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Iowa Soils Need Nitrogen

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IOWA SOILS Need

We are not doing a very good job of keeping up the available nitrogen content in Iowa soils. We could step up our yields and we would get a lot more good from the phosphorus and potassium fertilizers which we use if we had more available nitrogen in our soils.

This is the conclusion we have reached here at the Iowa Station following a good many experiments—some of which were with nitrogen fertilizers, others with phosphorus, potassium and with mixed fertilizers.

Results of the Tests

1. Yields could be increased if we had more available nitrogen in the soil. The fertility of Iowa soils is not being kept up. We have not yet established a system of agriculture which will maintain the fertility of our soils.

2. Unless the supply of nitrogen in the soil is sufficient, we do not get the best response from additions of phosphorus and potassium fertilizers applied to corn and small grains.

3. A lack of available nitrogen is most likely to limit the yield of corn on sandy, light-colored and eroded soils.

4. The need for nitrogen may be satisfied by the use of rotations which provide for the more frequent growing of legumes and by the conservation and use of manure.

5. Phosphorus fertilizer can best be used on the oat crop in which clover is seeded. In that way it is possible to get an increase in three crops—the oats, clover and the corn which follows the clover.

The Plant Food Picture

Just how much does a 100-bushel corn crop take from the soil? It takes about 160 pounds of nitrogen, 125 pounds of potassium and 40 pounds of phosphorus. Putting it another way, to produce 100 bushels of corn the soil must furnish the amount of nitrogen contained in 800 pounds of ammonium sulfate, the amount of potassium in 300 pounds of muriate of potash and the amount of phosphorus in 400 pounds of 20 percent superphosphate. If you have bought fertilizers, you know that's a pretty large bill.

The soils of Iowa have been depleted by heavy cropping and soil erosion to the point where maximum yields of corn cannot be obtained without the addition of some of the plant nutrients which have been removed. Nitrogen, the nutrient used in largest quantity (and probably of greatest importance in Iowa), can be supplied in adequate amounts by growing legumes in the rotation and by the proper use of manure.

Need More Nitrogen

The results of 24 experiments which we conducted in western Iowa in 1944 (see chart on next page) show the importance of nitrogen in producing a high yield of corn. In six of the experiments where corn followed clover the yield was increased 2.5 bushels by the application of 200 pounds of ammonium sulfate (containing 40 pounds of nitrogen) per acre as a side dressing. In 12 fields of corn the second year following clover the yield was increased 5.8 bushels. The average increase in yield on six fields in corn for the third consecutive year was 11 bushels. In other words, the soils became more and more deficient in nitrogen as the number of consecutive corn crops was increased.

The fact that the yields of second and third-year corn fertilized with nitrogen did not equal those of corn following clover was largely because not enough nitrogen fertilizer was added. A good first year's growth of sweet clover may add 80-100 pounds of nitrogen per acre, whereas only 40 pounds of nitrogen were applied in the fertilizer.

Experiments in both 1943 and 1944 on a variety of soils over the state indicate that a lack of available nitrogen in the soil is most likely to limit the yield of corn on sandy soils, the light-colored soils and the eroded soils. The dark colored, relatively level soils contain more nitrogen and are less likely to show a definite need for this nutrient when clover is grown infrequently. The response to nitrogen obtained in 1943 and 1944 un-
doubtless was greater than it would be over a period of years because of the high rainfall in these 2 years.

Where to Use Phosphorus

A good stand and a high yield of clover are important in furnishing a liberal supply of nitrogen for the succeeding corn crop. This means that you should inoculate in all cases and use lime on acid soils. Where phosphate is to be used in the rotation, you may wonder whether you would get more benefit from applying the phosphate to the oats and clover seeding, to the corn or to both.

Since clover generally responds more to phosphate than does corn, however, where the clover shows a good response to phosphate (which would indicate that the soil is low in available phosphorus) or potassium is deficient, the corn following will respond to additional fertilizer applied in the hill or row. In one of our Iowa Station experiments on the Agronomy Farm at Ames, superphosphate applied to oats at rates of 200 and 400 pounds per acre had no apparent residual effect on the first corn crop following the clover. An additional 100 pounds of superphosphate applied in the hill for corn increased the yield 8 bushels per acre.

Much superphosphate is used in the hill for corn. Superphosphate will increase the yield on many of the soils in the state. Judging from the results of over 80 experiments, however, the increase from 100 pounds per acre generally is not greater than 5 bushels and in many cases is not more than 2 bushels. Increases as large as 17 bushels per acre from 100 pounds of 20 percent superphosphate have been obtained in experiments, but such large responses are the exception rather than the rule.

One needs to keep in mind that phosphate won’t be of much value on corn which is suffering from nitrogen deficiency. Only when the corn has a liberal supply of nitrogen can phosphate give its maximum benefit. This is shown in the results of 18 of our experiments where 100 pounds of 20 percent superphosphate per acre were applied to corn fields in western Iowa in 1944 (see chart page 16). These fields may be grouped into two lots—one which showed definite nitrogen deficiency (more than 10 bushels response to nitrogen) and one which showed little nitrogen deficiency (less than 5 bushels response to nitrogen).

Potassium Helps Too

Corn takes a large quantity of potassium from the soil, and responds relatively well to potassium fertilizers. Yield increases up to 38 bushels per acre have been obtained from an application of 100 pounds of muriate of potash to corn grown on high-lime soils. Potassium deficiency is most likely to limit the yield of corn on the high-lime Webster soils of north-central Iowa, the sandy soils, and certain of the Clyde, Floyd and Carrington soils of northeast Iowa.

Most other Iowa soils contain large quantities of easily soluble
or exchangeable potassium and do not show the serious deficiency encountered in some of the high-lime soils. Where 10 pounds of potash have been used, such as in 100 pounds of an 0-20-10 fertilizer, few responses have been over 10 bushels per acre. This amount of potash has given an average increase in yield of approximately 5 bushels per acre in 58 experiments in eastern Iowa conducted during the past five years.

In 26 experiments conducted in 1944 on soils of western Iowa, considered to have higher quantities of available potassium than soils elsewhere in the state, the average response to an acre application of 10 pounds of potash in the row was 1.4 bushels.

As with phosphorus, we found that benefit from potassium is dependent upon an adequate supply of nitrogen.

### Complete Fertilizers—
#### Best Yield in 1944

In general, complete fertilizers containing at least 10 pounds of nitrogen gave larger increases in yield in 1944 than did nitrogen, phosphorus or potassium applied alone. The average acre increases from 39 experiments conducted in 1944 were 3.2 bushels from 100 pounds of 0-20-0, 3.5 bushels from 100 pounds of 0-20-10, 7.5 bushels from 100 pounds of 0-20-10 plus 10 pounds of nitrogen (50 pounds of ammonium sulfate), and 10.5 bushels from 100 pounds of 0-20-10 plus 40 pounds of nitrogen (200 pounds of ammonium sulfate).

Where corn shows a definite need for both phosphorus and potassium, the yield increase from a mixed fertilizer containing both of these nutrients should be larger than the sum of the increases produced by the two fertilizers added singly. You can get the maximum benefits from mixed fertilizers containing phosphorus and potassium only when the soil contains a liberal supply of nitrogen.

It is obvious from the data we obtained that where a real deficiency of nitrogen exists, the 2 to 4 pounds of nitrogen ordinarily applied in 100 pounds of such fertilizers as 2-12-6 or 4-12-4 are not enough. The small quantity of nitrogen may, however, be of advantage where a little more rapid growth of the very young plant is important in determining the final outcome. When the soil is cold and low in nitrogen at the time of planting, the small amount of nitrogen in the fertilizer may satisfy the needs of the corn until the soil supply of available nitrogen becomes adequate for further growth. This condition is found in listed corn more often than in surface-planted corn.

### Costs of Fertilization

In most of our experiments, the amount of fertilizer added has been small compared with the total amounts of fertilizer constituents contained in the corn crop. The cost of fertilizer per acre (except for nitrogen) has been low, and only relatively small increases in yield are needed to make the applications profitable.

The present prices of the fertilizers employed in our experiments with corn are $1.56 per acre for the phosphates, $0.48 for the potash, and $1.18 and $4.73 for the 10 and 40-pound applications of nitrogen, respectively. With corn at $1.00 per bushel, the yield increases required to cover the cost of the fertilizers would be 1.5 bu. for the phosphate, 0.5 bu. for the potash, and 1.2 and 4.7 bu. for the 10 and 40-pound rates of nitrogen.

If the results of all the experiments in 1944 are averaged together, all treatments have returned more value in corn than the cost of the fertilizer. The returns, however, varied considerably with the kind of the soil and the fertilizer used. On soils very definitely deficient in nitrogen, the largest profit was obtained from the treatment of 100 pounds of 0-20-10 plus 200 pounds of ammonium sulfate. The cost of this treatment was $6.77 and the average yield increase on these nitrogen-deficient soils was 18.3 bu. per acre (average of all fields giving a response of 10 bushels or more to nitrogen). On the other hand, the treatment of 100 pounds of 0-20-10 plus 50 pounds of ammonium sulfate was the most profitable on the fields in which corn followed clover. The cost of this treatment was $3.22 and the yield increase was 6.4 bushels. In most seasons, however, the nitrogen applied in addition to 0-20-10 would have less effect on the yield of corn following clover. The most profitable fertilizer to use under these conditions would be 0-20-0 or 0-20-10.

We are certain that many Iowa soils are not giving maximum yields of corn. Experiments with commercial nitrogen fertilizers have shown that the supply of nitrogen often is not enough to produce the highest yields. To obtain such yields, legumes must be grown more frequently, more manure must be applied, or commercial nitrogen fertilizer used to fill the deficit.

If the soil has plenty of nitrogen, both phosphorus and potassium will increase the yields. With the fertility of all the soils built up with good soil management practices, 100-bushel yields of corn should be common on many fields, with 70 or 80-bushel yields on the majority of fields in years with favorable weather conditions.

A machine for harvesting sumac leaves and twigs has recently been developed at the Iowa Station. Sumac has been receiving more attention in the United States since the war began, and while importation of tannin was impossible.