IRRIGATION AND NITROGEN MANAGEMENT TO IMPROVE NITROGEN FERTILIZER EFFICIENCY

J.C. Stark, I.R. McCann, D.T. Westermann, and T.A. Tindall

NITROGEN MANAGEMENT

Nitrogen fertilizer recommendations for potatoes in Idaho are based on a number of factors including a realistic yield goal, the type and amount of crop residues incorporated into the soil, N carryover from the preceding crop and an estimate of N mineralization. Mismanagement of N fertilizer can significantly reduce yield and quality. Inadequate N can reduce yields by promoting early senescence and shortening the tuber bulking period. On the other hand, excessive N levels in the soil at or before tuber set can delay tuber growth which also shortens the tuber bulking period and reduces yield. Excessive N can also reduce specific gravity and delay maturity, particularly when N is applied late in the growing season.

Split N applications usually increase N fertilizer use efficiency compared to single preplant applications (Kleinkopf and Westermann, 1987). This involves applying reduced amounts of N at planting and then providing the remainder of the crop's N requirement by applying N fertilizer with the irrigation water. Petiole testing should be used to adjust the amount and timing of split N applications according to crop needs. Research and grower experience has shown that the proper use of split N applications can optimize potato yield and quality by encouraging earlier tuber growth and maintaining maximum tuber bulking rates until vine kill.

Applying fertilizer N closer to the time the plant actually removes it from the soil also improves fertilizer use efficiency by reducing the potential for nitrate leaching. Studies have shown that the total amount of N fertilizer used may be decreased by 20% by using timely split N applications. Deficiencies of other nutrients can also reduce N fertilizer efficiency.

IRRIGATION MANAGEMENT

Irrigation management is also very important in the production of a profitable, high-quality potato crop. Because of the relatively high susceptibility of potatoes to drought, there often is a tendency to over-irrigate to avoid yield and quality losses. However, excessive irrigation can also cause significant yield and quality losses as well as leach large amounts of nitrogen out of the root zone where it is no longer available for crop production.

A study was conducted at Aberdeen in 1990 to evaluate the combined effects of irrigation and nitrogen management on nitrogen use efficiency of Russet Burbank potatoes. A solid-set sprinkler system was used to irrigate potatoes on a loamy sand soil. Irrigation treatments included irrigating at either optimal or excessive (30% excess) rates. Irrigations were scheduled using measurements of soil water content to maintain available soil moisture above 65%. Nitrogen treatments were established as subplots within the irrigation treatment mainplots. Preplant N fertilizer was applied at either 0, 40, 80 or 120 lb N/acre (applied as ammonium nitrate). In addition, all plots received an additional 120 lb N/acre (as urea ammonium-nitrate) applied as four, 30 lb N/acre applications with the irrigation water. The resulting total N fertilizer rates were 120, 160, 200 and 240 lb N/acre. Residual soil nitrate-N prior to planting was 80 lb N/acre.

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Average soil nitrate-N concentrations for the 0 to 2 foot depth were measured during the tuber bulking period at weekly intervals for four of the irrigation/N treatment combinations (Table 1). At the first sampling date (July 10), irrigation rate had relatively little effect on soil nitrate-N concentrations. However, as the season progressed, soil nitrate-N concentrations were reduced by about 40 to 60% by the high leaching treatment. The higher N fertilizer rates also increased soil nitrate-N concentrations.

The reductions in soil nitrate-N caused by high leaching also influenced petiole nitrate-N concentrations (Table 2). Again, the high leaching treatment apparently did not affect N availability early in the growing season. However, excessive irrigation eventually did cause reductions in petiolc nitrate-N ranging from about 2,000 to 3,000 ppm.

The highest yields for both irrigation treatments were obtained with the 160 lb N/acre treatment (a total of 240 lb/acre of soil + fertilizer N). Applying higher rates of N fertilizer significantly reduced yield and specific gravity.

Increasing the amount of N fertilizer applied also increased the amount of leachable nitrate-N remaining in the soil after harvest in the low leaching treatments (Table 3). The difference in residual nitrate-N levels between the low and high leaching treatments was used to estimate the amount of nitrate-N leached at each N level. At the 120 or 160 lb N/acre rates, little or no nitrate was leached. However, as the N fertilizer rate was increased above the amount required for maximum yield, the amount of nitrate leached increased by a similar amount.

MANAGEMENT GUIDELINES

1. Use split nitrogen applications to encourage earlier tuber set and maintain longer tuber bulking periods.
2. Time nitrogen applications to coincide with crop needs, using plant tissue testing to monitor crop nitrogen status.
3. Avoid excessive N fertilization, particularly late in the growing season.
4. Use a balanced fertilizer program to maximize nitrogen use efficiency.
5. Schedule irrigations to minimize leaching.
6. Avoid excessive early and late season irrigations when crop water use rates are comparatively low.
7. If possible, avoid long sets and deep irrigation.

REFERENCE

Kleinkopf, G.E. and D.T. Westermann. 1987. Scheduling nitrogen applications for Russet Burbank potatoes. University of Idaho Current Information Series, No. 637.

Table 1. Influence of irrigation and nitrogen rate on soil nitrate-N concentrations (0 to 2 foot depth), during the 1990 growing season.

Irrigation/nitrogen treatment	Sampling date					
	July 10	July 18	July 25	Aug 2	Aug 9	Aug 16
	$N0_3$-N (ppm)					
Low leaching/ 200 lb N/acre	21.1	19.0	15.7	18.3	20.0	18.3
High leaching 200 lb N/acre	21.7	8.6	9.5	10.7	9.8	7.3
Low leaching 240 lb N/acre	18.3	21.3	21.5	28.3	26.8	21.8
High leaching 240 lb N/acre	16.1	17.3	15.9	18.4	14.2	12.6
LSD_{005}	NS	10.3	5.6	5.4	6.2	7.7

Table 2. Influence of irrigation and nitrogen rate on petiole nitrate-N concentrations during the growing season. From a study conducted in 1990 at Aberdeen.

Irrigation/nitrogen treatment	Sampling date			
	June 27	July 11	July 25	Aug 9
	$N0_3$-N (ppm)			
Low leaching/ 200 lb N/acre	20,736	15,143	12,200	14,161
High leaching 200 lb N/acre	22,261	16,533	9,801	12,099
Low leaching 240 lb N/acre	21,120	15,986	13,074	15,014
High leaching 240 lb N/acre	21,598	13,836	10,042	12,356
LSD_{005}	NS	NS	1,860	2,313

Table 3. Influence of irrigation and nitrogen rate on postharvest soil nitrate-N (0 to 4 foot depth) and the quantity of nitrate-N leached at the end of the growing season.

Nitrogen fertilizer rate	Postharvest soil nitrate-N		Nitrate-N leached
	Low leaching	High leaching	(low-high)
lb/acre	lb N/acre		
120	115	104	11
160	144	148	-4
200	157	116	41
240	201	128	71