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Do Nitrogen Fertilizer Sources and the Timing of Application Affect Winter Wheat Yields and Profit?

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The cost of commercial nitrogen (N) fertilizers has been increased to a very high level due to high cost of natural gas, which is the main energy source for manufacturing N fertilizers. It is important to know how to compare different N sources and their impact on crop yields and farm profit. Figure 1 shows the unit prices of N for 4 common nitrogen fertilizers surveyed recently. Nitrogen from anhydrous ammonia is the cheapest while N from UAN (urea-ammonium nitrate solution) is the most expensive source.

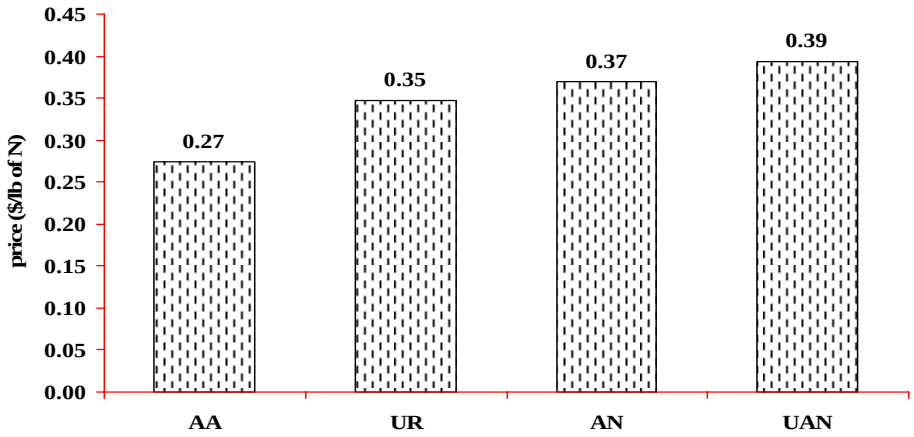

Figure 1. Current cost ($/lb of N) of different nitrogenous fertilizers in Oklahoma (AA: anhydrous ammonia 81-0-0 $450/ton; UR: urea 46-0-0 $320/ton; AN: ammonium nitrate 34-0-0 $252/ton; UAN: Urea ammonium nitrate solution 32-0-0 $220/ton).

Experiment 505 was established in the fall of 1970 under conventional tillage on a Grant silt loam. The source of nitrogen (N) includes anhydrous ammonia (AA), ammonium nitrate (AN), urea (UR), and sulfur coated urea (SCU) applied at 0, 30, 60, 120 and 240 lbs. N per acre annually. Split application of AN and UR has also been implemented. Sixty pounds of P_2O_5 and K_2O are also applied annually to supply phosphorus and potassium needs. The data from this experiment is used here to illustrate the effect of N sources, rates and time of application on yields and profits. Figure 2 shows the last 4 years' grain yield response of winter wheat to four sources and rates of nitrogen fertilizers. At the lowest rate of nitrogen (30 lb/ac) grain yield did not differ among the fertilizer sources. Differences among fertilizer sources were found at higher

rates. In general, grain yield decreased when the nitrogen rates increased from 60 to 240 lb/ac. This suggests that 60 lb/ac. N plus soil residual N were sufficient for wheat at this site.

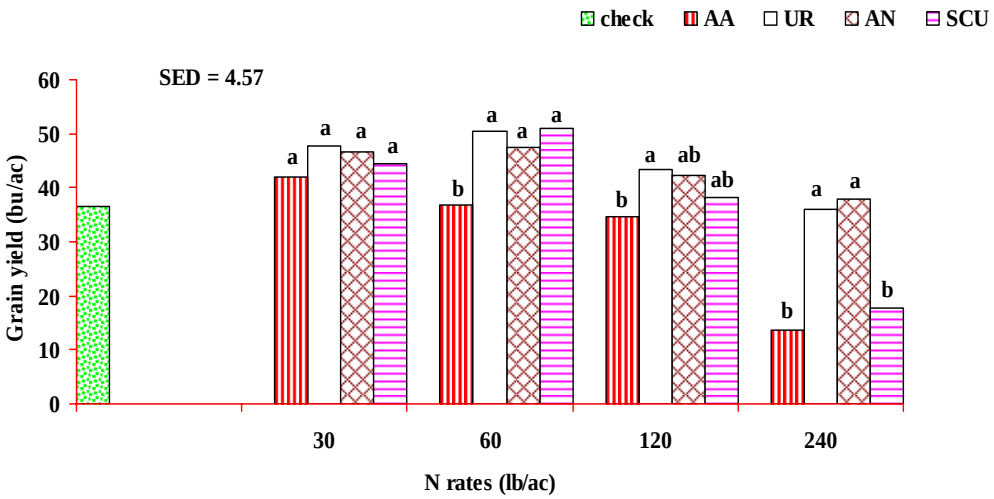

Figure 2. Response of wheat grain yield (bu/ac) to sources and rates of nitrogen for data averaged over 4 years (2001-2004) at Lahoma, OK. Within each N rate, letters followed by the same letter were not different from each other at significance level of 0.05.

This trend was generally true for the entire 34-year experiment (Figure 3). Those yield decreases with increases in N rates could be due to increased soil acidity over time. The acidity problem has been corrected with liming recently. Therefore, it is critical to lime acid soil in order to maximize crop yields and farm profit.

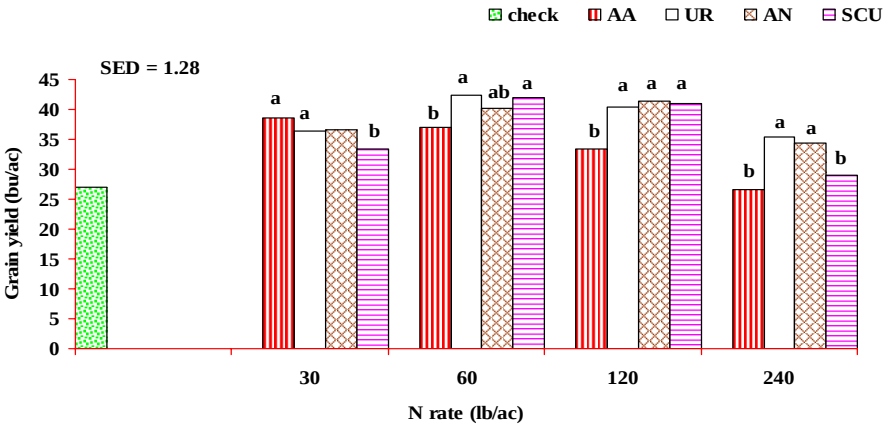

Figure 3. Response of wheat grain yield (bu/ac) to sources and rates of nitrogen for data averaged over 34 years (1971-2004) at Lahoma, OK. Within each N rate, bars followed by the same letter were not different from each other at level of significance of 0.05.

The optimum N rate for this experiment was 60 lb/ac plus residual soil nitrate-N, which was obtained after fitting yield response model. The net benefit obtained by the different sources and times of applications, ignoring other production costs, is shown in Figure 4. The relative profit of pre-plant applied N has the following trend: anhydrous ammonia > Urea > ammonium nitrate. Urea showed a significant difference in net benefit when split applied four times (pre-plant, Sep.16, Jan.1 and Feb. 15) and split between pre-plant and on Feb.15 (i.e. 2-split) compared with ammonium nitrate.

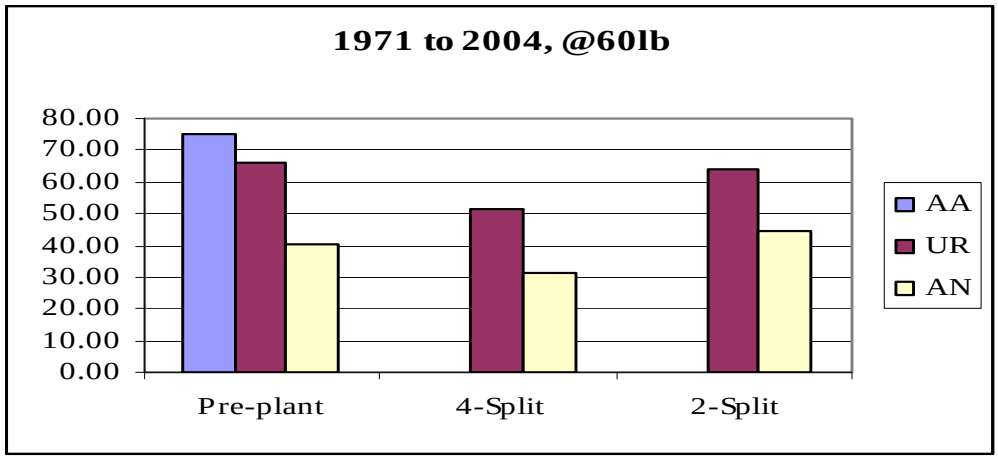

Figure 4. Net benefit ($/ac) of different sources and application times of fertilizer nitrogen for data averaged over 33 years at an N rate of 60 lb/ac at Lahoma, OK. The calculation of net benefit assumed a wheat price of $3/bu fertilizer costs from Figure 1, and $3/acre for each split application. Where AA, UR, and AN denote anhydrous ammonia, urea and ammonium nitrate; 4-Split denotes split application of N pre-plant, Sep. 16, Jan. 01 and Feb. 15 while 2-Split denotes N application pre-plant and Feb. 15. Within the same time of N fertilizer application, bars followed by the same letter were not statistically different from each other at significance level of 0.05.

In conclusion, no differences among N sources were found at 30 lb/ac. The optimum N rate over the last 4 years was 60 lb/ac N. At 60 lb/ac N or higher, AA had lower grain yields than other N sources but better relative profit than other N sources. Soil acidity can be a problem with high rates of N application.