# The Effect of Phosphate Fertilizer on Yield of Sugar Beets[1]

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Because of the lack of positive experimental evidence on the response of sugar beets to phosphate fertilizer in the Sacramento and San Joaquin Valleys of California, a series of experiments were undertaken during the 1947 crop season to ascertain the effectiveness of phosphate in increasing yields of sugar per acre.

Twelve separate trials were made—six were located in the San Joaquin Valley in Kern County and six in the lower Sacramento Valley. Each trial was conducted on a different major soil type on which sugar beets are grown in the areas concerned.

The experiments were located in fields which had not been fertilized with phosphate for at least the 2 previous years.

*Methods and Procedure.*—Each trial consisted of eight plots—four treated and four untreated. The plots were paired and the pairs laid end to end down the rows. A plot was four rows wide by 100 feet long. Alternate numbers of each pair of plots were treated so that the treatments occurred in a checkerboard arrangement.

The treatment was constant for each trial, but consisted of from 157 to 221 pounds of $P_2O_5$ per acre, depending upon the row spacing of the trial concerned. Single superphosphate was banded from 4 to 6 inches from the plants in the center two rows. The time of application varied among trials from just prior to planting to thinning time.

On the six trials in Kern County, petiole samples were taken from each plot at 4-week intervals and analyzed[3] to determine whether the treatment had been effective in increasing the phosphate intake of the plants and if a response was indicated by early low phosphate values.

Each trial, treatment and control alike, received nitrogen fertilizer of the type and amount that each grower applied to his field.

Eighty feet of the center two rows of each plot were harvested.

*Results.*—There was no visible response to the treatment in any trial at any stage of growth. The yield data are tabulated in table 1. Data are presented for eleven trials only as circumstances prevented harvest of the twelfth.

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[1]Conducted by the Spreckels Sugar Company in cooperation with Dr. Albert Ulrich of the Division of Plant Nutrition, University of California, and the Extension Service of Kern County, California.

[2]Spreckels Sugar Company.

[3]All petiole analyses were made by the Division of Plant Nutrition, University of California.

**Table 1.** Summary of yield data, 1947 phosphate trials. Each value is the mean of four replications.

| | Trial number and soil type | Treatment | Tons Beets per acre | Difference in tons beets per acre | Percent sugar | Difference in sugar percent | Tons sugar per acre | Difference in tons sugar per acre |
|---|---|---|---|---|---|---|---|---|
| 1. | Exeter sandy loam | P[1] | 21.21 | +.59 | 14.17 | - 1.13 | 3.003 | —.133 |
| | | O | 20.62 | | 15.30 | | 3.136 | |
| | Difference required for significance (19:1) | | | 4.13 | | .49 | | .55 |
| 2. | Delano loamy sand | P | 33.91 | +1.19 | 12.52 | +.02 | 4.247 | +.159 |
| | | O | 32.72 | | 12.50 | | 4.088 | |
| | Difference required for significance (19:1) | | | 2.86 | | .39 | | .42 |
| 3. | Hesperia sandy loam | P | 31.89 | +.31 | 14.26 | —.04 | 4.705 | +.237 |
| | | O | 31.58 | | 14.30 | | 4.468 | |
| | Difference required for significance (19:1) | | | 7.89 | | 2.44 | | .80 |
| 4. | Traver fine sandy loam | P | 33.72 | - -1.04 | 12.88 | - -.69 | 4.354 | —.372 |
| | | O | 34.76 | | 13.57 | | 4.726 | |
| | Difference required for significance (19:1) | | | 2.13 | | 2.41 | | .78 |
| 5. | Sacramento clay | P | 20.54 | —3.15 | 12.70 | - -.28 | 2.588 | —.545 |
| | | O | 23.69 | | 12.42 | | 3.133 | |
| | Difference required for significance (19:1) | | | 2.73 | | 1.06 | | .34 |
| 6. | San Emigdio fine sandy loam | P | 6.90 | +1.67 | 14.00 | - -.68 | .988 | +.206 |
| | | O | 5.23 | | 14.68 | | .782 | |
| | Difference required for significance (19:1) | | | 1.24 | | 1.68 | | .29 |
| 7. | Yolo clay loam | P | 5.75 | —.20 | 14.10 | +1.04 | .812 | +.049 |
| | | O | 5.95 | | 13.06 | | .763 | |
| | Difference required for significance (19:1) | | | 5.08 | | 4.89 | | .48 |
| 8. | Yolo clay | P | 15.37 | +.31 | 11.75 | - -.92 | 1.814 | - -.103 |
| | | O | 15.06 | | 12.67 | | 1.917 | |
| | Difference required for significance (19:1) | | | .86 | | 3.35 | | .70 |
| 9. | Yolo loam | P | 13.76 | —1.07 | 16.41 | - -.20 | 2.258 | —.198 |
| | | O | 14.83 | | 16.61 | | 2.456 | |
| | Difference required for significance (19:1) | | | 2.29 | | 2.81 | | 2.73 |
| 10. | Sacramento clay | P | 24.00 | —.97 | 17.34 | - -.54 | 4.135 | —.048 |
| | | O | 23.03 | | 17.88 | | 4.087 | |
| | Difference required for significance (19:1) | | | 7.16 | | .72 | | 1.21 |
| 11. | Columbia clay loam | P | 14.77 | .55 | 20.13 | - .81 | 2.973 | +.013 |
| | | O | 15.32 | | 19.32 | | 2.960 | |
| | Difference required for significance (19:1) | | | 2.11 | | .75 | | .367 |

[1] P = phosphate; O = control.

The yield data on trial 6 indicate a response to the treatment in tons of beets per acre. However, the increase is not significant in sugar per acre. It is felt that the yields from these plots were too greatly affected by curly top to afford conclusive evidence. In this trial there is a good correlation between yield and the number of beets harvested per plot. This, plus the fact that petiole analyses show no indication of a phosphate deficiency, leads to doubt of the significance of the response pending the result of further trials in this area.

No entirely satisfactory explanation can be offered for the significant decrease in yield in the phosphate treatment of trial 5. This may have been due to the fact that in three of the four replications from 30 to 50 more beets were harvested from the paired treated plots. There was no apparent reason for the population differences at harvest time other than the possible failure in obtaining comparable thinned stands.

The significant decrease in sugar percentage in trial 1 and the significant increase in sugar percentage in trial 11 do not amount to much in a practical way as the differences were not enough to significantly effect the yields of sugar per acre.

Petiole analyses on trials 1 through 6 show that the beets in the treated plots initially received greater amounts of $PO_4$ than the control plots; but the $PO_4$ levels in the control plots, with the exception of trial 2, never reached the critical level as defined by Ulrich[4]. In trial 2, the $PO_4$ concentration in the petioles from three of the four control plots reached the critical level sometime during the last month of growth. The deficiency was not of sufficient duration to be noted in yield response. Had the beets been allowed to grow for a longer period, a response may have been noted. It is clear that this area should be watched for possible future response to phosphate fertilization. The petiole analyses data for trial 2 are presented in table 2.

**Table 2.** Phosphate concentration in sugar beet petioles from trial 2.
Critical level = 600-800 ppm.
Expressed in ppm. of $PO_4$—P (dry basis)

| Replication number | Treatment | Date Sampling | | | |
|---|---|---|---|---|---|
| | | March 4 | April 28 | June 25 | July 18[2] |
| 1 | P[1] | 2750 | 3610 | 2280 | 1180 |
| | O | 2100 | 2340 | 2440 | 520 |
| 2 | P | 2980 | 3000 | 2480 | 1150 |
| | O | 1717 | 2240 | 1500 | 850 |
| 3 | P | 3310 | 3420 | 2530 | 1330 |
| | O | 2620 | 2330 | 2210 | 730 |
| 4 | P | 2770 | 3260 | 2780 | 1630 |
| | O | 1460 | 2740 | 2480 | 1170 |

[1]P = plot fertilized with superphosphate; O = control.
[2]Harvest date.

## Summary

1. Twelve experiments were conducted, each on a different soil, to determine if sugar beets would respond to phosphate fertilization.

2. Yield data did not indicate a definite response to phosphate in any of the trials.

[4]See paper by Albert Ulrich, "Plant analysis as a guide to the nutrition of sugar beets in California," on page 364 of these Proceedings.