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COMPARISON OF METHODS AND RATES OF NITROGEN APPLICATION IN WHEAT

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The efficiency of two nitrogen sources, urea and slow-release, sulfur-coated urea (SCU), was evaluated using different rates and application methods during 1976-77 on Chenab-70 wheat on a clay loam soil at the University of Agriculture, Faisalabad. A randomized complete block design, with 12-m^2 plots and four replications was used. The higest rate, 112 kg N ha^{-1} increased plant height and fertile tillers per unit area, more than other treatments. In general, banding gave greater yield than broadcasting or broadcasting and incorporating nitrogen regardless of source or rate of application. Urea nitrogen was used more efficiently than slow-release SCU.

Key words: Wheat, Urea, Sulfur-coated urea, Banding, Broadcasting, Broadcasting and Incorporating

INTRODUCTION

Wheat is well adapted to a wide range of climatic conditions and has a high yield potential when managed properly. Inadequate soil fertility often limits its high production potential. The best way to get a better yield of plant food material is the efficient use of the nutrients applied.

The commonly used nitrogen fertilizer such as urea, quickly releases all the nitrogen which is made rapidly available for plant use, while sulfur-coated urea (SCU) releases nitrogen slowly resulting in a regular supply being maintained during the whole growth period. SCU minimizes losses of nitrogen due to leaching and denitrification.

Extensive experiments have been conducted to compare fertilizer application methods on winter wheat [2,11]. Better yields were reported when nitrogen and phosphorus were placed in the root zone as compared to nitrogen applied broadcast. Weidmann [1] did not find deep placement of fertilizer as effective as broadcast application and incorporation into the soil in increasing yield. Rind *et al.* [3] stated that SCU gave better yields than ordinary urea both in greenhouse and field tests. In contrast, Bhatti [5] reported that urea was more effective than SCU. These contradictory findings indicate that further research is needed to evaluate, how wheat can use nitrogen efficiently. Therefore, this paper presents the results of the influence of different sources, rates, and application methods of nitrogen on wheat yield and its yield components.

MATERIALS AND METHODS

The efficiency of two nitrogen sources, urea and slow-release sulfur-coated urea (SCU), was evaluated using different rates and application methods during 1976-1977 on Chenab-70 wheat on a clay loam soil at the University of Agriculture, Faisalabad. The experiment was laidout in a randomized complete block design in 12-m^2 plots with four replications. The soil analysis before planting indicated 650 ppm nitrogen, 8.5 ppm available phosphorus and pH of 7.8. The following treatments of nitrogen were applied.

0 (control)
112 kg ha^{-1} urea banded
112 Kg ha^{-1} SCU banded
56 kg ha^{-1} urea banded
56 kg ha^{-1} SCU banded
56 kg ha^{-1} urea broadcast
56 kg ha^{-1} SCU broadcast
56 Kg ha^{-1} urea broadcast and incorporated
56 Kg ha^{-1} SCU broadcast and incorporated

Phosphorus was applied at 56 kg ha^{-1} as triple super phosphate before sowing and 80 kg ha^{-1} seed was planted with a single-row, hand drill in rows 20 cm apart. Fertilizer was banded in rows 20 cm apart, broadcast above ground, or broadcast and incorporated. Three irrigations of 7.5 cm of water were applied, and rainfall was 29.6 mm during the growing season. Grain yield, number of fertile tillers, 1000-grain weight, and plant height at maturity were recorded. Fertile tiller number was determined on three unit areas 0.42 m^2 each), randomly selected per plot. Twenty plants were randomly selected from each plot for plant height measurements. A representative sample (454 grams) of grain was taken for 1000-grain weight determination.

Table 1. Effects of nitrogen rates, sources and application methods on the traits of Chenab-70 wheat.

N rates kg ha^{-1}	Method applied	Sources	Traits			
			Grain yield	Fertile tillers	1000-Grain weight	Plant height
			Q ha^{-1}	.42 m^2	gm	cm
0	–	–	31.9 c[!]	117.5 e	41.1 a	108.3 b
112	Banded	Urea	44.3 a	153.7 a	43.4 a	113.9 a
112	Banded	SCU	40.5 ab	140.2 bc	42.0 a	111.8 ab
56	Broadcast	Urea	40.8 ab	144.5 b	42.1 a	109.6 b
56	Broadcast	SCU	38.5 b	137.7 c	41.9 a	111.6 ab
56	Banded	Urea	41.8 ab	138.7 c	42.4 a	110.6 ab
56	Banded	SCU	40.1 b	131.7 d	42.2 a	110.3 b
56	Broadcast & incorporated	Urea	39.4 b	136.7 c	42.5 a	108.2 b
56	Broadcast & incorporated	SCU	39.5 b	136.3 c	41.3 a	110.3 ab

! a-d Means with same letter do not differ significantly ($P < 0.05$).

RESULTS AND DISCUSSION

The results presented in Table 1 indicate that banding 112 kg ha^{-1} as urea produced the highest yield but not significantly more than either 56 kg ha^{-1} banded or broadcast as urea or 112 kg ha^{-1} banded as SCU. The lower yield at high N rates resulted partially due to lodging, which reduced grain yield.

McCutchen *et al.* [15] found that 100 kg N ha^{-1} applied as SCU gave the highest grain yield (51 bu grains/ha.). They suggested that later availability of nitrogen in the growing season stimulated grain filling and, thus, increased grain yield. Conversely, Bhatti [5] reported that SCU did not give any yield benefit over urea but its application depressed grain yield in wheat. Furthermore, kg ha^{-1} ammonium sulphate gave the highest yield. Little [8] reported that 224 kg N ha^{-1} applied as urea produced the highest grain yield but that 56 to 112 kg N ha^{-1} was more economical. Ernest and Pearson [13], Boatwright and Hass [4], and Beaton *et al.* [6] also demonstrated that the highest applications of nitrogen were less economical.

Tiller number is an important yield component of wheat. The number of fertile tillers were the highest in the plots receiving 112 kg ha^{-1} banded as urea (Table 1). Banding SCU was not effective as banding urea. Similarly Oertli and Lunt [7] obtained greater response with urea than with SCU. Slow dissolution of SCU may not provide adequate nitrogen for wheat plants during active vegetative growth. Increased tillering with 112 kg ha^{-1} banded as urea may result from accelerated plant growth, and is in agreement with the results of Rana [9] and Ernest and Pearson [13].

Applied nitrogen had no significant effect over control (Table 1) on 1000-grain weight. Maximum 1000-grain weight resulted from banding 112 kg ha^{-1} as urea and minimum 1000-grain weight was obtained in control plants. Without the high fertility of the experimental field and low stand density in control plots, 1000-grain weights might have differed. Control plants used soil resources efficiently for grain filling. These findings are in accord with those reported by Hobbs [14].

Nitrogen application also influenced plant height. Banding 112 kg N ha^{-1} as urea increased plant height significantly over control (Table 1), and agreed with the findings of Woodward [12], and Ashour and Salch [10].

The results of this study showed that a wheat crop uses urea better than SCU, because urea is readily available while slow release SCU may be too late to benefit from soil moisture. Therefore, we suggest that residual effects of SCU to the next crop be examined. Wheat is a short-season crop and SCU may be better utilized by long-season crops such as sugarcane or rice because the slow release of N may reduce the leaching of nitrogen.

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