Utilization of Phosphorus by Sugar Beets As Affected by Fertilizer Placement

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The practice of applying mixed fertilizers in bands below and to one side of sugar beet seed has been well established by fertilizer placement studies conducted over the past 20 years (6). In general this method of fertilizer application has resulted in highest yields of beets per unit of phosphate fertilizer applied in Michigan and Ohio (1,2,3,4,5).

The radioactive tracer method, in which the phosphate carrier is tagged with $^{32}P$, provides an additional way for comparing the availability of a phosphate fertilizer applied in several different ways. Only one report has been published concerning the absorption of fertilizer phosphorus by sugar beets from band versus other types of placement. Olsen and co-workers (7) determined the utilization of fertilizer phosphorus by sugar beets grown under irrigation in Colorado. Four phosphate materials in single band and rototilled band placement were compared in two experiments conducted in 1948 and 1949. Mixing fertilizer near the seed with a rototiller resulted in much greater uptake of fertilizer phosphorus during early growth than occurred from bands placed beside the row at thinning time. In later stages Olsen et al. (7) reported that fertilizer placed in bands supplied more phosphorus to beet plants than did that mixed in with a rototiller, especially in a dry year.

In view of the limited knowledge regarding the effect of fertilizer location on the absorption of fertilizer phosphorus by sugar beets, this study was undertaken to compare three methods of fertilizer application as they influenced yield and fertilizer phosphorus utilization.

MATERIALS AND METHODS

This experiment was conducted in 1950 on Brookston clay loam soil at the L. Ferden farm in Saginaw County, Mich. The area including the experimental plots was tile drained. The surface soil contained about 4.3% total organic matter and had a pH value between 6.0 and 6.3. According to the method of Spurway and Lawton (8) the soil to plow depth contained approximately 35 pounds of available phosphorus per acre, which is considered to be a low to medium quantity. The available soil potassium was medium to high. Plots were arranged in a randomized block, split-plot design with four replications. Each plot, 28 by 20 feet in size, included 12 rows of beets at a 28-inch spacing with approximately 1 beet plant per foot of row. One half of each plot was used for plant sampling, while the other half was used to obtain beet yields.

Superphosphate ammoniated to contain 4% N was used as the phosphate carrier, while supplemental ammonium nitrate and potassium chloride were added to give a total of 25 pounds of N and 50 pounds of K$_2$O per acre. The mixed fertilizer was applied by the following methods and at rates to contain the following amounts of P$_2$O$_5$ per acre:

1. 50 lbs. radioactive drilled.
2. 50 lbs. radioactive banded.
3. 100 lbs. radioactive banded.
4. 50 lbs. radioactive banded + 50 pounds non-radioactive drilled.
5. 50 lbs. non-radioactive banded + 50 pounds radioactive drilled.
6. 50 lbs. radioactive banded + 50 pounds non-radioactive side-dressed.
7. 50 lbs. non-radioactive banded + 50 pounds radioactive side-dressed.

Note that in four of the treatments, one half was added as non-tagged phosphate. The radioactive fertilizer had an initial specific activity of 0.15 microcuries per gram of P$_2$O$_5$.

Both drilled and band placement applications were made on May 8 with a fertilizer drill having belt type applicators. The drilled fertilizer was applied in rows 7 inches apart and approximately 3 inches deep before seeding. The band material was applied as single bands 11/2 inches to the side and above the beet seed at planting time. Segmented sugarcane was planted on May 8 and 9. Side-dressed fertilizer was applied on July 5 with a Planet Junior sidedresser. Plant samples from the four center rows of each sub-plot for all experiments on June 13, June 30, July 18, and Aug. 5, consisting of 20 plants per plot were taken at random. In three later dates 10 plants constituted a sample. A third sampling of roots derived from the tagged fertilizer at four sampling periods was taken on Oct. 17 from the four center rows of each yield sub-plot.

Sugar beet tops were separated from the roots at the first sampling, and the roots were washed to remove soil. The tops and roots were then dried, ashed with nitric, perchloric, and sulfuric acids, and the phosphorus was taken up in 0.2 N HCl and activity measured with a G-M counter. Total phosphorus in the ash solution was determined spectrophotometrically as molybdenum blue.

RESULTS AND DISCUSSION

The percentages of fertilizer in sugar beet tops and roots derived from the tagged fertilizer at the above dates are given in tables 1 and 2.

On June 15, 37 days after planting, the first sampling was taken from the whole plant since the roots were not dried. At this time, the percentage of fertilizer derived phosphorus in the beet plants receiving band applications ranged from 56 to 70. No significant difference in the percentage of fertilizer derived phosphorus was noted between the several banded treatments regardless of rate or placement combination. A single average combination, radioactive drilled + non-radioactive banded application, indicates low fertilizer phosphorus absorption from the banded or the drilled fertilizer. Slow lateral root extension accounts for this relatively low absorption.

At the second sampling period, 2 weeks after the first sampling period, the percentage of fertilizer derived phosphorus in the beet tops was about 60 and the root samples averaged about 70 for the banded treatments. The differences in the values between the several treatments were not significant. The radioactive fertilizer had an initial specific activity of 0.15 microcuries per gram of P$_2$O$_5$.