FERTILIZER STUDIES IN SOUTHERN MONTANA AND NORTHERN WYOMING IN 1946

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INTRODUCTION

The northern Big Horn Basin in Wyoming and the Clarks Fork of the Yellowstone River in southern Montana are two areas particularly adapted to the production of dried beans as a crop. Such a crop does not lend itself to replenishment of plant nutrients in the soil. The beans are sold for human consumption or seed and the straw does not provide any appreciable amount of livestock food. This, together with other contributing factors, has resulted in a very decided lowering in crop yields in the areas over a period of years. There are exceptions, of course, where good farming practices have maintained and increased yields of all crops. These exceptions, however, are all too few.

As a general statement it might be said that the northern Wyoming and Montana districts of The Great Western Sugar Company are much more subject to early "yellowing" than is any other area served by this Company. It is evident in many ways that such a condition is a result of depletion of nitrogen reserves.

The tests herein discussed had as objectives the investigation of the following questions:

1. Are responses to potash fertilizers obtainable in these areas?

2. What responses to ordinary amounts of phosphorous and nitrogen are obtainable on fields with a history such as many have in these districts?

3. Can analysis of plant parts (petioles) for nitrogen and phosphorous be correlated with responses in the form of increased yields?

EXPERIMENTAL PROCEDURES

Six treatments were used as follows, rates are acre basis:

1. 300 Lbs. (10-18-5) Complete fertilizer.

2. Untreated (Check).

3. 600 Lbs. (10-18-5) Complete fertilizer.

4. 125 Lbs. Treble Superphosphate.

5. 125 Lbs. Treble Superphosphate plus 150 Lbs. Ammonium Sulfate.

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6. 150 Lbs. Ammonium Sulfate.

Design of Experiments:

Randomized Complete Block.

Number of replicates each treatment; -

Belfry, Montana	- 4
Park City, Montana	- 4
Powell, Wyoming	- 2

Size of Plot; -

Belfry	- 8 rows x field length.
Park City	- 8 rows x field length.
Powell	- 24 rows x field length.

Time of Application; -

Belfry	- Immediately after planting.
Park City	- At thinning time.
Powell	- At thinning time.

Method of Application; - By side dressing.

Method of Harvest; -

Belfry and Park City - 10 samples per plot, 20 feet of row taken for yield determination, 3 of the above 10 samples were analyzed for sugar.

Powell - Entire plot harvested and weighed over dump in conventional manner. No sugar determinations.

Petiole Analysis Methods; -

Nitrates	- Phenol - Di Sulfuric.
Phosphorous	- LaMotte - Truog.

Values given in Table 1 represent averages of 4 replications for each date of sampling indicated.

Results and Discussion:

The results of petiole analysis, and harvest data at Belfry and Park City are given in Table 1.

It was noted at the first date of petiole analysis, July 30, that some plants in the Belfry field were showing symptoms of phosphate deficiency. This location alone gave response to phosphorous without nitrogen. Also significant is the very low level of phosphorous in all treatments at that location. Studying the data for both locations from the standpoint of limiting factors, it

would be inferred that phosphorous was the greater need at Belfry and nitrogen at Park City. At no time in the latter test were nitrates high enough in the petioles to give good distinction in the color test. Phosphorous remained fairly static throughout the season. Brown[1] indicates that the level of phosphate sufficiency is about 100 p.p.m. of p. in petioles, agreeing with Ulrich[2] of California. He disagrees with Ulrich, however, on a level of 450 p.p.m. NO_3 as sufficient for that element. Brown's data is based on Colorado and Nebraska samples where it is likely nitrates will be found at a higher level.

Referring to Table 1 then it would seem that at Park City the higher level of phosphate resulted in a much more rapid utilization of available nitrates to the extent that analysis failed to show any appreciable amount of nitrogen in that form at any time during the period. At Belfry one might theorize that phosphorous levels were so low that the applied nitrogen was utilized only slowly. Nitrate levels themselves were relatively low and therefore application of any fertilizer of any type was apprently beneficial. At Park City phosphorous alone failed to give any response, and while the yield for that treatment (4) is significantly below standard it is doubtful if the phosphate had any deleterious effect. Here again, practically any type of fertilizer beside phosphate gave an increase in yield. It might be argued that at this location potash had some beneficial effect since the two treatments containing that element gave the highest yields. The differences are not significant at the 5% level.

At neither location was any difference in sugar content measurable.

Results of the Powell, Wyoming,* test are given in Table 2.

Table 2: Summary of Harvest Results, Powell, Wyoming, 1946

Treatment No.	Soil Amendment (Per Acre Basis)	Tons Beets Per Acre
1.	300# (10-18-5)	14.89
2.	Untreated (ck.)	13.81
3.	600# (10-18-5)	17.34
4.	125# T.S.P.*	12.85
5.	125# T.S.P. plus 150# Amm. Sul.#(Approx. 10-18-0)	14.40
6.	150# Am. Sul.	13.66

* T.S.P. - Treble Superphosphate
\# Am. Sul. - Ammonium Sulfate

1 - Brown, R. J., The Great Western Sugar Company, Research Laboratory Report 46-002. "Petiole Tests of 1945".

2 - Ulrich (Private Communication).

* Conducted by R. K. Bischoff, Manager, Lovell, Wyoming Factory, The Great Western Sugar Company and Associates.

Here, as at Park City, the "phosphate only" treatment was lower in yield than check. Certainly on the basis of this test such a difference could not be significant. Nitrogen alone apparently gave no response, but when used in combination with phosphorous did give response in all cases at this location.

From a statistical viewpoint it would not seem proper to combine the data of these three locations, however, certain economic aspects of the use of such fertilizers need to be studied. For this purpose the results are averaged on the basis of the number of replications in each test. Sugar content is ignored since it was demonstrated in Table 1 that no differences of significance existed for that character. Table 3 provides a study of fertilizer costs vs. profit obtained by increased tonnage of beets.

Table 3 Summary of 3 Locations for Yield and Profit

Treatment No.	Soil Amendment (Per Acre Basis)	Tons Beets Per Acre	Fertilizer* Cost	Net Acre Gain By Treatment
1.	300# (10-18-5)	11.35	$ 9.90	$ 11.33
2.	Untreated Check	9.78	----	----
3.	600# (10-18-5)	12.29	19.80	14.14
4.	125# Treble Superphosphate	9.20	3.25	-10.94
5.	125# Treble Superphosphate Plus 150# Ammonium Sulphate	11.42	7.15	15.02
6.	150# Ammonium Sulphate	11.12	3.90	14.22

* Treble Superphosphate and Ammonium Sulphate @ $52.00 per ton. Complete (10-18-5) @ $66.00.

\# Beets @ $13.52 per ton.

Assuming potash had no influence, then the greater profit is obtained by use of the mixture of phosphate and ammonium sulphate, due in a measure to the lesser costs of these materials.

SUMMARY

The results do not show any need for potash, at least on those fields in this area where the levels of crop production are low. No doubt if the level of crop yields were doubled the relationship would be quite different.

Response to phosphate alone was obtained at only one location. Apparently the greater need is nitrogenous fertilizers or a combination wherein phosphate is in a lesser role than heretofore practiced in the area. The use of phosphate cannot be discontinued but rather might be modified for the inclusion of nitrogen in a fertilizer supplement.

Analysis of plant parts do tend to greater enlightenment on plant needs when used in conjunction with fertilizer tests. Better methods of analysis might make such tests yield more information, particularly the colorimetric test for nitrates.

Table 1: Summary of Petiole Analysis With Yield and Sugar Data - Billings, 1946

* T.S.P. - Treble Superphosphate
Am. Sul. - Ammonium Sulfate

Belfry, Montana

Treat. No.	Soil Amendment (Per Acre Basis)	Petiole Analysis: Parts Per Million P. 30 July	22 Aug.	18 Sept.	Parts Per Million NO_3 30 July	22 Aug.	18 Sept.	Harvest Results: Tons Beets Per Acre	Sugar %	Gross Sugar Per Acre (#)	Beets Per 100'
1.	300# (10-18-5)	55	57	45	2030	440	490	8.50	16.4	2790	80
2.	Untreated (CK.)	34	29	37	1350	780	460	6.87	15.8	2168	83
3.	600# (10-18-5)	68	47	62	2480	690	395	9.75	15.9	3103	76
4.	125# T. S. P.	95	52	76	1290	380	435	8.39	16.7	2796	70
5.	*125# T.S.P. Plus 150# *Am. Sul. Approx. (10-18-0)	89	68	41	1380	585	595	9.83	16.8	3289	82
6.	150# Am. Sul.	50	64	67	2170	470	560	9.05	16.4	2992	74
				Significant Difference - 5% Point				2.15	N.S.	722	

Park City, Montana

1.	300# (10-18-5)	260	240	230	305	150	220	12.44	17.3	4285	89
2.	Untreated (CK.)	240	200	190	215	202	245	10.68	17.3	3696	82
3.	600# (10-18-5)	205	195	170	385	110	192	12.31	17.0	4191	83
4.	125# T. S. P.	230	225	220	195	235	417	8.18	17.0	2779	70
5.	*125# T.S.P. Plus 150# *Am. Sul. Approx. (10-18-0)	225	240	150	185	190	285	11.53	16.9	3896	74
6.	150# Am. Sul.	175	200	200	260	152	255	11.92	17.4	4135	78
				Significant Difference - 5% Point				2.05	N.S.	712	