EFFECT OF MINERAL NITROGEN ON THE YIELD AND PROTEIN CONTENT OF FARM CROPS

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The production of mineral nitrogen has been greatly increased in recent years. A large part of this production may now be diverted to fertilizer use, which may make available a larger supply of commercial nitrogen for application on land devoted to general farm crops. There has been a tendency for the selling price of this material to decline. It is the cost and possibility of profit which will be the controlling factor in its use in general farm practice.

Nitrogen fertilizers may have two separate and distinct effects on crops. First, the crop may respond with an increased yield and second, there may be a considerable increased protein content of the crop. Under favorable conditions mineral nitrogen has been found to increase the yield and to some extent, the protein content of grain crops. When applied to hay and pasture grasses, its use is usually accompanied by a large volume of growth and a considerable gain in protein content of the grass.

The effective use of mineral nitrogen in crop production, broadly speaking, depends upon seasonal conditions, soil conditions, and the amounts and manner in which the nitrogen is used.

Soil conditions likely to give large crop response are those lands which have been largely depleted of the natural supply of organic matter and therefore have a low nitrogen-supplying power. Farms which have rather consistently had regular rotation of crops, including liberal additions of legume material to the soil, have been found less responsive to nitrogen fertilizers than soils not adjusted to this advantage.

It is essential to have a proper balance of fertility elements in soils if best results are to be obtained from the use of mineral nitrogen. The effect of this balance may be observed in results from the Enfield and Elizabethtown fields (Table 2). Nitrogen in the form of ammonium sulphate was added to redtop and bluegrass, and increases amounting to 3,000 pounds and 1,650 pounds of hay were obtained on the respective fields. When the same amounts of ammonium sulphate were balanced with applications of superphosphate, the gains in hay yields amounted to 4,770 pounds and 4,150 pounds respectively on the two experiment fields. The lack of balance was also apparent on the Garvis farm (Table 1), where phosphorus and potassium fertilizers gave a 2,350-pound increase in corn yield over the untreated land. When this fertilizer (0-20-20) was balanced with 100 pounds of nitrogen in the form of sodium nitrate, there was an increase in corn yield amounting to 4,250 pounds an acre.

Nitrogen makes up the largest quantity of the several fertility elements taken up by the corn crop. The average amount is 140 pounds of nitrogen in the grain, stalks, and cobs for each 100 bushels of grain under Illinois conditions. Potassium is the second highest of these elements with an average of 112 pounds in the entire growth which goes with 100 bushels of grain. Phosphorus is relatively low with an average of 18 pounds in the grain,

stalks, and cobs. Nearly two-thirds of the nitrogen, 102 pounds, was in the grain. More than twice the amount of potassium, 76 pounds, was in the stalk and cobs as compared to that in the grain, 36 pounds. There was approximately three times as much phosphorus in the grain, 13.4 pounds, as that in the stalks and cobs, 4.4 pounds.

Mineral nitrogen in the form of sodium nitrate applied in addition to phosphorus and potassium (0-20-20) on the Garvis farm (Table 1) gave an increase in total crop of 1,900 pounds an acre. There was a rather significant gain of 14 bushels of grain from this nitrogen treatment. This grain contained 11.0 percent protein compared to 10.5 percent protein in the corn without the nitrogen treatment. This small difference in total protein might be of little significance in the feeding value of the grain, and would therefore add little value to the crop.

The loss of available nitrogen has a depressing effect on corn yield as illustrated by results from the Young farm (Table 1). In this test, 2½ tons of oat straw was spread on the land in November and plowed into the soil the following spring. This application of straw apparently rendered unavailable approximately half of the nitrogen in the soil and, consequently, reduced the total dry matter in the corn crop by 3,550 pounds, or 32 percent. The total nitrogen in the crop was reduced 50 percent, phosphorus was reduced 62 percent, and the amount of potassium by 34 percent. There was a 14-bushel decrease in the grain yield, which contained 29 percent less protein because of the shortage of available nitrogen.

The untreated (none) land on the Young farm (Table 1) was relatively high in available nitrogen because it had been under a system of fallow cultivation through the 1941 season in order to destroy thistles.

The addition of nitrogen fertilizers to various grasses usually results in larger yields and higher protein content. The benefits are usually in proportion to the amount of nitrogen applied, up to a certain limit. At Enfield, where 100 pounds of ammonium sulphate were applied to a redtop sod in April, a hay yield increase of 770 pounds with a protein content of 6.5 percent was obtained. Where 500 pounds an acre of ammonium sulphate were added, the hay yield gained 4,370 pounds and contained 9.4 percent protein. Thus the larger amount of nitrogen produced more hay which had a relatively higher feeding value based on protein content.

The redtop hay yield was increased 3,000 pounds by the addition of 400 pounds of ammonium sulphate, and the protein content was increased 80 pounds a ton over that on untreated (none) land (Table 2). Where 500 pounds of superphosphate were added along with the ammonium sulphate, there was an additional increase of 1,770 pounds of hay but no additional increase in protein. The 1945 season was unusually favorable for the growth of redtop, which may in part account for the large hay yields.

The eroded hill land, on which the Elizabethtown field is located, is very deficient in available nitrogen and phosphorus, and will not grow bluegrass satisfactorily without the addition of these elements in an available form. This soil condition accounts for the rather unusual increase from 250 pounds up to 4,400 pounds of hay an acre where nitrogen and phosphorus (NP) were added to the soil (Table 2). The rather large increase in protein content of the bluegrass, 150 pounds up to 310 pounds at Elizabethtown and

180 pounds up to 308 pounds at Joliet, was due in part to the physiological change in the growth of the grass brought about by the fertilizer treatment. Kentucky bluegrass at the full head stage of growth is usually a stemmy hay, but the nitrogen fertilizer caused the growth to become almost entirely of a leafy nature. This change in growth habit accounts in part for the relatively large gain in total protein in the grass on fertilized land.

The untreated (none) soil on the Joliet field grew satisfactory bluegrass without additional treatment as indicated by the 1,560 pounds as the acre yield. The relatively lower hay yields on the fertilized land of the Joliet field were due in part to seasonal conditions and management difficulties. This fertilized land produced a heavy growth which persisted late in the fall and caused smothering out of the growth, with consequent reduction in yield the following spring.

TABLE 1.—COMPOSITION AND YIELD OF CORN AS AFFECTED BY VARIOUS SOIL TREATMENT ON TWO FARMS, 1942

Soil Treatment	Entire Crop, lbs. an Acre				Grain			
	DM	N	P	K	bu.	Protein %	P %	K %
Garvis Farm								
None.....	7170	94	7	83	73	10.0	.14	.59
PK.....	9520	115	11	96	82	10.5	.20	.50
NPK.....	11420	151	15	130	96	11.0	21	.55
Young Farm								
None.....	11110	151	16	174	77	11.4	.24	.68
Straw....	7560	75	6	115	63	8.1	.11	.72

DM—stalks, grains, cobs.
PK—500 lbs. 0-20-20 fertilizer.
N—625 lbs. $NaNO_3$
Straw—2½ tons oat straw.

TABLE 2.—YIELD AND COMPOSITION OF REDTOP AND KENTUCKY BLUEGRASS HAY AS AFFECTED BY NITROGEN AND PHOSPHATE FERTILIZERS ON THREE FIELDS, 1945

Soil Treatment	Enfield		Elizabethtown		Joliet	
	Hay lbs./A	Protein lbs./ton	Hay lbs./A	Protein lbs./ton	Hay lbs./A	Protein lbs./ton
	Red Top		Bluegrass		Bluegrass	
None.....	3290	132	250	150	1560	180
N.....	6290	212	1850	310	2540	308
NP.....	8060	200	4400	305	2330	300

N—ammonium surphate
Enfield 400 lbs. an acre each year total 800 lbs.
E-town 500 lbs. an acre each year total 2500 lbs.
Joliet 500 lbs. an acre each year total 2500 lbs.

P—20% superphosphate
Enfield total 500 lbs.
E-town total 500 lbs.
Joliet total 750 lbs.