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Sulfur-Coated Urea as a Slow Release Nitrogen Source for Onions

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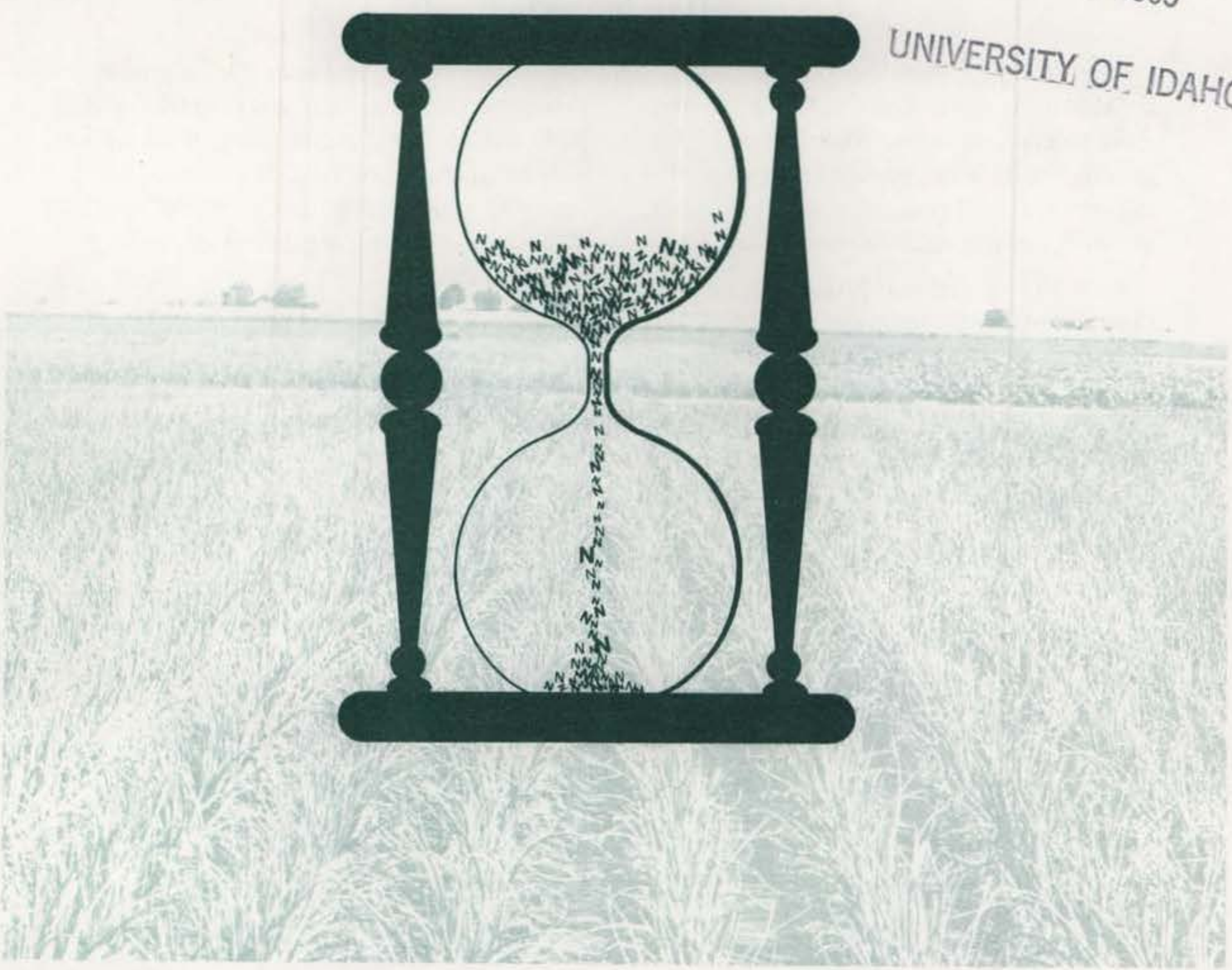

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Summary

Field studies with onions (*Allium cepa* L. cv Monarch) were conducted in 1980 and 1981 to evaluate sulfur-coated urea (SCU) in comparison with preplant and split applications of urea. Treatments were evaluated at two N rates, 50 and 200 pounds per acre.

Root NO_3-N and soil NO_3-N concentrations in bed centers indicated slower release of N from SCU than from urea. Nevertheless, total and large bulb (over 3 inches diameter) yields, apparent N recovery and N uptake in onion bulbs and leaves were significantly higher with SCU than with preurea under low N conditions. Onion production, apparent N recovery and N uptake with SCU did not differ significantly from split urea treatments. Soil NO_3-N following harvest was significantly lower in 1980 with SCU than with urea regardless of urea application timing.

The results suggest that preplant SCU will provide N to onions as effectively as more commonly used N sources while reducing the risk of contaminating ground water with NO_3-N.

About the Authors

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Introduction

Adequate nitrogen (N) is necessary for maximum onion production, yet excessive N broadcast and shallowly incorporated preplant can reduce stands and yield. Excessive N applied during the season can contribute to storage losses of onions when maturity is delayed and onions are inadequately field-cured. Field curing — the drying down of outer onion scales and necks — is necessary to reduce fungal and bacterial diseases that cause onions to rot in storage. Providing optimum N helps ensure maximum economic production without adversely affecting onion yield or storability. Onion growers commonly broadcast N preplant and sidedress N later to provide adequate N throughout the season.

Repeated furrow irrigation moves soil N and fertilizer N to bed centers where onion root activity may be limited. Accumulation of NO_3-N in bed centers with repeated irrigation may reduce fertilizer N available to the onion plant and may contribute to NO_3-N contamination of ground waters.

Residual NO_3-N following onions is subject to leaching during wet winters and during the following irrigation season. A recent well water survey within the production area reported NO_3-N concentrations exceeding the public health standard of 10 ppm. Furthermore, these NO_3-N concentrations were correlated ($r=.7$) with concentrations in the same waters of DCPA, a registered herbicide for onions. These factors emphasize the need for improved onion N fertilization practices that will reduce residual NO_3-N following harvest, yet provide adequate N for maximum economic production.

Slower release of preplant banded fertilizer N might reduce the movement and accumulation of N in bed centers. Sulfur-coated urea (SCU), a slow-release N fertilizer developed by the Tennessee Valley Authority National Fertilizer Development Center, has potential for increasing onion utilization of fertilizer N while reducing residual NO_3-N following harvest. This study was conducted to evaluate SCU as a slow-release N source for onions produced in southwestern Idaho and eastern Oregon.

Methods

A field study was conducted in 1980 and 1981 at the University of Idaho Southwest Idaho Research and Extension Center near Parma. SCU was compared with urea banded preplant or in split applications (50% banded preplant and 50% sidedressed). All N fertilizers were applied at rates of 50 and 200 pounds N per acre. Treatments were arranged in a randomized complete block design with five replications.

The SCU used in this study was developed to release approximately 30 percent of the N content within the first week of its application, assuming adequate moisture is present. The remainder of the N was released more slowly.

The study was conducted on a Greenleaf silt loam previously cropped with wheat. Residual soil N (NO_3-N and NH_3-N) was determined before planting both years from samples collected to a depth of 12 inches. Residual soil N measured less than 30 pounds N per acre. University of Idaho fertilizer N recommendations for 1980 and 1981 were approximately 140 pounds N per acre based on initial soil test N and previous crop. Phosphorus and potassium were broadcast and incorporated during seedbed preparation according to recommendations in University of Idaho Current Information Series 315, *Fertilizer Guide for Onions*.

The sulfur added with SCU treatments was balanced for all urea treatments in 1980 using $CaSO_4$ (gypsum). Approximately 40 pounds SO_4-S per acre were provided from the growing season irrigation water. In addition, soil test SO_4-S was above 10 ppm in both years. Since SO_4-S was adequate for onion growth, no attempt was made to balance the S in SCU and urea treatments in 1981.

Soil samples from selected treatments were collected from the 0- to 6-inch depth of bed centers to monitor NO_3-N accumulation. Roots were collected to a depth of 6 inches in five approximately biweekly samplings beginning June 23, 1980, and June 22, 1981. Root NO_3-N content was determined after the samples were rinsed with tap water, oven-dried at 65°C and ground.

Bulbs and leaves were collected in mid-August, and their total N contents were determined to provide an estimate of N uptake. Apparent recovery of applied N was calculated to estimate the relative efficiency of the different treatments. The calculation was as follows:

$$\text{Apparent N recovery} = \frac{\text{N uptake for N applied} - \text{N uptake for check}}{\text{N applied}} \times 100$$

Onion maturity in each treatment was estimated in mid-September using the percentage of tops down. Onion yield and grade were determined in mid-October, and grade was again determined after approximately 3 months storage.

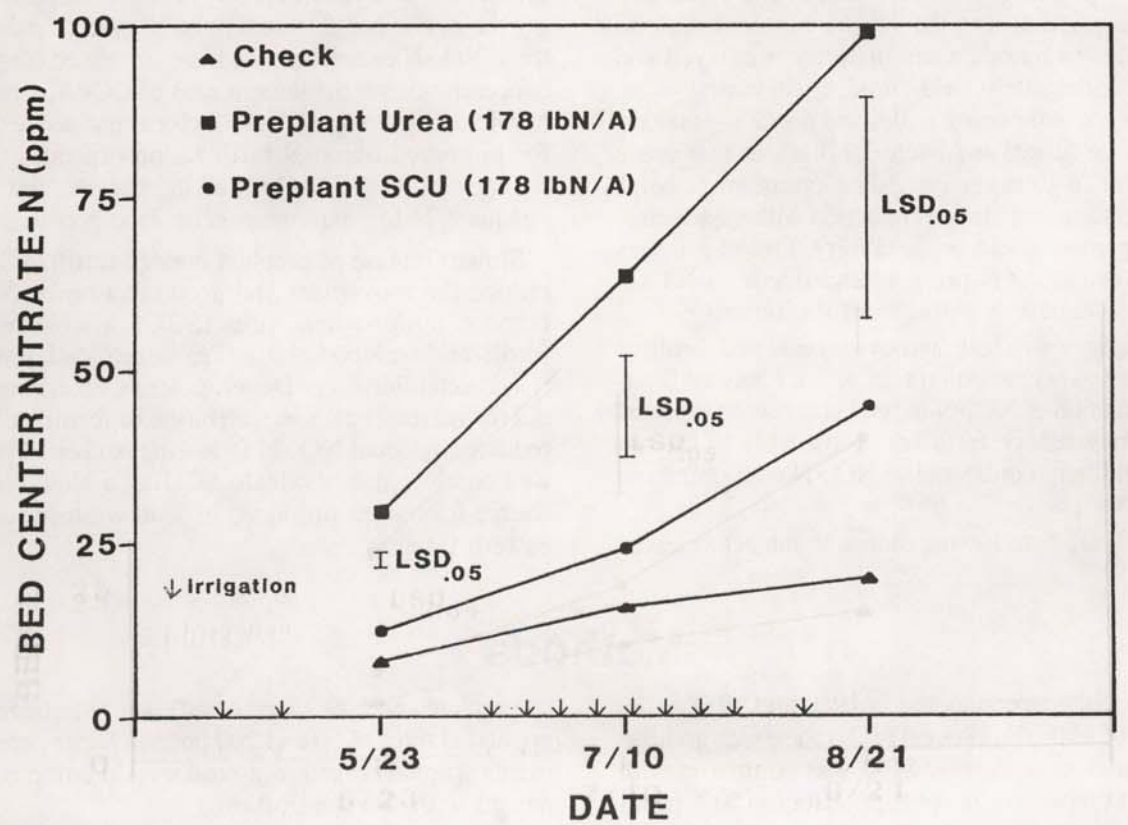

Fig. 1. Mean bed center NO_3-N as affected by N source and sampling date at Parma, 1980.

Results and Discussion

Bed center NO_3-N increased in 1980 with repeated irrigation (Fig. 1). Bed center NO_3-N during August 1980 was higher for preplant urea than for SCU, which suggests N release from SCU was slower. Preplant banded or sidedressed urea applications in some years can result in greater residual NO_3-N following harvest than will occur with SCU.

Root NO_3-N increased with N applied and generally declined with each subsequent sampling (Fig. 2). Root NO_3-N for preplant urea was significantly higher than with SCU on June 23. By July 8, root NO_3-N for preplant urea and SCU did not differ significantly. At the high N rate, root NO_3-N from mid-June to maturity was higher for split urea than for both SCU and preplant urea. Root NO_3-N concentrations with SCU — approximately 4,000 ppm in late June (the 4-leaf stage) declining to approximately 1,000 ppm in mid-August (the 13-leaf stage) were apparently adequate for maximum yield in this study.

Application of N significantly increased N uptake (Table 1). Uptake of N consistently averaged less from preplant urea than from SCU. Split urea and SCU treatments did not differ significantly in N uptake.

Apparent N recovery at the lower N rate was nearly double the apparent N recovery of the higher N rate (Table 1). Apparent N recovery of the most effective treatments did not exceed 60 percent even under limited N conditions where maximum recovery would be expected.

At the low N rate, apparent N recovery with SCU was significantly higher than with preplant urea but did not differ significantly from split urea treatments. At the higher N rate, split urea and SCU did not differ significantly in apparent N recovery. Both SCU and split urea apparent N recovery was greater than for preplant urea.

Adding N hastened maturity (Table 1). The percentage of tops down at the high N rate tended to be greater than at the low N rate. The low N rate in turn resulted in percentage tops down that were significantly higher than with the check. Within N rates, treatments did not differ significantly. Delayed onion maturity caused by limited N is probably seldom noticed by growers since onions normally are adequately fertilized in commercial fields.

The application of N significantly increased large bulb (over 3 inches diameter) and total bulb yield.

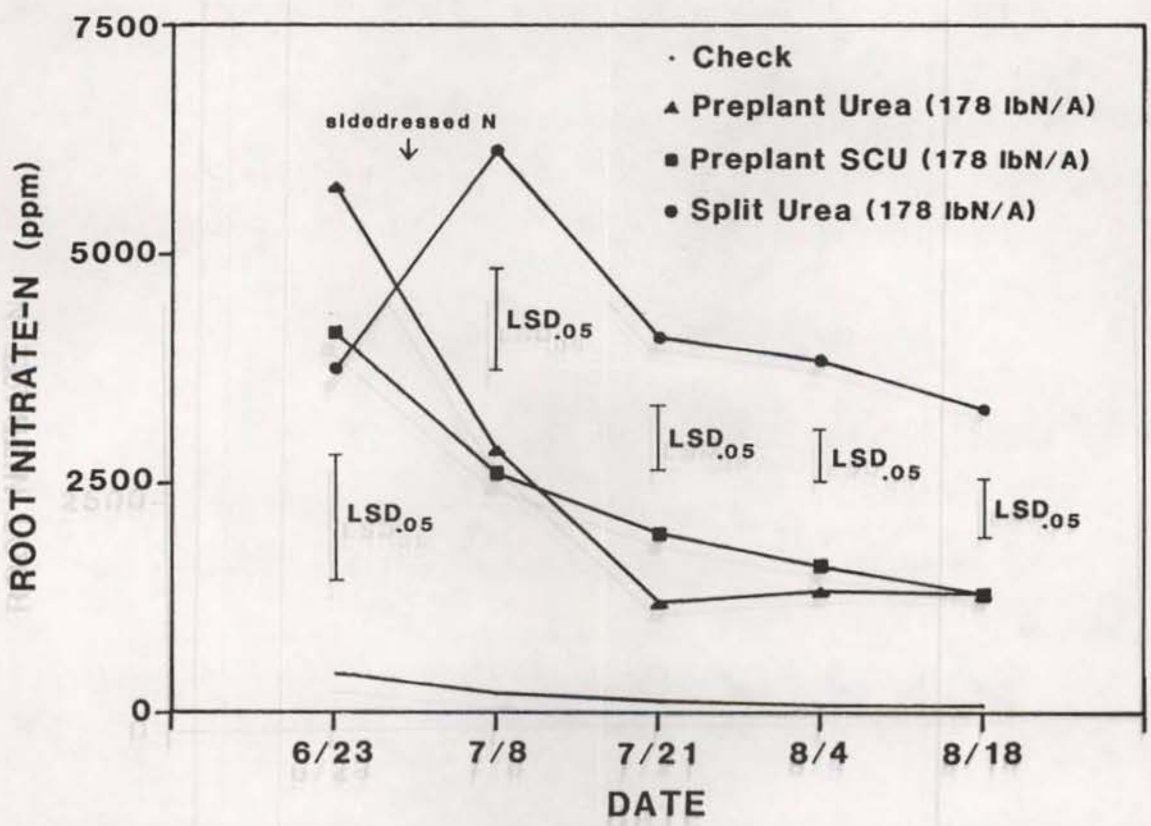

Fig. 2. Mean root NO_3-N as affected by N source, timing of application and sampling date at Parma, 1980.

Onions following wheat normally respond favorably to N since wheat generally uses available soil N and leaves high C:N ratio residues which limit N available to the following crop. The higher N rate was more productive than the lower N rate. Total and large bulb yields for SCU were significantly higher than for preplant urea at both N rates. The SCU and split urea total and large bulb yields did not differ significantly at either low or high N.

Limited N during the season increased shrinkage in storage (Table 1). Shrinkage was significantly higher for the check than for all other treatments. Percent rots was not affected by N treatments.

Table 1. Apparent fertilizer N uptake, N recovery, tops down, yield, shrinkage and rots as affected by N rate and N source within N rate.

Treatment	N uptake	N recovery	Tops down	Yield: Total bulb	Yield: Large bulb	Shrinkage	Rots
	(lb/acre)	(%)	(%)	(cwt/acre)		(%)	
N rate							
Check	54.2[1]	-	9	343	192	10.8	13.4
56 kg/ha (Low N)	74.4	40	30	509	385	6.1	14.8
224 kg/ha (High N)	102.1	24	51	564	449	4.1	16.1
N sources							
Low N							
Preplant urea	63.5	18	29	452	298	7.8	16.5
Split urea	77.5	47	42	520	408	6.2	13.9
SCU	82.2	55	47	556	449	4.2	14.1
High N							
Preplant urea	92.1	19	49	529	395	5.2	17.1
Split urea	107.2	26	50	552	467	3.2	15.5
SCU	106.9	26	54	610	485	3.7	15.8
LSD[2]$_{.05}$	16.7	22	17	78	97	4.8	5.5

[1]Values are averaged across all replications and years.

[2]Means must differ by more than the LSD$_{.05}$ to be considered statistically different at the 5% level of significance.

Conclusion

Concern for groundwater quality is increasing. Groundwater contamination with NO_3-N in this production area has been reported, with onion production implicated as partially responsible. Fertilization practices need to be used that maximize fertilizer N utilization by onions while reducing the potential for environmental degradation.

The SCU resulted in lower NO_3-N concentrations in years when significant bed center accumulation occurred. Lower bed center NO_3-N accumulation and lower root NO_3-N with SCU indicate SCU released N more slowly than preplant urea. Nevertheless, higher N uptake, apparent N recovery and yield under limited N conditions suggest N derived from SCU was used more effectively than N derived from preplant urea. Less N available to onions from preplant banded urea may be attributed to the fact that repeated irrigation moves NO_3-N to bed centers where onion root activity may be limited.

The results suggest that a slow-release N source with release characteristics comparable to the SCU used in this study can be used effectively to produce irrigated yellow sweet Spanish onions in southwestern Idaho and eastern Oregon. Slow-release N can provide adequate N for maximum production while reducing residual NO_3-N.

Slow-release N fertilizers such as SCU are more expensive than conventional N sources on a per-unit N basis. However, with evidence for improved efficiency from SCU, N rates could be reduced. Also, banding of SCU in conjunction with the planting operation would preclude the need to broadcast N preplant and later sidedress N for onions.

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