THE EFFECT OF LIQUID AND DRY FERTILIZERS ON THE PHOSPHORUS CONTENT AT EARLY STAGES OF GROWTH AND ON THE YIELD OF SEVERAL CROPS

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By

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AN ABSTRACT

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Field experiments were initiated to investigate the comparative effectiveness of liquid and solid fertilizers on the yield and phosphorus content of onions, carrots, table beets, sugar beets, oats and corn.

The findings of the studies were as follows:

1. Excellent agreement between the phosphorus contents of duplicate samples was obtained by the nitric-perchloric-sulphuric acid digestion method of ashing.

2. Significant differences (5 percent level) in yield of onions were obtained between plots fertilized with 800 pounds per acre of liquid fertilizer over those fertilized with the solid form. Plots receiving the 400 pounds rate of liquid fertilizer out-yielded those where the same amount of fertilizer in dry form was used. This yield response was not in agreement with the previous year's results.

3. Onions, carrots and table beets yields were higher on fertilized plots than on unfertilized areas. The percent increase in yield due to fertilizers was highest with onions, intermediate with table beets and lowest with carrots.

4. No consistent differences in the phosphorus content of carrots, onions and table beets were obtained from plants growing on either liquid or solid fertilizers. A decrease in phosphorus content of carrots was observed with successive sampling dates. Onions growing on the unfertilized plots were lower in phosphorus than those from the fertilized areas at all sampling dates.

5. Fertilizer increased the yield of corn. The forms of fertilizer were not materially different in their effect on yield or phosphorus content of the tissue.

6. Sugar beet yields and percent apparent purity of the root were highest on the plots where the solid fertilizer was used at the three locations.

7. No consistent difference in the effect of the two forms of fertilizers on the phosphorus content of sugar beet leaves and percent sucrose of the roots was observed.

8. Higher yields of oats were obtained on plots where fertilizer was used. However, there was no consistent difference that could be ascribed to the form of fertilizer. There was a slight tendency for the phosphorus content to be higher in oats obtained from the liquid fertilizer plots of Flow Mix than from oats growing on solid fertilizer plots.

9. In general, the effectiveness of the two forms of fertilizer on the yields of the crops investigated is equal, providing the method of placement of the fertilizer is identical.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

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INTRODUCTION

Crops often respond to a soil application of phosphorus fertilizer. Recent investigations have shown that the effect of phosphate materials on the yield and phosphorus content of a plant depends on its water soluble phosphorus content, the particle size, and the nature of the admixed salts.

The recent introduction of liquid fertilizers, competitive in price with the dry materials, suggest the need for an evaluation of the comparative effectiveness of the two forms.

The purpose of this study was to compare the effect of liquid and dry fertilizers on the phosphorus content and yield of several crops.

REVIEW OF LITERATURE

Any liquid containing one or more available plant nutrients is classed as a liquid fertilizer.

Several advantages are assigned to liquid over dry fertilizers, and some claims unsupported by research data are made by vendors of the liquid materials. Robertson (17) listed several advantages and disadvantages of the two forms. The advantages of liquids over solid forms are: 1) they can be handled with small pumps resulting in a saving of hand labor; 2) a uniform broadcast application is easily obtained by spraying; 3) materials are completely soluble in water and can be used in irrigation water and as starter solutions; 4) uniformity in mixtures is easily obtained; 5) pesticides are generally compatible with liquid fertilizers and can be applied as foliar sprays; 6) they simplify the manufacture of tailored grades; 7) the availability of nitrogen and potassium is not decreased when applied to the soil in liquid form; and 8) the phosphorus is completely water soluble.

Disadvantages, however, include: 1) special application and storage equipment is required; 2) complete fertilizers can be manufactured only in low grades; 3) they contain small quantities of secondary and minor elements; 4) application equipment for placing fertilizer in the recommended position

in the soil with respect to the seed is generally unavailable; 5) phosphorus fixation in the soil may be increased; 6) calcium and magnesium contents of liquid fertilizers have to be kept low to prevent precipitation of other nutrients; 7) rates of application of actual nutrients may be limited because of the large volume of water needed; 8) liquid fertilizers corrode certain metals; 9) they may be difficult to merchandise; 10) completely soluble carriers are required for their manufacture, thus limiting the carriers that may be used; 11) grades high in potassium, suitable for several crops growing on light sandy or organic soils, are difficult to formulate unless low grade fertilizers are accepted.

Cook and Owens (4) observed that as the water-soluble phosphorus in the fertilizer was increased from 0 to 100 percent, the percent of phosphorus in plant tissue at the four-week sampling date was increased from 0.15 to 0.25 percent. This indicates that fertilizers with low water-soluble phosphorus content may not provide enough phosphorus for optimum growth of plants.

Dickman and De Turk (5) concluded that the response of plants to phosphorus applications should be evaluated on the basis of dry weight and the phosphorus intake by the plant. "A phosphorus limitation factor" was suggested; this was obtained by dividing the dry-weight increase per milligram of phosphorus absorbed by plants receiving soluble P_2O_5 into

the corresponding value for plants using rock-phosphate as the source of phosphorus. This serves as a relative index of the phosphorus level in plants.

Values greater than unity indicated that the plants were deficient in phosphorus. Values less than unity demonstrated that phosphorus had been absorbed in excess of the ability of the plant to utilize it for dry-weight production. In sand cultures, no quantity of rock phosphate was found capable of producing plants containing as high a percentage of phosphorus as that of plants receiving soluble phosphorus.

Krantz, et al. (7), working with corn plants, observed that the plants absorbed the bulk of their phosphorus late in the season after the root system was almost fully developed. This helped to explain why the level of soil phosphorus was important in determining the phosphorus composition and the total uptake by corn plants. They showed a marked early vegetative growth response to phosphorus, but there was no increase in yield of corn.

Ownes, et al. (15) found that four-week old sugar beet plants grown on soil receiving fertilizer of high phosphorus water-solubility were higher in total phosphorus than were plants from plots treated with less soluble fertilizers. However, this relationship did not exist in samples analyzed four weeks later. These data suggest that in the very early growth period of sugar beets, fertilizers containing large

amounts of dicalcium phosphate (ten percent water soluble) phosphorus) may not supply sufficient phosphorus for maximum development.

Viets, et al. (19) used leaf anslysis as a diagnostic procedure for evaluating fertility experiments with corn. The sixth leaf from the plant base was analyzed. A concentration of 0.295 percent phosphorus was established as the critical level. In eight corn fertilization experiments where ammonium nitrate was used as the source of nitrogen, they found a significant correlation between yield of corn and the phosphorus content of leaves. (Phosphorus and nitrogen contents of leaves were more highly correlated with soils high in available phosphorus than in soils with low available phosphorus).

Domby, et al. (6) have shown that the phosphorus content of oat forage was increased by an application of phosphorus in the absence of applied nitrogen. Top-dressing oats with 72 pounds of nitrogen per acre reduced the phosphorus content of forage compared with forage grown on plots receiving no nitrogen. However, because of increased yields resulting from the use of nitrogen, the total phosphorus contained in the oats was proportional to the amount of nitrogen applied.

Bigger, et al (2) reported that the amount of phosphorus extracted from organic soil with any of the three reagents

used, was closely correlated with the amount of phosphorus applied to the soil. Green-tissue tests of sugar beet petioles showed an increase in the concentration of water extractable phosphorus when the amount of phosphorus applied was increased from 50 to 100 pounds of phosphate per acre. The plant tissue collected on three of the seven sampling dates showed significant increases in extractable phosphorus when the amount of phosphorus extracted and applied were compared.

Lawton (10) noted that the utilization of phosphorus by sugar beets grown on Sims clay loam was greatest during the first two months on plots where the fertilizer was applied in a band. As the lateral growth of the roots increased in July and August, it was found that the utilization was greatest from plots in which the fertilizer was drilled into the soil in 7-inch drill widths. Side-dressed fertilizer was readily absorbed when applied two months after planting. Yields of roots were increased in all cases.

Lawton, et al. (9) have shown that as the concentration of available soil phosphorus increases, the utilization of added fertilizer phosphorus decreases.

Studies on the uptake of phosphorus from different phosphate fertilizers were conducted by Poulsen (14) He showed the effect of phosphate fertilizers on crop composition and yield to be greatest in years of unfavorable weather

conditions for crop growth. Differences in the effects of different fertilizers were also greatest in such years.

Rich and Attoe (16) have shown that most of the phosphorus applied to the soil in the form of commercial fertilizer usually was not absorbed by the first crop that followed. The residual fertilizer phosphorus was ordinarily not subject to appreciable leaching, and accumulation of it occurred in the plow layer. They also noted that the percentage of phosphorus in the plant tissues varied inversely with the yield. Thus, each product of yield and percentage content of phosphorus, when plotted against the cropping time, appeared to be representative of the phosphorus supplying power. The authors reported a phosphorus content of dry tissue varied between 0.09-0.5 percent.

Rogers (18) compared the relative effects of ammoniated superphosphate and concentrated superphosphate on several crops grown both in the greenhouse and in the field. He concluded that a high water-solubility material is not required for small grains, corn, or cotton grown on acid soils in the southeastern states. However, limited tests in Iowa suggest that nitrophosphate of low water-solubility may be less effective on alkaline soils than the more soluble superphosphate.

Penner (13), using ammonium phosphate in liquid form and in granules, found that localized placement increased the fertilizer uptake by wheat.

Lewis, et al. (8) reported that applications of water-soluble fertilizers maintained higher levels of available soil phosphorus and greater plant growth. The rapidity with which the level of available phosphorus was established in the soil when water-soluble fertilizers were applied indicated that the time of application is less important that formerly considered. They concluded that water-soluble phosphorus fertilizer could be applied during any season of the year without an accompanying loss in efficiency.

Lawton, et al. (11) worked with different rates and methods of application of superphosphate to legume hay. They found that by increasing the rate of fertilizer the yields and percent of phosphorus in the plant increased. They also showed that as the depth of placement increased from 0-36 inches, the amount of phosphorus absorbed by the plant decreased.

Cole (3) indicated that the addition of soluble phosphorus fertilizers to soil resulted in monolayer sorption of phosphorus on the surface of calcium carbonate particles. If the phosphorus concentration was sufficiently high, a precipitate of dicalcium phosphate or a compound with similar properties was formed. The initial products of these reactions, however, contained more soluble phosphorus than more stable phosphorus compounds.

EXPERIMENTAL PROCEDURE

Field Experiments

Vegetable Crops (Onions, Carrots, and Table Beets)

Experiments with onions, carrots, and table beets were located at the Michigan Muck Experimental Farm. The soil is classed as a Houghton muck and ranges in pH from 6.0 to 6.5. In the virgin state according to Brown (1), it contained 86 percent organic matter, 3.3 percent nitrogen, 0.21 percent potassium, 0.12 percent phosphorus, 2.5 percent iron and 0.0011 percent copper.

Two rates of application per acre, 400 and 800 pounds, of a 5-10-10 fertilizer in liquid and dry form were compared. An unfertilized check was included. The treatments were replicated either three or four times depending on the area of land available. The fertilizers were applied with a special drill (Figure 1) in a band two-inches below the seed thus eliminating any effect that might be caused by different methods of fertilizer placement. Downing's yellow globe onions, Chantenay carrots and Detroit dark red table beets were planted May 5. Plant samples consisting of the entire plant were taken from each plot on July 17, July 27, and August 10. The samples from the various treatments from

each replication were composited and analyzed for total phosphorus.

Oats

Experiments with oats were located in Jackson County on Boyer sandy loam. The pH of this soil area was 6.9. It contained 32 to 42 pounds of available phosphorus per acre and 87 to 106 pounds available potassium (0.13 NHCl extractant). The Jackson variety was grown.

Liquid (9-9-9) and dry (12-12-12) fertilizers were applied at rates of 25, 50, and 100 pounds per acre of nitrogen, phosphoric acid and potash. Unfertilized plots were included in the experiment. Liquid fertilizers were sprayed on the surface of the soil immediately before plowing. The dry fertilizers were applied at planting time in contact with the seed. Planting followed immediately after plowing on May 7.

In the Flow Mix experiment the oats were planted on May 18. Three rates of fertilizer were used. The lowest rate, 150 pounds per acre of 5-20-20, represented a rate of approximately one-half the amount that would be recommended for oats on this soil. The medium rate, 300 pounds per acre of 5-20-20, represented the recommended analysis and rate. The high rate, 600 pounds of 5-20-20 per acre represented twice the recommended rate. Flow Mix was used in amounts equivalent to these three rates, or 7.5:30:30, 15:60:60, and 30:120:120 pounds per acre of nitrogen, phosphoric acid, and

potash respectively. Flow Mix was applied just prior to a heavy rain. The application of the dry fertilizer and planting operations were completed five days later.

Corn

Two experiments with corn were located in a field in Kalamazoo County. The soil type was Kalamazoo sandy loam. The pH varied between 6.3 and 6.7. The soil contained 52 and 106 pounds per acre of available phosphorus and potassium respectively (0.13 NHCl extractant). In one experiment, the comparison of liquid and dry fertilizer was superimposed on a tillage experiment. Paired rows received liquid and dry fertilizer. No unfertilized areas were left because of the possibility of influencing future work on these plots. The liquid and dry fertilizers were applied at planting time in bands two inches to the side of and two and six inches below the seed. Five hundred pounds per acre of 12-12-12 was used. Liquid fertilizer was applied at the rate of 667 pounds per acre of 9-9-9 which is equivalent to 60 pounds each of nitrogen, phosphoric acid, and potash--the same as for the dry form. Michigan hybrid 250 corn was planted on May 21.

In the second Kalamazoo County experiment, Flow Mix fertilizer was applied as a preplanting treatment as was described for oats. The dry fertilizer was applied at planting time in two bands two inches to the side of and two and six inches below the seed. Three rates of the two fertilizer

forms, equivalent to 125, 250 and 500 pounds per acre of 5-20-20 fertilizer, were compared in this experiment. Corn was planted on May 29.

The third experiment on corn was located on the College farm. The soil was a Metea sandy loam. The pH was 5.7 to 6.0 and contained 10 to 15 pounds of available phosphorus and 60 to 100 pounds of available potassium per acre. Liquid (9-9-9) and dry (12-12-12) fertilizers were applied in amounts equivalent to 50 pounds per acre each of nitrogen, phosphoric acid and potash. The fertilizers were placed in two bands as described in the preceding paragraph. Michigan hybrid 480 corn was planted on June 1.

Sugar Beets

Experiments on beets were located on three farms in Sanilac County. The soil on each farm was mapped as Parkhill loam. The two forms of fertilizer in an amount equivalent to 500 pounds per acre of 6-24-12 were placed in a band two to three inches below the seed at planting time. Plantings at all three locations were made during the week of May 25.

Preparation of Tissue Samples

Samples of the entire plant of carrots, onions, and table beets were taken. Composites of the replications of the various treatments were prepared for all plant samples.

Samples of the above-ground portion of oats, sugar beets, and corn were used for analysis. The samples were dried at 150° F and ground in a Wiley mill.

Chemical Analysis of Tissue Samples

A one-gr. sample of plant tissue was placed in a 250-ml. pyrex beaker and digested in 25 mls. of nitric acid for two hours. This was followed by the addition of 6 mls. of a 2:1 mixture of 70 percent perchloric acid and concentrated sulphuric acid. Digestion was continued until all traces of organic material had disappeared. The residue was transferred to a 100-ml. volumetric flask and made up to volume. The flasks were left undisturbed over night to permit the silica to settle out, and hence cause no interference in the subsequent determination of phosphorus. An aliquot was pipetted off and transferred to a small sample bottle for the determination of phosphorus.

Phosphorus was determined in the following manner. One ml. of the ashed plant extract was transferred to a Coleman Cuvette. Nine mls. of warm distilled water, six drops of ammonium molybdate and six drops of F-S reducing agent were then added and thoroughly mixed. The color was allowed to develop for fifteen minutes. Readings were made using a Coleman model 14 Universal Spectrophotometer, equipped with a 6500 Angstrom filter.

Fig. 1. Seed and fertilizer drill used on the vegetable crops.

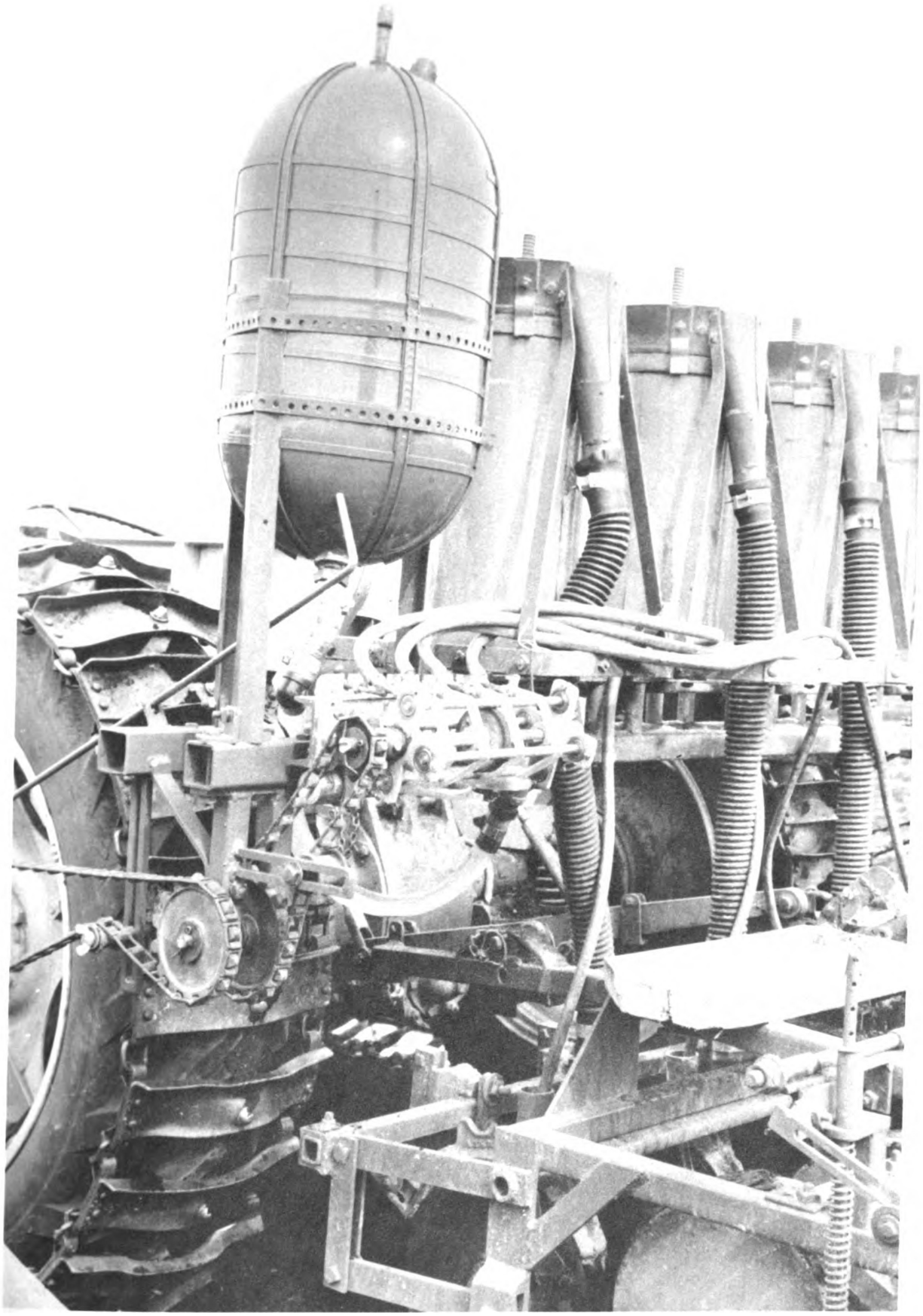
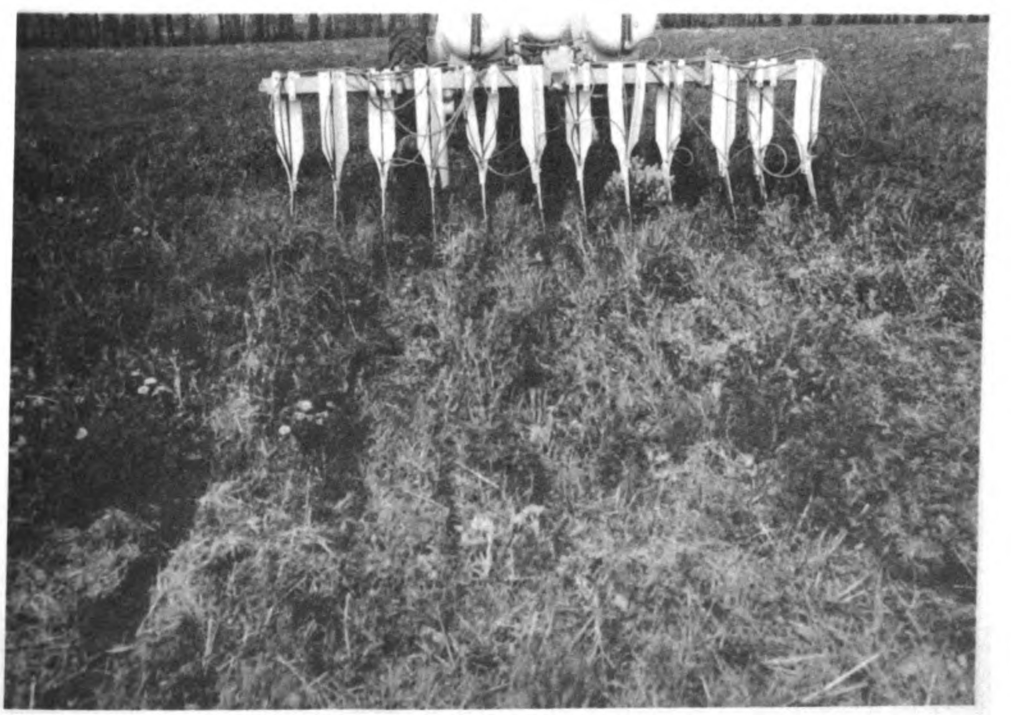


Fig. 2. Flow-Mix fertilizer was applied with a Flow-Mix applicator. The applicator had several tanks, one contained liquid phosphoric acid, another potassium chloride dissolved in water, and a third anhydrous ammonia. Each material was metered separately. Anhydrous ammonia was mixed with the potassium chloride at application time. The mixture was injected into the soil in bands to an average depth of four inches close to the phosphoric acid. The two distinctly separate fertilizer bands were possible with dual outlets on each applicator blade. The blades were spaced 14 inches apart.



RESULTS AND DISCUSSION

The data in Table 1 show the effect of dry and liquid 5-10-10 fertilizer applied at two rates on the phosphorus content of onions, carrots and table beets at three stages of growth.

Onions growing on the unfertilized plots were lower in phosphorus content than those from the fertilized areas at all sampling dates. There was no consistent difference in the phosphorus content of plants obtained from plots receiving fertilizer in either the liquid or dry forms or between sampling dates. The differences observed are probably within experimental error.

Significant differences in yield (table 2) were obtained between plots fertilized with 800 pounds per acre of liquid fertilizer over those fertilized with the solid forms. Plots receiving the 400-pound rate of liquid fertilizer out-yielded those where the same amount of fertilizer in the dry form was used. This yield response was opposite to the results reported by Robertson et al. (17) in 1955 from the same area. The yield of onions significantly increased as the amount of plant food applied increased.

The phosphorus content of carrots was higher than that of onions or table beets at all sampling dates. With one

TABLE 1

THE EFFECT OF RATE OF APPLICATION OF LIQUID AND DRY FERTILIZERS ON THE PHOSPHORUS CONTENT OF DOWNING'S YELLOW GLOBE ONIONS, CHANTENAY CARROTS, AND DETROIT DARK RED TABLE BEETS AT THREE STAGES OF GROWTH GROWN ON HOUGHTON MUCK IN 1956

Date	Pounds of 5-10-10 per acre	Percent Phosphorus* (Oven dry tissue)		
		Onions	Carrots	Table Beets
June 17	800 liquid	.274	.451	.298
	800 dry	.243	.416	.262
	400 liquid	.291	.453	.256
	400 dry	.315	.438	.223
	No fertilizer	.227	.383	.241
July 27	800 liquid	.284	.396	.340
	800 dry	.313	.350	.315
	400 liquid	.291	.363	.256
	400 dry	.291	.336	.223
	No fertilizer	.157	.284	.215
August 10	800 liquid	.279	.274	.290
	800 dry	.245	.287	.243
	400 liquid	.276	.362	.282
	400 dry	.272	.315	.250
	No fertilizer	.155	.235	.247

*Data obtained from a composite sample of four replications of each treatment of table beets and onions and three replications of carrots.

exception (800 pound rate sampled August 10) the phosphorus contents of plants were highest on plots where the liquid fertilizer was applied as compared to those receiving it in the dry form. Plants from the unfertilized plots were lowest in phosphorus content. In general, the phosphorus contents of the tissue decreased with the successive dates of sampling. There were no significant differences in yield of carrots between plots treated with either form or rate of application of fertilizer. Yields from the unfertilized plots were significantly lower at the 5 percent level than those from fertilized areas.

In all cases the phosphorus contents of table beets were highest from plots receiving the liquid fertilizer as compared to those fertilized with a comparable amount of the dry material. There were no consistent differences between dates of sampling. The phosphorus content of plants at the first sampling dates were highest from plots receiving the 800 pounds of fertilizer per acre. This relationship did not hold for the last dates of sampling.

The yield of roots was significantly higher (5 percent level) from fertilized than from unfertilized plots. Increasing the amount of fertilizer applied from 400 to 800 pounds per acre resulted in a significant yield increase. The yield differences between the liquid and dry fertilizer plots were not significant at the 5 percent level. However,

TABLE 2

THE EFFECT OF RATE OF APPLICATION OF LIQUID AND DRY FERTILIZERS ON THE YIELD OF DOWNING'S YELLOW GLOBE ONIONS, CHANTENAY CARROTS AND DETROIT DARK RED TABLE BEETS GROWN ON HOUGHTON MUCK IN 1956

Pounds of 5-10-10* per acre	Yields		
	Onions (50-pound bags per acre)	Carrots (Tons per acre)	Table Beets (Tons per acre)
800 liquid	862	29.2	18.3
800 dry	743	29.7	16.9
400 liquid	652	29.7	13.8
400 dry	591	29.0	12.5
No fertilizer	121	24.7	6.7
L.S.D. (5 percent level)-	69	2.5	2.1

*Fertilizers applied in a band two inches below the seed.

the liquid fertilizer plots at both rates of application outyielded those receiving the dry form.

The percent increase in yield due to fertilizer was highest with onions, intermediate with table beets and lowest for carrots. This suggests that carrots were able to utilize residual fertilizer more effectively than onions and table beets.

Data in Table 3 show that there was a significant response (5 percent level) in yield of oats due to fertilizer. Plots receiving the two higher rates of liquid fertilizer outyielded the plots receiving a comparable amount of the dry material. The differences in the phosphorous contents of the tissue obtained from the liquid and dry fertilizer plots at the three nutrient levels were not consistent. There was a slight tendency, at the first two sampling dates, for the phosphorus contents to be higher in plants growing where dry material was applied. The phosphorus content of oats from the unfertilized plots was lowest in the samples taken June 8 and June 13.

The apparent difference in the uptake of phosphorus in the early stages of growth by plants growing on the dry fertilizer plots over those from the liquid areas may be explained by the difference in placement, with respect to the seed, of the fertilizer. The dry fertilizer was applied in contact with the seed and the liquid was sprayed on the surface of the soil.

TABLE 3

THE EFFECT OF METHOD AND RATE OF APPLICATION OF LIQUID AND DRY FERTILIZERS ON THE YIELD OF GRAIN AND THE PHOSPHORUS CONTENT OF JACKSON OATS AT FOUR STAGES OF GROWTH ON BOYER SANDY LOAM IN JACKSON COUNTY, 1956

Pounds per acre			Bushels per acre		Percent Phosphorus (Oven dry tissue)***							
					June 8		June 13		June 26		July 16	
N	P_2O_5	K_2O	Dry*	Liquid**	Dry	Liquid	Dry	Liquid	Dry	Liquid	Dry	Liquid
25	25	25	54.9	50.8	.210	.212	.237	.184	.241	.233	.195	.264
50	50	50	55.2	60.7	.247	.189	.186	.194	.219	.198	.186	.199
100	100	100	57.5	62.9	.263	.197	.261	.259	.235	.270	.196	.230
No fertilizer			45.0		.191		.189		.231		.225	
L.S.D. (5 percent level)			7.2									

*Dry: applied in contact with seed.
**Liquid: sprayed on the surface of soil before planting.
***Results of the chemical analysis of the tissue were obtained from a composite sample of the four replicates.

Data in Table 4 show that, in general, the yield of oats was higher from fertilized than from unfertilized plots although the difference was not significant at the 5 percent level. In five of six comparisons the phosphorus content of oats was higher from samples taken from Flow Mix plots as compared to those obtained from plots where the dry form was used. Oats from unfertilized plots were lower in phosphorus than the average samples taken from fertilized plots.

The lack of response might be explained by the lateness of the planting date (May 18). The data in Tables 3 and 4 should not be compared because there was 18 days difference in planting time due to untimely rains.

The data in Table 5 show no difference in corn yields from plots receiving either liquid or dry fertilizer. There was, however, a difference in the phosphorus content of the tissue at both sampling dates. The percent phosphorus was higher where liquid fertilizer was used. In the experiment the liquid and dry forms of fertilizer were applied in bands to the side of and below the seed. This eliminated any effect that might be due to differences in the method of fertilizer application.

Yields of corn (Table 6) were higher on the fertilized plots than on the unfertilizer areas. Yields were higher from plots where dry fertilizers were used than where the Flow Mix was applied. No increase in yield was obtained

TABLE 4

THE EFFECT OF FLOW MIX AND DRY FERTILIZER APPLIED AT THREE RATES ON THE YIELD OF GRAIN AND THE PHOSPHORUS CONTENT OF JACKSON OAT PLANTS AT TWO STAGES OF GROWTH, ON BOYER SANDY LOAM IN JACKSON COUNTY, 1956

Pounds per acre			Bushels per acre		Percent Phosphorus (Oven dry tissue)			
					June 26		July 16	
N	P_2O_5	K_2O	Flow Mix*	Dry**	Flow Mix	Dry	Flow Mix	Dry
7.5	30	30	45.3	40.7	.235	.291	.265	.233
15	60	60	46.7	50.9	.300	.231	.310	.235
30	120	120	43.1	45.3	.286	.237	.275	.244
No fertilizer			43.8		.235		.238	

L.S.D. (5 percent level) 10.6

*Flow Mix injected in the soil five days before planting.

**Dry: fertilizer applied in contact with the seed.

TABLE 5

THE EFFECT OF LIQUID AND DRY FERTILIZERS ON THE YIELD OF MICHIGAN HYBRID 250 CORN AND THE PHOSPHORUS CONTENT OF THE TISSUE, AT TWO STAGES OF GROWTH, ON KALAMAZOO SANDY LOAM IN KALAMAZOO COUNTY, 1956

Pounds per acre*			Bushels per acre		Percent Phosphorus (Oven dry tissue)			
					July 2		July 17	
N	P_2O_5	K_2O	Dry	Liquid	Dry	Liquid	Dry	Liquid
60	60	60	67.6	64.7	.315	.370	.300	.374
Significance			N.S.**					

*Fertilizers were applied at planting time in bands two inches to the side of, and two and six inches below the seed.

**N.S. - statistically no significant difference.

Fig. 3. Corn fertilized with liquid and dry fertilizer.


SOLID
FERTILIZER
LIQUID
FERTILIZER

TABLE 6

THE EFFECT OF FLOW MIX AND DRY FERTILIZER ON THE YIELD OF GRAIN AND PHOSPHORUS CONTENT OF MICHIGAN HYBRID 250 CORN TISSUE AT TWO STAGES OF GROWTH, ON KALAMAZOO SANDY LOAM IN KALAMAZOO COUNTY, 1956

Pounds per acre			Bushels per acre		Percent Phosphorus (Oven dry tissue)			
					July 2		July 17	
N	P_2O_5	K_2O	Flow Mix	Dry	Flow Mix	Dry	Flow Mix	Dry
6.25	25	25	55.7	59.5	.270	.345	.271	.271
12.50	50	50	55.4	58.0	.350	.352	.374	.315
25	100	100	56.3	57.1	.325	.341	.374	.335
Check			50.5		.180		.257	

L.S.D. (at 5 percent level) 6.22

*Flow Mix fertilizer injected in the soil before planting corn.

**Dry fertilizer was applied at planting time in bands two inches to the side of, and two and four inches below the seed.

from plots where more than 6:25:25; and 25 pounds per acre of nitrogen, phosphoric acid and potash was applied. The phosphorus content of the corn from plots where dry fertilizer was applied was higher than where Flow Mix was used on the first sampling date. This is explained by the relative position of the bands of dry material, which were two inches to the side and two and six inches below the seed. The Flor Mix fertilizer was applied in bands 14 inches apart and six inches deep. At the time of the second sampling, plants from plots receiving the two highest rates of Flow Mix fertilizer had a higher phosphorus content than those from plots where the same quantity of plant food in the dry forms was used.

On the College Farm the phosphorus content of corn was highest where liquid fertilizer was used (Table 7). However, the difference in yield between plots was 1.9 bushels which was not significant (5 percent level).

No consistent difference in the effect of the two forms of fertilizer on the phosphorus content of sugar beet tissue (Table 8) was observed at any location.

Beets at the Skowton farm where fertilizer was applied were higher in phosphorus at the first two sampling periods than those from the unfertilized plots. The difference tended to disappear at the final sampling date. The sugar beet plants made appreciably less growth on the unfertilized area than where fertilizer was used.

TABLE 7

THE EFFECT OF LIQUID AND DRY FERTILIZER ON THE YIELD OF GRAIN AND THE PHOSPHORUS CONTENT OF MICHIGAN HYBRID 480 CORN TISSUE AT TWO STAGES OF GROWTH, ON METEA SANDY LOAM IN INGHAM COUNTY, 1956

Pounds per acre*			Bushels per acre		Percent Phosphorus (Oven dry tissue)			
					June 25		July 17	
N	P_2O_5	K_2O	Dry	Liquid	Dry	Liquid	Dry	Liquid
50	50	50	71.3	73.2	.211	.275	.220	.270
Significance			N.S.**					

*Fertilizers applied at planting time in bands two inches to the side of, and two and six inches below the seed.

**Statistically no significant difference.

TABLE 8

THE EFFECT OF LIQUID AND DRY FERTILIZERS ON THE PHOSPHORUS CONTENT OF SUGAR BEETS AT THREE STAGES OF GROWTH, ON PARKHILL LOAM IN SANILAC COUNTY, 1956

Date of Sampling	Form of Fertilizer	Percent of Phosphorus (Oven dry tissue)		
		Draher farm	Kreuger farm	Skowton* farm
June 19	Liquid	.368	.357	.361
	Dry	.381	.364	.342
	No fertilizer	-	-	.290
July 10	Liquid	.384	.331	.326
	Dry	.367	.354	.341
	No fertilizer	-	-	.315
July 19	Liquid	.371	.319	.340
	Dry	.324	.315	.311
	No fertilizer	-	-	.333

*30, 120, and 60 pounds of N, P_2O_5, and K_2O per acre were applied in a band two to three inches below the seed to eliminate any differential effect of placement.

Table 9 shows that at all locations plots fertilized with dry fertilizer outyielded those where the liquid form was used. Similarly, the percent apparent purity was highest in samples obtained from the areas receiving the dry fertilizer. The differences in sucrose content were not consistent.

TABLE 9

THE EFFECT OF LIQUID AND DRY FERTILIZERS ON THE YIELD, PERCENT SUCROSE, AND PURITY OF SUGAR BEETS ON PARKHILL LOAM AT THREE LOCATIONS IN SANILAC COUNTY, 1956

Form	Draher farm			Kreuger farm			Skowton farm*		
	Tons per acre	Per-cent sucrose	Per-cent purity	Tons per acre	Per-cent sucrose	Per-cent purity	Tons per acre	Per-cent sucrose	Per-cent purity
Liquid	7.9	18.1	85.0	6.2	18.6	87.0	8.6	18.1	79.0
Dry	9.8	17.7	90.0	7.4	19.5	88.0	11.7	17.8	85.0

*Unfertilized plots not harvested because of low yield estimated at three tons per acre.

SUMMARY

Field experiments were undertaken to determine the comparative effectiveness of liquid and solid fertilizers on the yield and phosphorus content of onions, carrots, table beets, sugar beets, oats and corn.

The results are summarized as follows:

1. Excellent agreement between phosphorus contents of duplicate samples was obtained by the nitric-perchloric-sulphuric acid digestion method of ashing.

2. Carrots, table beets and onions yields were higher on fertilized plots than on unfertilized areas. The percent increase in yields due to fertilizers was highest with onions, intermediate with table beets and lowest with carrots.

3. Significant differences (5 percent level) in yield of onions were obtained between plots fertilized with 800 pounds per acre of liquid fertilizer over those fertilized with the solid form. Plots receiving the 400 pound rate of liquid fertilizer out-yielded those where the same amount of fertilizer in dry form was used. This yield response was not in agreement with the previous year's result.

4. No consistent differences in the phosphorus content of carrots, onions and table beets were obtained from plots where either liquid or solid fertilizers was applied.

A decrease in phosphorus content of carrots was observed with successive sampling dates. Onions growing on the unfertilized plots were lower in phosphorus than those from the fertilized areas at all sampling dates.

5. Higher yields of oats were obtained on plots where fertilizer was used. However, there was no consistent difference that could be ascribed to the form of fertilizer. There was a slight tendency for the phosphorus content to be higher in oats obtained from the liquid fertilizer plots or Flor Mix than from oats growing on plots receiving solid fertilizer.

6. Fertilizer increased the yield of corn. The forms of fertilizer were not materially different in their effect on yield or phosphorus content of the tissue.

7. Sugar beet yields and percent apparent purity of the root were highest on the plots where the solid fertilizer was used at the three locations.

8. No consistent difference in the effect of the two forms of fertilizers on the phosphorus content of sugar beet leaves and percent sucrose of the roots was observed.

9. In general, the effectiveness of the two forms of fertilizer on the yields of the crops investigated is equal, providing the method of placement of the fertilizer is identical.

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Date Due
