EFFECT OF NBPT-AMENDED UREA AND UAN ON NO-TILL CORN IN SOUTHERN ILLINOIS[1]

E.C. Varsa, J.M. Jemison, M.W. Osborn, A.K. Leis, S.W. Hnetkovsky, and N. Jan[2]

ABSTRACT

Field evaluations of the urease inhibitor N-(n-butyl) thiophosphoric triamide (NBPT) have been extensively conducted across the USA with encouraging results. Most response data collected to date has been with corn. In this report results from 7 years of experiments at two southern Illinois locations (Belleville and Carbondale) are presented. NBPT addition to broadcast-placed urea, when evaluated across N rates and locations, gave no-till corn yield increases averaging 8.4 bu/ac in 13 experiments. For dribble placement of urea the response to NBPT was 12.0 bu/ac for 9 experiments across the two locations. Ear leaf N composition was also increased by NBPT treatment of urea by 0.16 and 0.21 percent for broadcast and dribble placements, respectively, for the above-mentioned experiments. Corn yield responses to NBPT treatment of urea-ammonium nitrate (UAN) solutions were much smaller. In 8 experiments, broadcast UAN amended with NBPT resulted in an average corn yield increase of 2.3 bu/ac across the two locations. In 13 experiments in which dribble-placed UAN amended with NBPT was evaluated, yield increases of 3.3 bu/ac were obtained compared to non-treated UAN. Ear leaf N was also increased by the presence of NBPT in UAN but by less than 0.10 percent for either placement method.

Commercial availability of NBPT is anticipated in 1995 under the registered trade product name of AgrotaiN™. The International Minerals and Chemical Corporation - Agrico Chemical Group is currently undertaking product development.

INTRODUCTION AND OBJECTIVES

N-(n-butyl) thiophosphoric triamide (NBPT) is a potent urease inhibitor that has been extensively evaluated under field conditions in the USA since 1984. Lowered ammonia volatilization losses from surface-applied urea has been shown to be an outcome of urea treatment with NBPT (Beyrouty et al., 1988). In a summary of 78 field trials conducted from 1984-1989 across the USA, Hendrickson (1992) reported an average corn yield increase of 6.6 bu/ac with NBPT addition to urea and 2.7 bu/ac for NBPT-amended urea-ammonium nitrate (UAN) solution from trials that were on sites responsive to nitrogen. Subsequent field results have been encouraging and product development of NBPT has advanced such that commercial availability is anticipated in 1995. NBPT

[1]Presented at the Twenty-Third North Central Extension-Industry Soil Fertility Conference, October 27-28, 1993. St. Louis, MO.

[2]Associate Professor and former Graduate Assistants, Plant and Soil Science Dept., Southern Illinois University, Carbondale, IL.

will be marketed as the registered trade product AgrotaiN™ by the International Minerals and Chemical Corporation (IMC)-Agrico Chemical Group (Sutton, 1993).

The objectives of this report are to summarize the results of NBPT-treatment of urea and UAN on no-till corn yields and ear leaf N composition in southern Illinois. Results from 43 field experimental comparisons are presented and represent results that may be typical of soils in southern Illinois and in adjacent states.

MATERIALS AND METHODS

Field experiments with NBPT were conducted in 1985 and 1987 to 1992 at the Southern Illinois University Belleville Research Center and the Carbondale Agronomy Research Center. Soils at the two locations have a pH range of 6.0 to 6.8 and organic matter content ranging from 1.2 to 1.8 percent. All experiments were conducted on sites that had previously been in corn and no-tillage practices were used during each experiment. Nitrogen sources (as urea or UAN) without and with the inhibitor were surface-applied as broadcast or dribble placements within 2 to 3 weeks following corn emergence. Dribble placement of N was in narrow (1 to 2 inch-wide) bands about 4 to 6 inches from the corn rows.

Most all inhibitor comparison results reported herein represent means over 2 or 3 N rates, such as 75 and 150 lbs N/ac or 80, 120, and 160 lbs N/ac. Occasionally, only a single, moderate rate of N was employed (ex. 120 lbs N/ac), especially if placement or inhibitor rate effects were evaluated. In the initial years of study, NBPT was applied at generally higher rates than in later studies. In the 1985 studies, NBPT was coated on urea at a rate of 0.92 percent (w/w). NBPT rates of 0.25 and 0.50 percent (w/w) were used in 1987 and 1988 experiments with urea and were denoted as 1X and 2X rates in those experiments. In 1989 to 1992 studies, NBPT rates were gradually reduced from 0.30 percent in 1989 to 0.25 percent in 1992. For experiments with UAN, NBPT was dissolved in the N solution to achieve a 2.0 lbs a.i./ac rate in 1985, 1987, and 1988 and a 1.0 lb a.i./ac rate for 1989 to 1992.

For all experiments a randomized complete block design was employed with all treatments replicated 4 to 6 times.

In the summarization of the yield and ear leaf N response data from NBPT-treatment of urea (in 1987 and 1988), only the 1X NBPT rate was used in the evaluation. This allowed for a more conservative interpretation of that data.

RESULTS AND DISCUSSION

NBPT Treatment of Urea

For broadcast placement of urea, NBPT treatment resulted in a yield increase in 4 of 7 experiments at Belleville and 5 of 6 experiments at Carbondale (Figure 1). These responses were the result of comparison of NBPT-treated urea at the 1X rate with non-treated urea. Comparing yields across all 7 experiments at Belleville, NBPT treatment resulted in a yield increase that averaged 6.3 bu/ac, whereas a yield increase of 10.7 bu/ac was obtained

at Carbondale from the 6 experimental comparisons (Table 1). Across both locations, the average yield increase for broadcast placement of NBPT-treated urea compared to non-treated urea was 8.4 bu/ac. In these same experiments ear leaf N composition was found to increase by 0.16 percent from NBPT use (Table 1).

Dribble placement of urea fertilizers tended to increase yield responses from NBPT addition moreso than broadcast placement of NBPT-treated urea. Comparing non-treated urea with NBPT treatment at the 1X rate, yield increases averaged 14.0 bu/ac at Belleville and 9.5 bu/ac at Carbondale (Figure 2 and Table 1). Positive yield responses to NBPT were obtained in all 5 experiments at Belleville and in 3 of 4 experiments at Carbondale. Averaged across both locations (9 experiments), NBPT use with dribble-placed urea increased yield by 12.0 bu/ac and enhanced ear leaf N compositions by 0.21 percent (Table 1). In studies where the 2X NBPT rate was evaluated, (Figures 1 and 2), a greater yield benefit was usually observed, relative to the 1X rate, but the increased yield was not determined by the product developers to be cost-effective relative to the increased product cost.

The substantial yield responses from NBPT treatment of urea were associated with lengthy durations (7 to 10 days) of little or no rainfall following fertilizer application. It is during such periods that ammonia volatilization losses from the hydrolysis of urea would have likely been reduced by NBPT. When treatment application was followed within a day or two by a substantial rain (> 0.5 in.), then usually only small or no yield benefits ensued from NBPT use.

The higher yields from dribble placement of NBPT-treated urea compared to broadcasting were probably a result of concentrating the same amount of inhibitor to a smaller soil surface area thereby effectively increasing the inhibitor concentration in zone of application.

NBPT Treatment of UAN Solutions

Small but mostly consistent yield increases were observed at Belleville with broadcast placement of NBPT-treated UAN compared to non-treated UAN (Figure 3). The average yield increase, over 4 experiments, was 4.3 bu/ac (Table 1). However, the yield response to broadcast placement of NBPT-treated UAN, compared to non-treated UAN, at Carbondale was less than 1 bu/ac when averaged over 4 experiments. Ear leaf N was also increased by less than 0.10 percent by NBPT treatment of UAN at either location when averaged over all experiments (Table 1).

Corn yield response to dribble placement of NBPT-treated UAN tended to be greater than those obtained from broadcast placement of the inhibitor with UAN. At Belleville, in 6 experiments, NBPT-inclusion with UAN gave an average yield increase of 5.4 bu/ac (Figure 4). At Carbondale, in 7 experiments, the inhibitor treatment resulted in an average yield increase of 1.6 bu/ac (Table 1). At both locations ear leaf N was increased by less than 0.05 percent by the inhibitor addition to the UAN.

The generally much smaller yield increases obtained from NBPT treatment of UAN compared to inhibitor treatment of urea was probably a result of the urea composition difference in UAN compared to granular urea. Most UAN

solutions contain only about one-half of its N as urea-N. Therefore, only one-half of the N would be expected to gain benefit from the NBPT presence. The ammonium nitrate portion would be unaffected by NBPT. Furthermore, especially with broadcast placement, the fertilizer solution and inhibitor would be diluted by its intimate contact with the residues and soil surface, diminishing its effectiveness.

ACKNOWLEDGEMENTS

Funding support from the Allied Chemical Corporation, EniChem Americas, Inc., Agrico Chemical Co., and the Fluid Fertilizer Foundation was gratefully appreciated during various phases of this research.

REFERENCES

Beyrouty, C.A., L.E. Sommers, and D.W. Nelson. 1988. Ammonia volatilization from surface-applied urea as affected by several phosphoroamide compounds. Soil Sci. Soc. Am. J. 52:1173-1178.

Hendrickson, L.L. 1992. Corn yield response to the urease inhibitor NBPT: five-year summary. J. Prod. Agric. 5:131-137.

Sutton, Allen R. 1993. Personal communication. International Minerals and Chemical Corporation (IMC)-Agrico Chemical Group. Henderson, KY.

Table 1. The effect of NBPT-treated urea and urea-ammonium nitrate (UAN, 28% N) solution on no-till corn yield and ear leaf N composition as affected by placement at the Belleville Research Center and Carbondale Agronomy Research Center of Southern Illinois University. A summary of 43 experimental comparisons (1985-1992).

N Source, Placement, & Location	Yield			Ear Leaf N		
	-NBPT	+NBPT	(Diff.)	-NBPT	+NBPT	(Diff.)
	bu/ac			%		
Urea-Broadcast						
Belleville (7 expts)	104.0	110.3	(+6.3)	2.36	2.54	(+0.18)
Carbondale (6 expts)	84.0	94.7	(+10.7)	2.18	2.31	(+0.13)
Ave. (13 expts)	94.7	103.1	(+8.4)	2.27	2.43	(+0.16)
Urea-Dribble						
Belleville (5 expts)	91.2	105.2	(+14.0)	2.26	2.49	(+0.23)
Carbondale (4 expts)	77.5	87.0	(+9.5)	2.05	2.23	(+0.18)
Ave. (9 expts)	85.1	97.1	(+12.0)	2.17	2.38	(+0.21)
UAN Solution-Broadcast						
Belleville (4 expts)	101.5	105.8	(+4.3)	2.55	2.64	(+0.09)
Carbondale (4 expts)	104.2	104.5	(+0.3)	2.48	2.55	(+0.07)
Ave. (8 expts)	102.9	105.2	(+2.3)	2.52	2.60	(+0.08)
UAN Solution-Dribble						
Belleville (6 expts)	110.3	115.7	(+5.4)	2.59	2.63	(+0.04)
Carbondale (7 expts)	100.0	101.6	(+1.6)	2.49	2.53	(+0.04)
Ave. (13 expts)	104.8	108.1	(+3.3)	2.54	2.58	(+0.04)

Figure 1. No-Till corn yield response to broadcast placement of NBPT-treated urea compared to non-treated urea at Belleville and Carbondale, 1985-92.

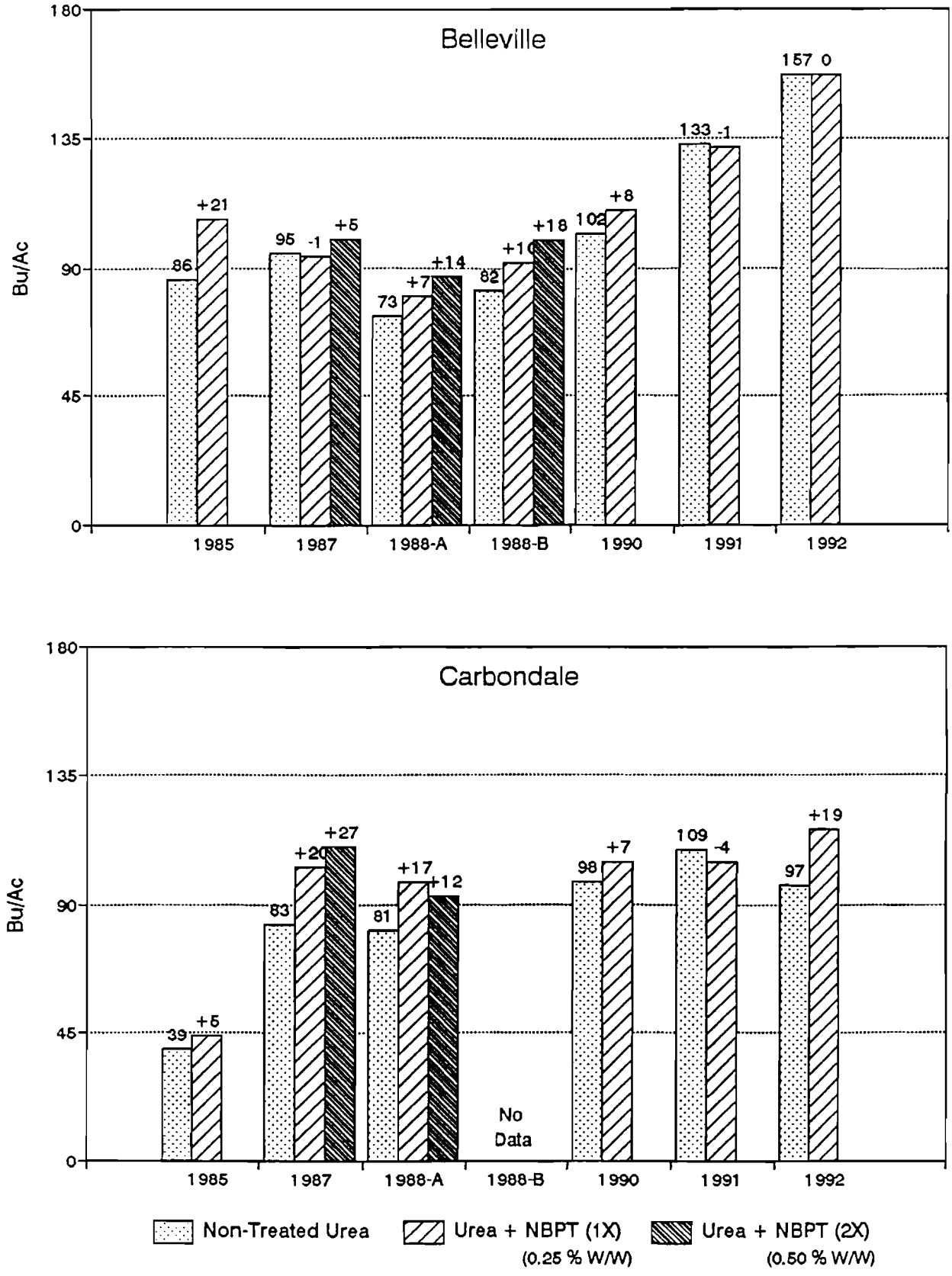


Figure 2. No-Till corn yield response to dribble placement of NBPT-treated urea compared to non-treated urea at Belleville and Carbondale, 1985-1991.

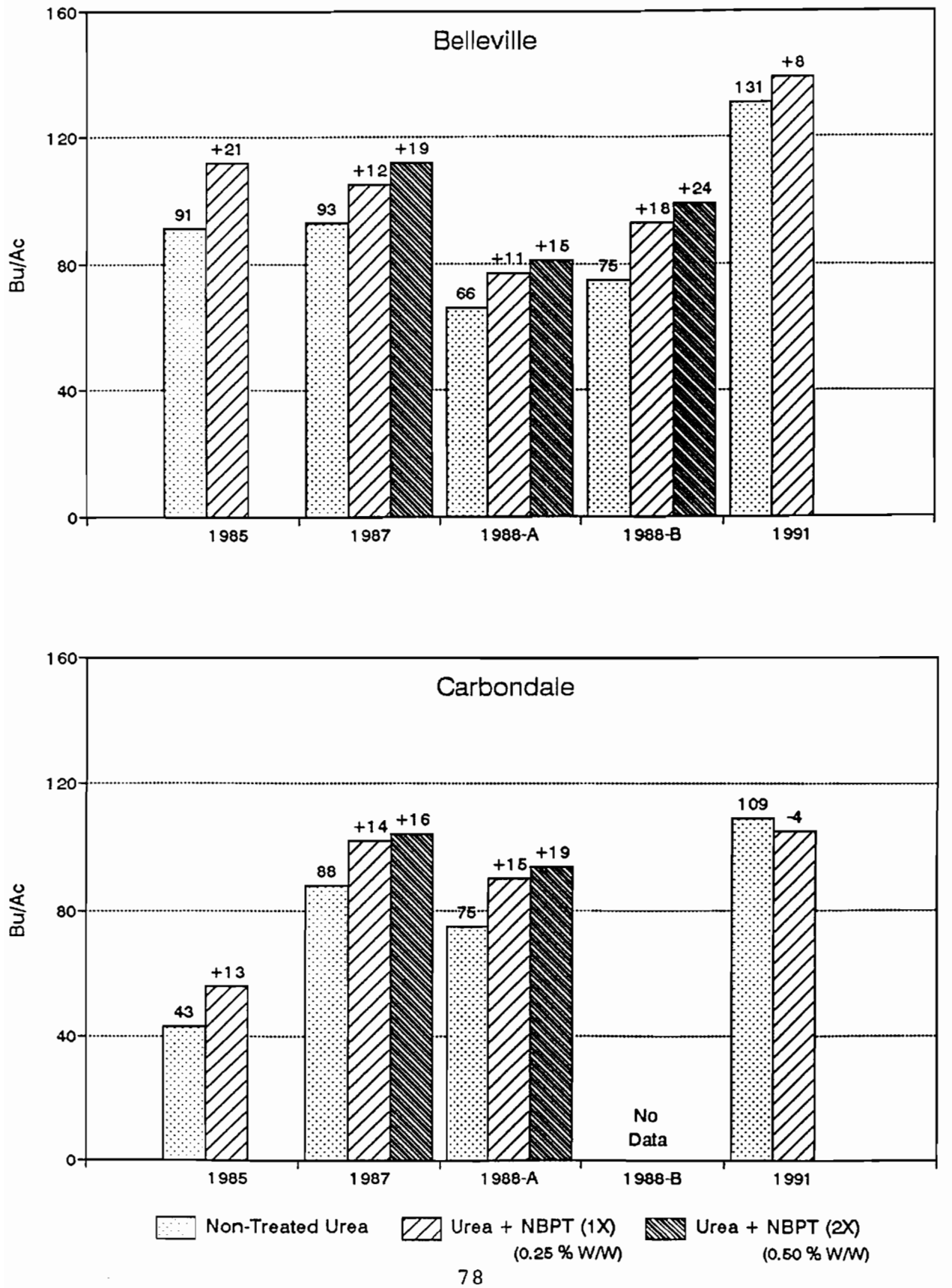


Figure 3. No-Till corn yield response to broadcast placement of NBPT-treated UAN compared to non-treated UAN at Belleville and Carbondale, 1985-91.

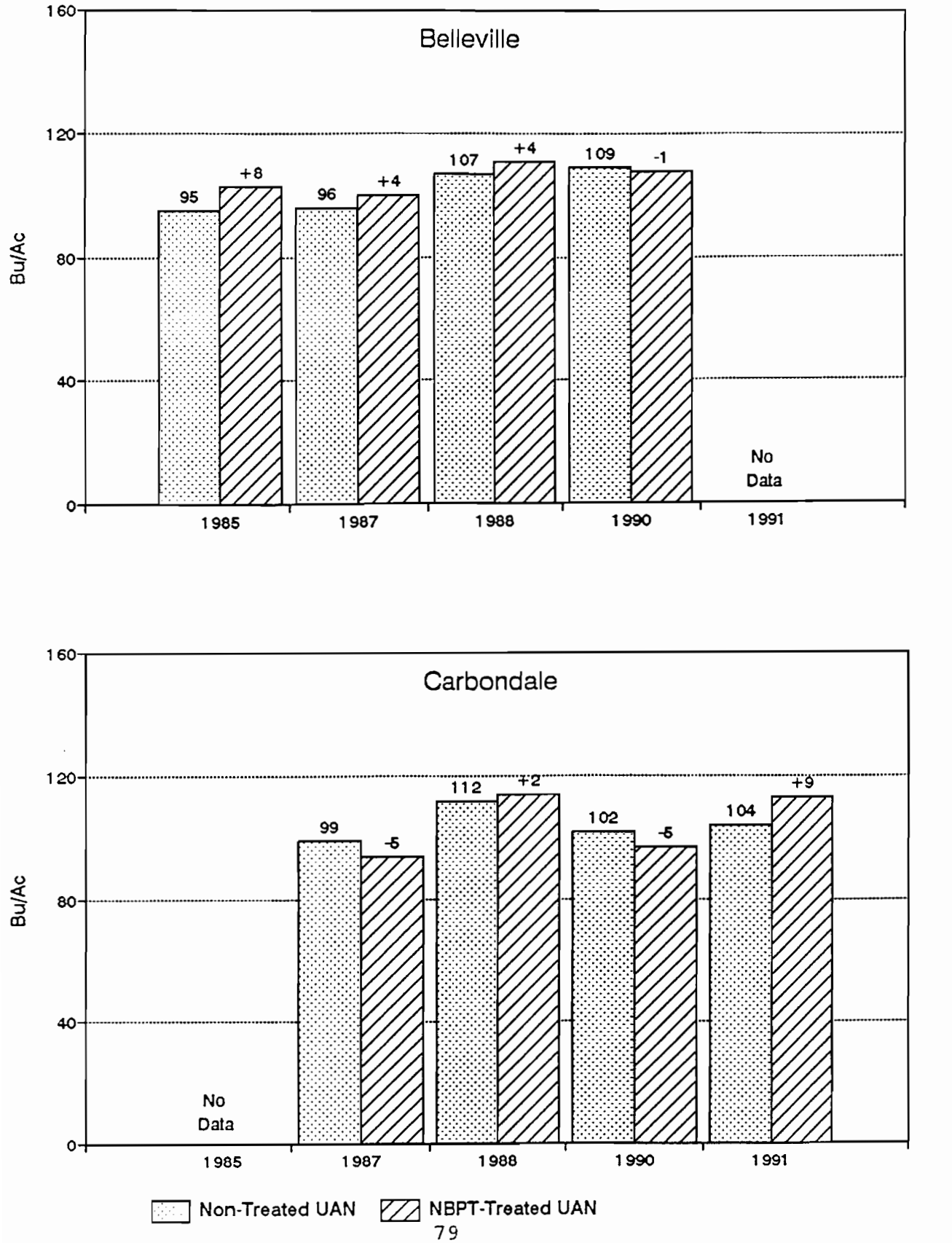
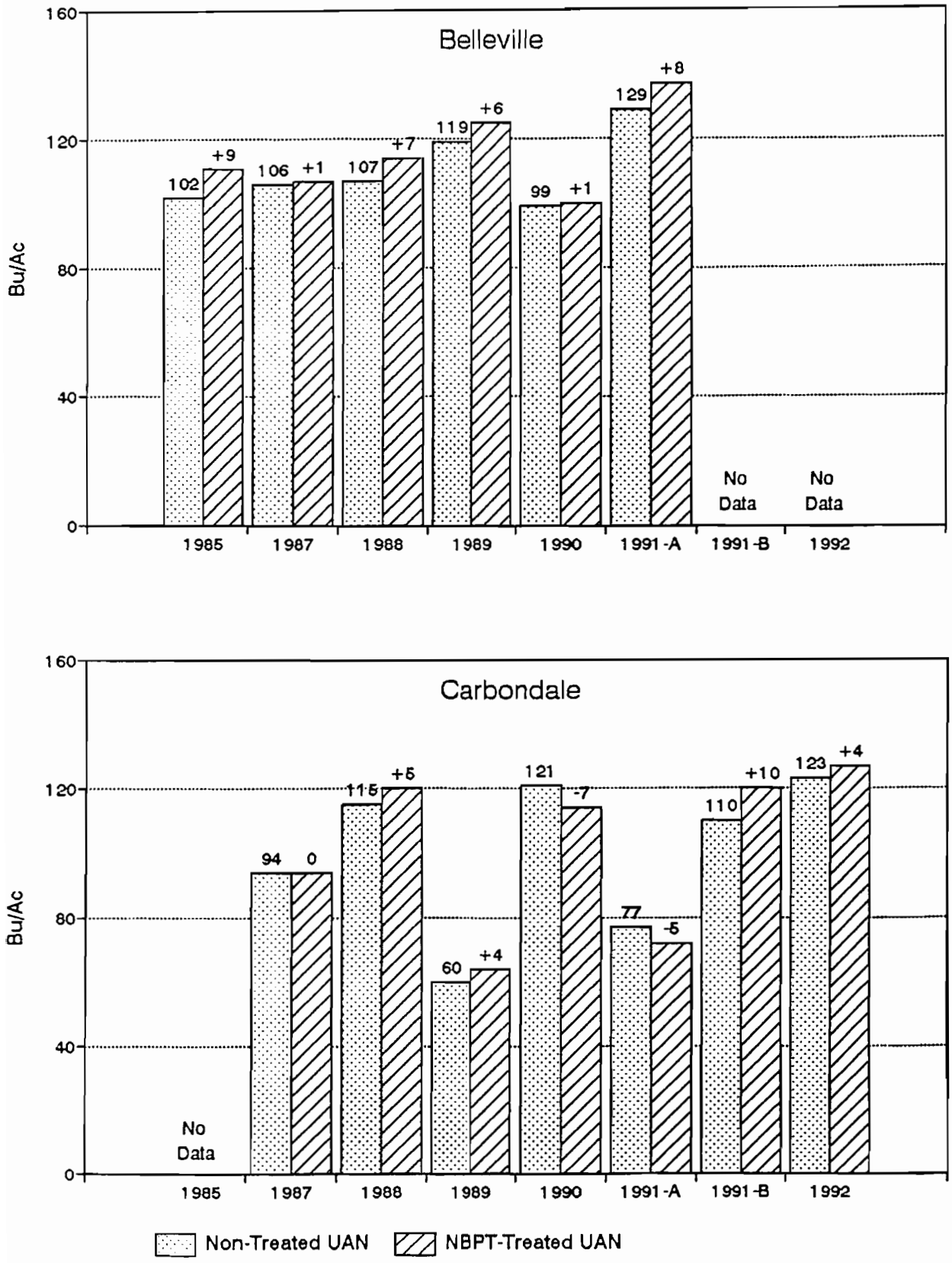


Figure 4. No-Till corn yield response to dribble placement of NBPT-treated UAN compared to non-treated UAN at Belleville and Carbondale, 1985-1992.



PROCEEDINGS OF THE TWENTY-THIRD

NORTH CENTRAL EXTENSION - INDUSTRY

SOIL FERTILITY CONFERENCE

October 27-28, 1993, Holiday Inn St. Louis Airport

Bridgeton, Missouri

Volume 9

Program Chairman and Editor:

Dr. Lloyd Murdock
University of Kentucky
Research and Education Center
P.O. Box 469
Princeton, KY 42445