IOWA STATE UNIVERSITY

AGRONOMY
• Crops
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GETTING THE MOST OUT OF N FOR CORN

High profitable yields of corn depend on an adequate quantity of available N (nitrogen), usually more than the soil can supply naturally. The extra N may come from legumes, manure or fertilizer.

We have conducted continuing field research for over two decades comparing the yield response of corn to N from these sources. These research data are the basis for N fertilizer recommendations for corn and for adjustments for N contributions from legumes and manures.

Changing prices of corn and fertilizer N can affect the rate of fertilizer N which gives maximum net profit per acre. The possibility of inadequate supplies of N fertilizer to meet the needs of corn producers may require that less than economically optimum rates—rates which give maximum net profit per acre—of N be applied to some corn acres.

This publication gives current N recommendations for corn and adjustments of those recommendations for legume N and manure N. The effect of different prices of corn and fertilizer N on the economic optimum rate per acre is shown. In the event of inadequate supplies of N fertilizer, we give a method to allocate available N to corn in different crop sequences to get the most out of your N for corn.

YIELD RESPONSE TO N

Results of selected experiments showing the yield response to N rates in recent years are listed in table 1. The continuous corn experiments show large yield responses at the low N rates but with responses occurring up to and beyond 160-pound N rates. Economic analyses of these and other data have shown that optimum rates of N are frequently in the range of 180 to 200 pounds for third year corn or more in years with favorable weather. There are only small differences between preplant and sidedressed applications of N.

The effect of legume N on yield response to fertilizer N is illustrated in table 1 by the data from a rotation and N rate experiment. This and similar experiments at several experimental farms are used to evaluate the quantity of N provided by legumes to following corn crops.

N RECOMMENDATIONS

Nitrogen recommendations in table 2 are given by soil areas which are outlined in figure 1 and apply under the average weather conditions of each soil area and an N to corn price ratio of 1:20.

The recommendations in table 2 for fertilizer N and adjustments for legume N are based on field experiments. These experiments have shown that for a given location, corn grown in a wide range of rotations all fit on the same corn yield response curve to N, regardless of source. The total available N other than that from the soil, may come entirely from legumes, fertilizer, manure or combinations of all three. This is illustrated in figure 2 and is basic to adjusting fertilizer N rates according to need, which will be explained later.

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NITROGEN-CORN PRICE RATIOS

The optimum rate of fertilizer N for corn depends on the yield increase obtained from fertilizer N and the relative prices of N and corn. In past years, the low price of fertilizer N relative to corn resulted in the economic rate of N being close to the rate which gave maximum yield. Due to the low price of N and of corn in past years, a wide range of N rates could have been applied with little effect on net returns due to N (table 3). Application of 140 compared to 220 pounds per acre reduced profit only $3 per acre. Thus, corn price fluctuations had little influence on the recommended optimum rate of N.

Changes in both fertilizer N and corn prices may affect the economic optimum rate. Ratios of selected prices of N to corn are shown in table 4. The effect of changing price ratios on optimum rates is shown in table 5 for corn yield response data obtained from six site-years of preplant application of N. Note that when fertilizer N is 5¢ per pound, increasing the corn price from $1.00 to $3.00 per bushel has little influence on the optimum rate of N. This is because this rate is near the rate which gave maximum yield (195 pounds of N for these data).

However, with corn price kept at $1.00 per bushel and nitrogen price increased from 5¢ to 25¢ per pound, the optimum rate decreased from 180 to 122 pounds per acre. For these data with corn at $1.00 per bushel, each 5¢ increase per pound of N resulted in the economic optimum rate decreasing about 15 pounds per acre. With corn at $1.50, the decrease is 10 pounds; and with corn at $3.00, the decrease is 5 pounds. Note, also, that with a constant price ratio (e.g., 5¢ N and $1.00 corn or 10¢ N and $2.00 corn, both give a ratio of 1:20) the economic optimum rate of fertilizer N remains the same.

ALLOCATION OF INADEQUATE N

If there is inadequate N fertilizer to meet the recommended needs for all corn acres, the amount applied per acre should be that for which the last pound of N added gives equal yield response for each acre of corn on your farm. A method to allocate an inadequate amount of fertilizer N to corn based on need follows:

The number of intended corn acres and the crop sequence is needed. For example:

Acres	Crop Sequence
100	3rd year corn
200	Corn following soybeans
100	Corn following good alfalfa stand

The recommended fertilizer N rate per acre is needed for each crop sequence and the total amount of required N is determined. Continuing the example:

Acres	Crop Sequence	Recommended lbs. N/A	Required lbs. N
100	3rd year corn	190	19,000
200	Corn following soybeans	150	30,000
100	Corn following alfalfa	50	5,000
400 A		Totals	54,000 lbs.

The total amount of N wanted is 54,000 pounds. If this amount can be obtained, there is no problem. But, assume you can get only 40,000 lbs. of N. This would result in a shortage of 14,000 lbs. (54,000 - 40,000).

How can this amount of N be used to give the greatest yield increase or to maximize net returns? The answer is to divide the shortage of 14,000 lbs. of N by the 400 corn acres, giving 35 lbs. of N per acre. This amount is subtracted from each recommended rate. Continuing the example:

Acres	Crop Sequence	Recommended lbs. N/A	Allocated lbs. N/A
100	3rd year corn	190	155
200	Corn following soybeans	150	115
100	Corn following alfalfa	50	15

The total amount allocated is equal to 40,000 lbs. N. This will put each corn acre at the same point on the corn yield response curve shown in figure 2. If some acres are fertilized more and some less than that just suggested, the yield gained from those acres receiving more N will be less than the yield lost from those acres receiving less N. The 15 pounds of N would not be profitable to apply alone and would probably be contained in a broadcast application along with phosphorus and potassium or in a starter fertilizer. Thus, the 40,000 pounds of N could be reallocated according to the method described. With no N applied to the 100 acres of corn following alfalfa, the reduction per acre would be 30 pounds. This would allow 160 pounds of N per acre for the third year corn and 120 pounds of N per acre for corn following soybeans.

The key to any approach is to determine at an early stage (1) the number of corn acres, (2) the crop sequence of those corn acres, (3) the optimum rate of N per acre, (4) the total amount of N required, and (5) the total amount of N available from the supplier.

MANAGEMENT FACTORS

Plant population. If N rate per acre is reduced below optimum levels, reduce the plant population accordingly. Use these guidelines: for average plant populations of 18,000 to 20,000 plants per acre, reduce plant population by 1,000 plants per acre for each 20-pound N reduction; for plant populations of 21,000 to 23,000, reduce by 1,000 plants per acre for each 15-pound N reduction; and for plant populations of 24,000 to 25,000, reduce by 2,000 plants per acre for each 20-pound N reduction. Do not adjust stand levels below 16,000 plants per acre.

Early planting. Corn planted close to May 1 or earlier has a greater response to N than corn planted after mid May.

Sidedressing N. Sidedressed N is a good method of N application (see table 1). If N is to be sidedressed, consider: equipment availability in your area, row spacing, and row curvature in contour corn. Availability of N fertilizer for sidedressing should be determined. June 15 to 20 is about as late as normally planted corn can be sidedressed.

Weed and insect control. Weeds which compete for nutrients and moisture must be eliminated. Control of insects which feed on corn roots is also necessary for efficient use of nutrients.

Manure application. Most of the nitrogen and all of the phosphorus and potassium needs of corn can be met with effective manure application if manure is available. The application needs to be uniform and incorporated into the soil. Estimate tons applied per acre and subtract 5 pounds of N per ton of manure from the N needs of corn. See ISU Pamphlets 552 and 429 (Rev.) for information on nutrient content of animal manures.

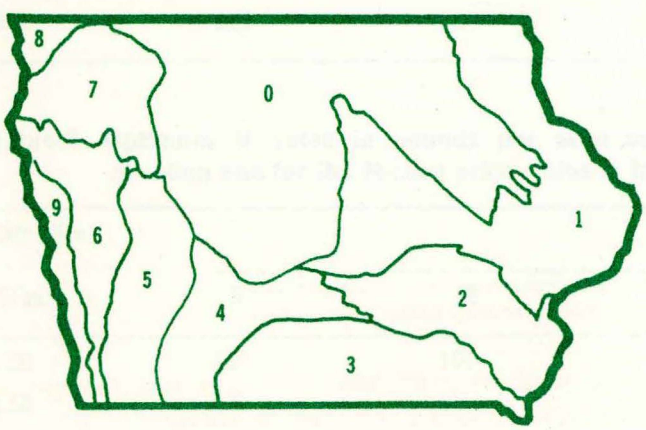

Fig. 1. Major soil areas of Iowa corresponding to areas listed in table 2.

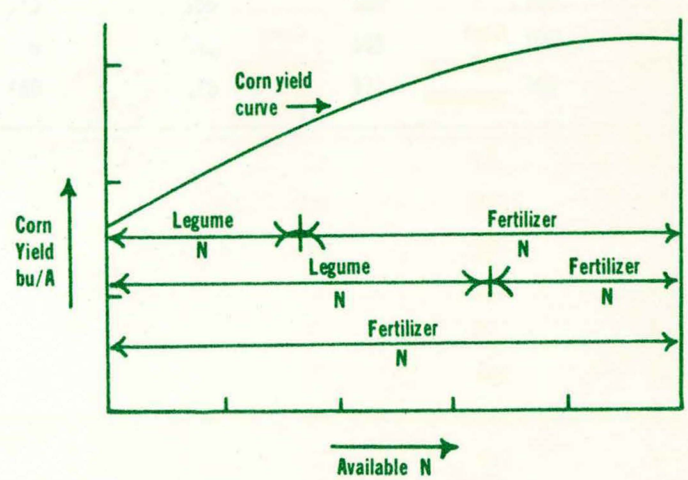

Fig. 2. Common nitrogen response curve illustrating that a similar yield of corn can be obtained with various combinations of legume and fertilizer N.

Table 1. Corn yield response (bu/A) due to N obtained in experiments conducted by Iowa State University.

	N rates, lbs/A					
Experiment	**0**	**40**	**80**	**160**	**200**	**320**
			(bu/A)			
N-K[1] (1967-73)	69	95	123	145		150
Time of application (1968-70)						
Preplant NH_3[1]	74	100	125	145		
Sidedress NH_3[1]	74	97	127	145		
Preplant N[2] (6 site-years)	81	105	124	144	146	
NPK lime[3] (1963-71)	81		103	109		
N-lime-stand-hybrid[4] (1963-70)	66		111	126		
Rotation fertility[1] (1961-71)		**0**	**60**	**120**		
Continuous corn		56	104	123		
CCCO		66	104	124		
CSbCO		103	124	132		
CCOM		108	122	129		
CCOM		134	136	138		
COMM		139	140	141		

[1]Experiment conducted at Clarion-Webster Experimental Farm.
[2]Experiments from 3 locations.
[3]Experiment conducted at Galva-Primghar Experiment Farm.
[4]Experiment conducted at Shelby-Grundy Experiment Farm.

Table 2. Recommendations of fertilizer N for each major soil area for continuous corn and adjusted recommendations for previously grown legumes. The nitrogen to corn price ratio is 1:20.[1]

Soil area	Corn following soybeans	Corn following good alf.	Corn following fair alf.	2nd yr. corn after good alf.	Cont. 3rd yr. corn	Cont. corn with 10 tons manure[2]
0	150	50	90	160	190	140
1	160	60	100	170	200	150
2	160	60	100	170	200	150
3	130	30	70	140	170	120
4	150	50	90	160	190	140
5	140	40	80	150	180	130
6	130	30	70	140	170	120
7	110	0	50	120	150	100
8	90	0	30	100	130	80
9	150	50	90	160	190	140

[1]Adjustments of N recommendations for noncontinuous corn are: for corn following soybeans in a corn-soybean rotation, subtract 40 lbs. or 1 lb. per bushel of soybeans; for first-year corn following 50-100% legume meadow, subtract 140 lbs.; following 20-50% legume meadow, subtract 100 lbs.; for second year corn following 50-100% legume meadow, subtract 30 lbs. Cattle or hog manure from feedlots should be credited for at least 5 lbs. of immediately available N per ton.

[2]Subtract 5 lbs. N for each additional ton of manure applied.

Table 3. Increase in net returns per acre from increased corn yields due to N, $1.00 per bushel of corn and 5¢ per pound of N. Data are from six site-years of preplant application of N.

N, lbs/A	0	40	80	120	140	160	180	200	220	240
Increase, bu/A	0	24	43	56	60	63	65	65	64	62
Net $ increase/A	0	22	39	50	53	55	56	55	53	50

Table 4. Selected N to corn price ratios.

Corn price	N price, ¢/lb.					
$/bu.	5	10	15	20	25	30
1.00	1:20	1:10	3:20	1:5	1:4	3:10
1.50	1:30	1:15	1:10	2:15	1:6	1:5
2.00	1:40	1:20	3:40	1:10	1:8	3:20
2.50	1:50	1:25	3:50	2:25	1:10	3:25
3.00	1:60	1:30	1:20	1:15	1:12	1:10

Table 5. Optimum N rates in pounds per acre using the yield data from six site-years of preplant application and for the N-corn price ratios in table 4.

Corn price	N price, ¢/lb.					
$/bu.	5	10	15	20	25	30
1.00	180	166	151	137	122	108
1.50	185	175	166	156	146	137
2.00	188	180	173	166	159	151
2.50	189	183	178	172	166	160
3.00	190	185	180	175	171	166

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