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Rate and Fall versus Spring Application of Urea Nitrogen for Corn

J. BENTON JONES, JR.

D. J. HOFF

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Ohio Agricultural Experiment Station
Wooster, Ohio

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Rate and Fall versus Spring Application of Urea Nitrogen for Corn[1]

J. BENTON JONES, JR., AND D. J. HOFF [2]

INTRODUCTION

The need for nitrogen fertilization is increasing as more farmers devote a larger percentage of their acreage to corn, and strive to increase production efficiency.

Urea is a popular nitrogen fertilizer in Ohio and ranks high in tons of material sold as compared to other nitrogen fertilizer sources.

Little data is available in Ohio with regard to the use of urea as a nitrogen fertilizer for corn. Objective of this study was to secure information regarding the effect of time and rate of application of urea upon corn yield.

UREA AS A FERTILIZER MATERIAL

Urea is a white crystalline material produced synthetically from ammonia (NH_3) and carbon dioxide (CO_2) under high pressure. Urea's 45 percent nitrogen content and good physical condition has contributed to its acceptance as a nitrogen fertilizer. In Ohio, urea ranks third in sales for nitrogen containing fertilizers.

Urea can be absorbed directly by the plant, however the conversion of urea to ammonium carbonate $(NH_4)_2CO_3$ is quite rapid and absorption of nitrogen by the plant from a urea fertilized soil probably occurs in the ammonium (NH_4) or nitrate (NO_3) form. Hydrolysis of urea is temperature dependent, the rate of reaction decreasing with decreasing temperature. Applied when the soil temperature is less than 40° F., urea is slowly hydrolyzed to ammonium carbonate by the urease enzyme found in soil organic matter. Further nitrification to the nitrate form is almost completely prevented at the normally low winter soil temperatures. As urea is slowly hydrolyzed the ammonium ion is readily adsorbed onto the soil colloids and is not easily removed by leaching.

GENERAL PROCEDURE

Yield data from comparisons of rate and time of application were obtained from approximately 150 experimental sites established during the four years, 1958 to 1961, by High School Vocational Agricultural teachers and students. About 200 students and their teachers were involved in establishing, maintaining and harvesting these plots. Instructions and fertilizer materials[3] were supplied each cooperator. The majority of these demonstration plots were placed within established corn fields. Except for the fertilizer applied, the plots were managed similarly as the entire field. Soil samples and leaf tissue were collected by each coöperator for analysis, and the final yield checks were made by the cooperators. Statistical and chemical analyses were made by the agronomy staff at the Ohio Agricultural Experiment Station, Wooster, Ohio. This report summarizes all yields obtained during the past four years from these demonstration plots. Each demonstration plot contained 4 to 6 individual plots 50 feet long and 4 corn rows wide. The treatments were not replicated, each plot representing single treatments. Ear leaf samples were collected at the time of silk and yield checks were made using the two center rows in each plot. Sufficient length of row was harvested to obtain one-hundredth of an acre of yield sample.

COMPARISON OF FALL VERSUS SPRING APPLICATION OF UREA FOR CORN

1. Introduction

In common practice, broadcast applications of nitrogen for corn are made in the spring. In many areas of the state, early spring weather conditions may delay the essential preplanting operations, resulting in late planting. Applying the needed nitrogen in the fall or winter when the ground is in a suitable condition would assist the farmer in meeting a specific time schedule in the spring. However, nitrogen is not readily stored in soil. The common nitrogen carriers are either in the ammonium form (such as ammonium sulfate and anhydrous ammonia) or nitrate form (such as sodium or potassium nitrate) or both (such as ammonium nitrate). When applied in the fall, nitrate is readily leached from the soil during the winter and early spring months. The

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[2]Assistant Professor and Associate Professor respectively, Ohio Agricultural Experiment Station, Wooster, Ohio.

[3]All fertilizer materials were supplied by American Cyanamid Company.

ammonium ion, on the other hand, is a cation and is adsorbed on the clay colloids and is not removed from the soil by leaching. With increasing soil temperature in the spring, ammonium is converted to nitrate by soil bacteria. The conversion of ammonium to nitrate can result in sizeable losses of nitrogen from the soil by leaching. In addition, runoff and erosion can remove from the soil sizeable quantities of nitrogen irrespective of form.

All of the nitrogen in urea appears in the ammonium (NH_4) form. When urea is hydrolyzed to ammonium carbonate, it behaves like any ammonium-containing fertilizer. The purpose of this study was to determine the effect on yield of fall (about November 15th) and spring (about April 1st) applications of urea for corn.

2. Method

Urea was broadcast at two rates, 40 and 80 lbs. of nitrogen per acre in the fall (about November 15, 1959) and spring (about April 1, 1960). The plots were not replicated and one plot received no nitrogen either in the fall or spring. Thirteen demonstration plots were established by Vocational Agriculture teachers in some of the large corn producing areas in Ohio. Corn was planted by each cooperator, and except for the nitrogen variable, the cooperator used the same cultural and row fertilizer practices followed in the remaining portion of the corn field. Each demonstration consisted of five 22' x 50' plots, each plot representing one treatment. The two center corn rows from each plot were harvested for yield. The yield results are presented in Table 1.

3. Results

For corn following grain (usually corn), both rates of nitrogen applied either in the fall or spring increased corn yield, but the largest increases were produced by the spring application.

The yield responses noted in this experiment were similar to yield responses obtained with other fall applied ammonium-nitrogen fertilizer materials, indicating that urea is no better or no worse than these other materials when fall applied. Although, statistically, the yields are not significantly different between fall and spring applied urea, the yield trend suggests that a portion of the fall applied nitrogen is not contributing to the yield and may have been leached away.

Not all locations experienced the same reduction in yield indicating that not all of the applied urea nitrogen was lost. In some instances, very little fall applied nitrogen was lost and all the nitrogen applied contributed to the yield obtained. This indicates that under certain soil and climatic conditions, very little fall applied nitrogen may be lost. Any condition which would slow nitrification and reduce leaching and erosion losses should prevent sizeable losses of fall applied nitrogen. However, losses usually occur and should be carefully considered when making fall nitrogen applications.

TABLE 1.—Comparison of Corn Yields for Fall[1] and Spring[2] Applied Urea-Nitrogen at Two Rates. Vo-Ag Demonstration Plots 1959—1960

CORN FOLLOWING GRAIN

Treatment	lb. N/A	Yield[3] bu/A	Increase Over Check bu/A
No Nitrogen	None	76-*	--
Fall	40	85*	9
Fall	80	94*	19
Spring	40	93*	18
Spring	80	97*	23
L.S.D. (.05)		13	
C.V. 13.7%			

CORN FOLLOWING LEGUME

Treatment	lb. N/A	Yield[4] bu/A	Increase Over Check bu/A
No Nitrogen	None	105*	--
Fall	40	121*	16
Fall	80	120*	15
Spring	40	120*	14
Spring	80	134*	29
L.S.D. (.05)		16	
L.S.D. (.01)		22	
C.V. 11.2%			

[1] Urea was applied about November 15, 1959.

[2] Urea was applied about April 1, 1960.

[3] Mean of 7 yield determinations.

[4] Mean of 6 yield determinations.

*Duncan multiple range test.

COMPARISON OF RATES OF UREA-NITROGEN FERTILIZATION WITH AND WITHOUT ROW FERTILIZER

1. Introduction

Many farmers are relying entirely upon application of row fertilizer to supply all of the nitrogen required by the corn. Usually the amount of nitrogen applied in the row seldom exceeds 20 to 40 pounds of nitrogen per acre, which is insufficient when corn follows a non-legume crop. Farmers are beginning to recognize that additional nitrogen is needed for optimum yields when corn follows a non-legume. The suitability of urea as a supplemental nitrogen fertilizer was determined in the following series of field experiments.

2. Method and Results

Urea was broadcast prior to plowing at two rates, 150 pounds of nitrogen per acre in 1958 and 100 pounds of nitrogen per acre in 1959 on a series of demonstration plots established by Vocational Agriculture students and teachers. Each demonstration consisted of six plots, 22' x 50', each plot representing an individual treatment. Thirty-nine demonstrations were set out in 1958 and 52 in 1959.

In 1958, no row fertilizer was applied; all the phosphorus and potassium was broadcast and plowed down with the nitrogen. However, in 1959, row fertilizer was applied (since no broadcast application of P and K was made) which generally included some nitrogen (10 to 20 lbs. N per acre). The yield results are given in Table 2.

The responses to the applied urea nitrogen indicate the need for supplemental nitrogen if best yields are to be obtained, particularly when the preceding crop is a non-legume. Also a very large nitrogen yield response was obtained for third year corn in the 1959 demonstrations.

TABLE 3.–Average Corn Yield As Affected By Various Combinations of N, P, and K. Soil Fertility Demonstrations – 1958[2].

Treatment[1]	Lb. N/A Applied	Yield bu/A	Yield Inc. Over Check bu/A
No Fertilizer Applied	0	90	--
PK	0	88	-2
NK	150	104	14
NP	150	103	13
NPK	150	106	16
L.S.D. (.05)		12	
L.S.D. (.01)		15	
C.V. 26.5%			

[1]65 lb. P/A and 124 lb. K/A.

[2]39 locations.

In 1958 (Table 3), a comparison between various combinations of applied fertilizers of nitrogen, phosphorus, and potassium indicated that nitrogen was the element responsible for all yield increases. Nitrogen with either phosphorus or potassium or phosphorus and potassium gave significant increases over the check of phosphorus and potassium yield; the combination of all three nitrogen, phosphorus and potassium giving the best yield.

In 1960 and 1961 comparisons were made between yield responses to supplemental nitrogen with and

TABLE 2.–Yield Response of Corn to Supplemental Urea-Nitrogen, When Following Corn or Grain or When Following a Legume-Grass Meadow. Vo-Ag Demonstration Plots 1958–1959.

Previous Crop	Number of Locations	−N bu/A	+N bu/A	Yield Inc. with N bu/A
1958				
Corn or Grain	19	85	115[1]	30
Legume-Grass Meadow	20	98	111[1]	13
L.S.D. (.05) 9 bu/A				
1959				
Corn or Grain	31	76	100[2]	24
Legume-Grass Meadow	31	87	93[2]	6
Second Year Corn	20	72	100[2]	28
Third Year Corn	7	55	100[2]	45
L.S.D. (.05) 8 bu/A				
L.S.D. (.01) 11 bu/A				

[1]150 lb. N/A

[2]100 lb. N/A

TABLE 4.–Comparisons of Yields of Corn for Urea-Nitrogen Applied With and Without Row Fertilizer. Vo-Ag Demonstration Plots 1960.

Treatment	Supplemental Lb. N/A	Row Fertilizer		Yield + bu/A	Increase Over Check bu/A
Check	None	None		68	--
Nitrogen	80	None		76	8
Row Only	None	Regular Farm Practice*		83	15
Nitrogen + Row	80	Regular Farm Practice*		98	31
			L.S.D. (.05)	10	
			L.S.D. (.01)	13	
C.V. 16.3%					

+Mean of 14 yield determinations.

*Average rate of fertilizer applied: 16 lb. N/A, 20 lb. P/A., 35 lb. K/A.

TABLE 5.–Comparison of Yields for Rate of Urea-Nitrogen With and Without Row Fertilizer for Corn Following Grain and Legume. Vo-Ag Demonstration Plots 1961.

Treatment	Lb. N/A Applied	Row Fertilizer Applied	Yield bu/A	Increase Over Check bu/A
		CORN AFTER GRAIN[1]		
Check	None	None	74	-
Nitrogen Only	80	None	82	+ 8
Row Only	None	Regular Farm Practice*	84	+10
Nitrogen Plus Row	40	Regular Farm Practice*	86	+12
Nitrogen Plus Row	80	Regular Farm Practice*	94	+20
Nitrogen Plus Row	120	Regular Farm Practice*	99	+25
		CORN AFTER LEGUME[2]		
Check	None	None	94	-
Nitrogen Plus Row	40	Regular Farm Practice*	98	+ 4
Nitrogen Only	80	None	100	+ 6
Nitrogen Plus Row	80	Regular Farm Practice*	102	+ 8
Row Only	None	Regular Farm Practice*	103	+ 9
Nitrogen Plus Row	120	Regular Farm Practice*	108	+16
C.V. 14%		Treatment L.S.D. (.05)	6	
		Treatment L.S.D. (.01)	8	

[1]Yield mean of 15 observations.

[2]Yield mean of 19 observations.

*Average rate of fertilizer applied: 19 lb. N/A, 25 lb. P/A, 29 lb. K/A.

without row fertilizer, the row fertilizer supplying the needed phosphorus and potassium[4]. In 1960, each demonstration consisted of four plots 22' x 50', each plot representing a single treatment. Eighty pounds of nitrogen per acre was applied to two of the plots. The amount and type of row fertilizer applied were according to the cooperators' normal practice. The yield results are given in Table 4 (1960).

In 1961, each demonstration consisted of six plots 22' x 50', each plot representing a single treatment. Nitrogen as urea was applied at four rates (0, 40, 80, and 120 lbs. N per acre) with row fertilizer. One plot received row fertilizer only, another plot received nitrogen only and one plot was left unfertilized.

In 1960 (Table 4), urea-nitrogen alone did not significantly increase yield over the check yield, mainly due to a lack of sufficient phosphorus and potassium. Row fertilizer alone increased the yield over the check yield 15 bushels per acre while the combination of both urea-nitrogen (80 lbs. N per acre) and row fertilization resulted in a 30 bushel yield increase over the check yield. Neither nitrogen alone nor the row fertilizer alone was providing sufficient fertilizer nutrients to obtain the best yield.

Similar results were obtained in 1961 (Table 5). Irrespective of the previous crop (grain or legume), both row fertilizer plus supplemental urea-nitrogen were needed to obtain the best yield. However, previous crop did influence the degree of the supplemental urea-nitrogen yield response. Best yields were obtained at the highest rate of nitrogen fertilization.

SUMMARY

Urea, with its high nitrogen content (45 percent) and physical form, make it a suitable fertilizer material.

In this report, yield responses were given (1) using urea in fall versus spring application comparisons and (2) using urea as a supplemental nitrogen fertilizer for corn. Although urea was not compared with other nitrogen sources, the yield responses were such to indicate its value as a nitrogen fertilizer.

In fall-spring application comparisons, a portion of the nitrogen applied is lost during the winter months when urea is fall (about November 15) applied for corn the following spring. The fall applied nitrogen is probably lost in several ways depending on the time of application, climatic conditions and extent of leaching. In some individual instances, no appreciable quantities of nitrogen were lost when urea was fall applied. No appreciable loss is probably the exception rather than the rule. Except under unusual conditions a portion of the fall applied nitrogen will be lost from the soil. Urea behaves similarly to other ammonium-nitrogen fertilizer when fall applied.

Corn, either in continuous rotation or following a non-legume crop, requires sizeable quantities of nitrogen for optimum yield. Results indicate that from 80 to 120 pounds of nitrogen per acre are required for best yields. Such quantities of nitrogen cannot be easily applied as row fertilizer and are generally broadcast prior to plowing or planting. Best responses were obtained when suitable quantities of phosphorus and potassium were also applied. Row application of a complete fertilizer plus supplemental urea-nitrogen gave the best yields over either row fertilizer alone or supplemental urea-nitrogen alone. Urea was found to be a suitable nitrogen fertilizer. Economic yield responses were obtained using urea as a supplemental nitrogen fertilizer. Although comparisons were not directly made with other nitrogen fertilizers, the yield responses obtained with the use of urea were similar to yields obtained in other experiments using other common nitrogen sources.

ACKNOWLEDGMENTS

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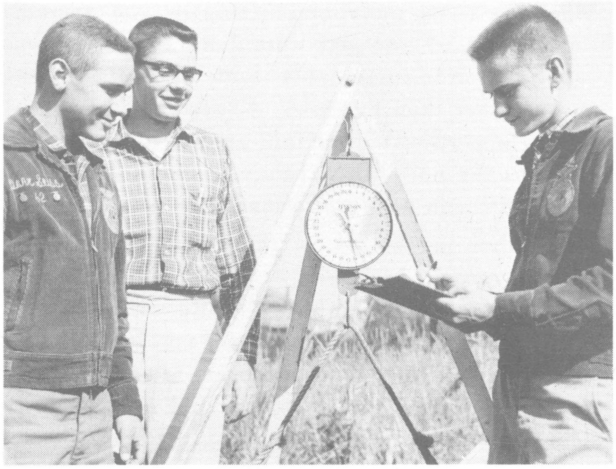
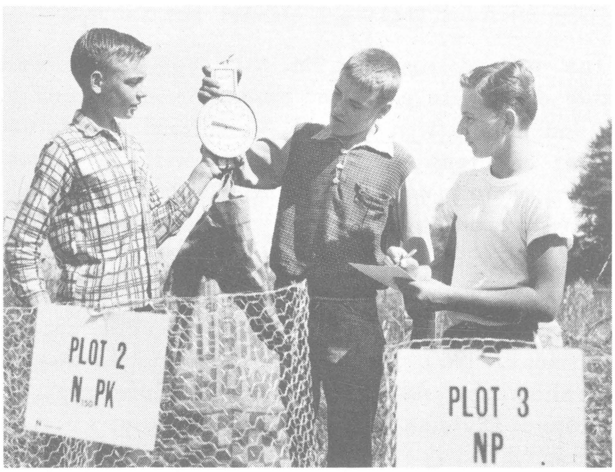
[4]The method of applying phosphorus and potassium is not to be considered a critical aspect of the data presented. Row application was used because it was a convenient method of application.



High School Vocational Agricultural Students Weighing Corn from Demonstration Plots. Hayesville, Ohio. 1960.

John Watkins, High School Vocational Agriculture Teacher and Bill Roberts Checking Ear Size of Corn from Demonstration Plot. Prospect, Ohio. 1959.



Checking Weight of Ears taken from a Demonstration Plot at Croton, Ohio. 1959.

Harvesting Demonstration Plot at Croton, Ohio. Center Willis Fravel, Vo-Ag Teacher with Two Students. 1959.