THE EFFECTS OF RATE AND TIMING OF NITROGEN APPLICATIONS ON THE YIELD AND NITROGEN RECOVERY OF IRRIGATED CORN

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High crop yields require that adequate amounts of N be present and available to the root at the times it is needed to support growth. However, for a production system to be efficient in the use of the nitrogen and to minimize any potential adverse environmental effects, care must be used to minimize loss during the growing season and minimize amounts of residual N remaining in the soil at the end of the cropping season. This requires that proper N rates be applied and that the N be applied in such a way to maximize uptake and minimize loss.

Unfortunately, applying all N prior to planting irrigated corn on sandy soils can lead to losses prior to uptake by mechanisms such as leaching or denitrification. Therefore, management practices such as split or delayed applications or the use of nitrification inhibitors have been used to increase the length of time which the N remains in the soil available to the corn root. Recent work has shown that some hybrids differ in the period when they take up nitrogen; some hybrids tend to take up essentially all N prior to grain fill while others take up large amounts of N during the grain fill period. Thus, a nitrogen fertilization program designed for optimum efficiency should reflect all these soil and plant conditions.

The objectives of this study were to look at a number of combinations of nitrogen rate and times of application, monitor their suitability as fertilization alternatives by determining their effects on corn growth and yield, and monitor the amounts of N entering the plant and remaining in the soil at the end of the growing season.

Materials and Methods

A field experiment was conducted at the Southwest Purdue Ag Center near Vincennes In in 1984 and 1985. The soil used was an Ayrshire fine sandy loam (Aeric Ochraqualf). This soil is characterized by a sandy surface layer about 18 inches thick over a sandy clay loam subsoil. A solid set sprinkler irrigation system was used which provided a uniform water distribution area in the center four rows of each 12 row plot. Irrigation was scheduled using a "checkbook" method, backed up by tensiometers.

The research area had been cropped to soybeans in both 1982 and 1983. The area was moldboard plowed each spring and a seed bed prepared and herbicides incorporated using a disk and a rotera. Herbicides used were atrazine and Sutan. Corn was planted at a population of 28,100 seeds per acre in 30 inch rows using a John Deere 7000 planter. Six gallons of 10-34-0 fertilizer was applied per acre at planting to stimulate early growth.

Nitrogen was applied as granular urea at rates of 0, 75, 150 and 225 lbs N/acre. Four application systems were used at the 150 and 225 lb N rates. These consisted of all N preplant (pre), all at the V-6 growth stage (delay), a split system with 1/3 preplant and 2/3 at the V-12 stage (2-way), and a four way split system with 75 lbs N preplant and the balance divided evenly and applied at V-12, tasseling and tasseling plus 14 days (4-way). Preplant applications were incorporated with secondary tillage and all other treatments were broadcast on the soil surface and irrigated in. All plots received equal amounts of irrigation water and treatments were applied to the same plots each year. The experimental design used was a randomized complete block with six replications.

Plant growth measurements made included earleaf N and plant height at silking, final population and lodging at harvest, grain and stover yields, and grain N content. In addition, in the fall after harvest and again in spring prior to planting, soil samples were taken to five feet to determine the residual NH_4^+ and NO_3^- present.

Results and Discussion

In 1984, the first year of the experiment, no response to N rates above 75 lb/acre was observed. In the second year of the study, however, response to 150 lb N/acre was observed. This would indicate that a substantial amount of N was available to the crop initially from the previous soybean crops and that N loss was relatively low during the 1984 and 1985 growing seasons. Total N recovered in stover and grain showed no differences between plots receiving N fertilizer in 1984, but significant rate effects in 1985 as the residual N was depleted. Estimates of fertilizer N recovery made by measuring total N uptake in stover and grain and subtracting values for the check plots showed efficiency values ranging from 45 to 132% in 1984, and 28 to 73% in 1985.

Nitrogen levels remaining in the soil in the fall ranged from 29 lb N in the top five feet of soil for the check plots in 1985 to 258 lb N remaining in the 225 lb, 4-way split treatment. In general, the more N applied and the later it was applied, the higher the residual soil N in the fall. However, resampling these plots in the spring showed that a substantial amount of residual N was no longer present in the root zone. It is probable that it leached below the root zone in this permiable soil over winter.

The results from this study raise some important points. First, applying the appropriate N rate is critical; extra N above that needed for crop growth will be left in the root zone and be subject to loss. Second, timing must be considered carefully; it's possible to apply N too late to be effectively utilized by the crop, as in the 4-way split applications in this study. These points are particularly important given the high rainfall and warm winter temperatures common to southern Indiana. Any residual N remaining in the soil after harvest will normally be lost through leaching to depths below the root zone or out through tile lines. This can contribute to NO_3^- enrichment of ground and surface waters.

Table 1. Effect of N rate and timing on corn grain yield and N recovery in the plant, 1984 and 1985 average.

N Treatment	Grain Yield	N Recovery in the Plant
	bu/acre	lb/acre
0 check	91 d	87 c
75 pre	148 c	146 b
150 pre	181 ab	199 a
150 delay	179 ab	187 a
150 2-way	168 b	185 a
150 4-way	173 ab	183 a
225 pre	182 ab	203 a
225 delay	180 ab	199 a
225 2-way	187 a	198 a
225 4-way	177 ab	197 a

Table 2. Effect of N rate and timing of N applications on NH_4^+ and NO_3^--N recovered in the soil, 1984 and 1985 average.

N Treatment	Fall Soil N	Spring Soil[1] N
	lb N/acre	
0 check	44	40
75 pre	58	54
150 pre	101	66
150 delay	78	56
150 2-way	76	50
150 4-way	114	66
225 pre	106	65
225 delay	95	66
225 2-way	123	81
225 4-way	230	80

1 Spring 1985 data only. Analysis of spring 1986 samples is incomplete at writing.

PROCEEDINGS

OF THE SIXTEENTH NORTH CENTRAL EXTENSION-INDUSTRY SOIL FERTILITY WORKSHOP

OCTOBER 29-30, 1986

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