plats tested 16.7 per cent crude protein for the first crop and 17.31 per cent for the second crop. Thus, hay from the phosphated plats had 10.38 per cent more crude protein than did the check plats. When the increase in yield of the phosphated plats is considered, this increase seems highly significant. The total acre yield of crude protein for the phosphate plats was 850 pounds as compared to 464 pounds for the check plats, an increase of 83 per cent. Having only the results from two crops and for but one year, it would not be wise to draw any final conclusions; however, it seems that the addition of phosphorus definitely increased the protein content and yield of the alfalfa.

FIGURE +5

This graph shows the comparison of phosphorus and the check on the yield of alfalfa for three different years. The phosphorus was applied in 1929 after the first crop had been harvested and from the graph it will be observed that the effect of the fertilizer was increasing the yield at the time the eighth crop was harvested.

Fig # 3.


1.5 Tons
1.0 Tons
0.9 Tons
0.6 Tons
0.7 Tons
0.4 Tons
1.6 Tons
1.0 Tons
0.75 Tons
0.5 Tons
P2O5 Check P2O5 Check
2nd. Crop 3rd. Crop
1929
P2O5 Check P2O5 Check P2O5 Check
1st. Crop 2nd. Crop 3rd. Crop
1930
1.13 Tons
0.75 Tons
1.37 Tons
0.76 Tons
1.06 Tons
0.63 Tons
P2O5 Check P2O5 Check P2O5 Check
1st. Crop 2nd. Crop 3rd. Crop
1931

RESIDUAL EFFECTS OF PHOSPHORUS ON GRAIN

A number of farmers with farms adjoining the Carbon County Experimental Farm planted sugar-beets in 1930 and applied phosphorus to this land at the time of seeding. This phosphorus was applied at the rate of 125 pounds to the acre. In each case the addition of phosphorus gave an increase in yield. As the use of phosphorus was in the experimental stage a number of the farmers treated one acre with phosphorus, leaving the adjoining acre as a check; this continued throughout the entire field. In 1931, owing to the shortage of irrigation water, most of the land on which beets had been grown the previous year was seeded to grain with no additional fertilizer. It was from three of such adjoining fields that the following data was obtained on the crops of 1931. A study of these fields were made by the writer to supplement the work done with fertilizers on the Experimental Farm.

Farm No. 1 - Colsess barley was grown. Within two weeks after the grain had emerged the residual effects of the phosphorus was apparent. The grain on the phosphated plats was ripe on July 20, while that on the check plats did not ripen until July 29. The average height of the barley, from the plats to which phosphorus had been applied the year previously, was 36.4 inches as compared to 29.2 inches for the check plats. The acre-yield of the phosphated plats was 63.62 bushels as compared to 41.46 bushels for the check or unphosphated plats. The phosphorus increased the height 24.65 per cent and the yield 53.93 per cent.

Farm No.2 - Trebi barley was grown on this farm in acre strips with the alternating strips used as a check. The effect of the phosphorus was noticeable within two weeks after the grain had emerged. The barley on those strips to which the phosphorus had been applied was ripe July 23;

on the check plats the barley did not ripen until August 3. The average height of the plants on the phosphated plats was 37.8 inches as compared to 30 inches for the check plats; in other words, or the phosphorus caused an increase of 26 per cent in height of plants. The yield of the phosphated plats was 68.2 bushels as compared to 52.0 bushels for the checks. The increase in yield was 31.15 per cent.

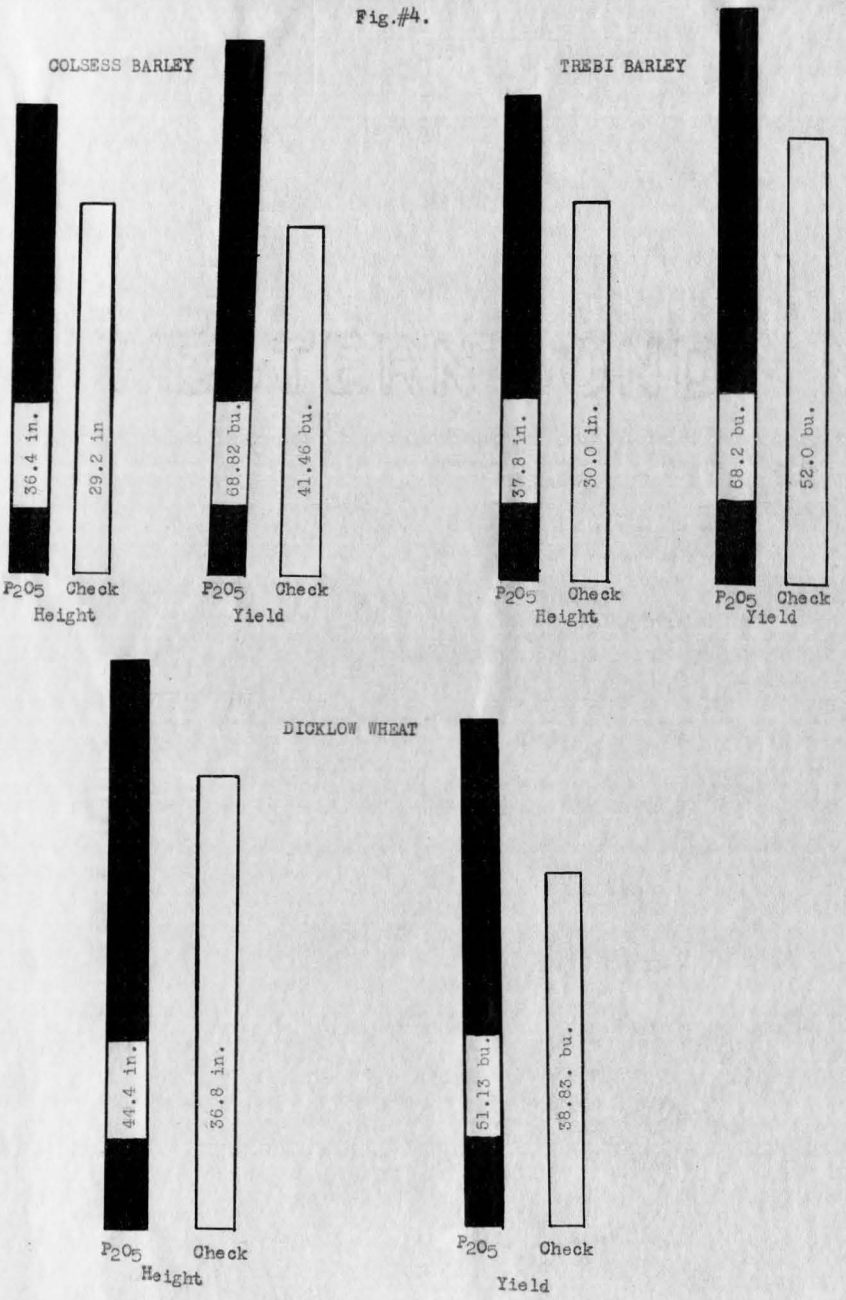
Farm No. 3 - Dicklow wheat was grown on this farm. The plan of planting was similar to that of the Farms 1 and 2. The wheat on the phosphated plats was ripe by August 7 and on the check plats by August 15. The average height of the wheat grown on the treated plats was 44.4 inches as compared to 36.8 inches for the checks. The treated plats yielded 51.13 bushels to the acre as compared to 38.83 bushels for the checks. The phosphorus produced an increase of 20.65 per cent in height and an increase in yield of 31.65 per cent over the checks.

The fact that the phosphorus produced an increase in height is considered of much importance in this region, especially with barley, as this is frequently so short that it is difficult to harvest with self-binders. The earliness in ripening is also of importance because it may save one irrigation.

FIGURE +4

This graph shows the residual effect of phosphorus on the height and yield of Golsess and Trebi barley also the effect of the phosphorus on Dicklow wheat. This data was gathered in 1931 from farms adjoining the Carbon County Experimental Farm.

Fig.#4.


COLSESS BARLEY
36.4 in.
29.2 in
68.82 bu.
41.46 bu.
P2O5
Check
Height
Yield
TREBI BARLEY
37.8 in.
30.0 in.
68.2 bu.
52.0 bu.
P2O5
Check
Height
Yield
DICKLOW WHEAT
44.4 in.
36.8 in.
51.13 bu.
38.83. bu.
P2O5
Check
Height
Yield

SUMMARY

Of all the fertilizers used, phosphorus was the only one which gave both an increase in yield and sugar content each year. The phosphorus gave a decided stimulating influence to the beet seedling throughout the growing season, and this stimulation was largely responsible for the increase in yield.

The yields for 1929 were all rather low and the response of the different fertilizers was probably influenced by the method by which the fertilizer was applied.

The nitrogen produced a retarding effect on the beets during the seedling stage, and it appeared impossible for the beets to overcome this disadvantage.

During drough periods the beets on the phosphated land withstood this handicap much better than the beets grown on the other fertilizer treatments.

Phosphorus gave a slight increase in per cent of sugar but was not significantly better than the other fertilizers. The increase in yield of sugar was due mainly to the increase in tonnage and not to the sugar content. Where barnyard manure was applied alone the per cent of sugar was increased as well as the acre-yield of sugar.

The addition of barnyard manure and phosphorus gave the greatest increases in acre-yields of both beets and sugar as well as in sugar content.

Phosphorus not only increased the yield of alfalfa but also increased the protein content and improved the quality of the hay.

The effect of phosphorus on alfalfa was continuing after three years from time of application, or at the end of the eighth crop.

Phosphorus had a marked residual effect on barley and wheat, increasing the height, yield, and date of maturity.

The application of barnyard manure supplimented with phosphorus is one of the determining factors in crop production in the region where these studies were made.

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