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TIMING OF INITIAL NITROGEN APPLICATION DID NOT AFFECT POTATO YIELD

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Abstract. **Potato (*Solanum tuberosum* L.) is an important vegetable crop in Florida and requires nitrogen fertilization for economical yields. Current nitrogen (N) recommendations call for the initial 60 to 90 lb/acre N to be applied at planting. Some commercial potato producers make the initial N application several weeks prior to planting. Early applied N will not be absorbed until the seed tuber sprouts and roots are present in the soil, but this early applied N can be subject to leaching from rain or excess irrigation between the times of application until seed piece sprouting. In the Middle Suwannee River Basin, nitrates have been found in the Suwannee River and associated springs at concentrations greater than 10 ppm nitrate-N. Therefore it is important to determine crop production practices which might reduce the likelihood of N losses to the groundwater. In this study, two early-N timing treatments were evaluated, 60 lb/acre N applied at planting (at planting) and the same amount of N applied at plant emergence (at emergence). Potatoes with both treatments received 15 lb/acre of starter-N banded with the seed pieces at planting. Timing of first N application had no effect on potato tuber yield in any tuber size grade in three years of trials, except for Size A tubers in 2002. In this first year of trials, yield of Size A tubers (but not total marketable yield) was greater with N application at plant emergence than with the planting N application. These results showed that the first large N application can be withheld until plant emergence, increasing the likelihood of fertilizer N being taken up by the young plant and reducing the risk of N leaching losses.**

Potato is an important vegetable crop in Florida with about 36,000 acres grown in the 2002-2003 production season (Florida Agric. Statistics Serv., 2004) from several major production areas. Potatoes are produced in Miami-Dade, Manatee, Collier, the Tri-County Agricultural Area (St. Johns, Flagler, and Putnam), and Suwannee Counties, and has a total state crop value of $130 million. Potato production averages 270 cwt/acre for the state.

Nitrogen is important for economical potato production and represents about 4 to 5% of the total costs of production. Results of research on amount of fertilizer N needed vary by state, but generally best yields in several states were obtained with N in the range of 150 to 250 lb/acre (Griffin and Hesterman, 1991; Hochmuth et al., 2003; Lewis and Love, 1994; Minotti et al., 1994). Research results also vary for timing and placement of N fertilizer. Potatoes grow rapidly so there are substantial needs for early N (Goins et al., 2004) with rates being reduced later in the season for maximum N utilization efficiency. An adequate amount of N is required early in potato plant development for best growth (Goins et al., 2004), but recommendations for the exact timing of this N vary among potato production states. In some production situations, split-N applications were similar to a single application (Feibert et al., 1998), but other researchers found there were advantages to split-applications of N (Kidder et al., 1991; King et al., 1999; McCubbin et al., 1955; Prunty and Greenland, 1997). Applications of large amounts of N during tuber bulking, especially where soil water content is maintained at a high level, can lead to more problems with brown center and hollow-heart (McCann and Stark, 1989). Banding was found to be superior to broadcasting N (Westermann and Sojka, 1996). In Florida, considerable research has been conducted since the 1950s on potato fertilization and this work has been summarized by Hochmuth and Cordasco (2000). Results from this summarized research and from six years of on-farm studies in the early 1990s by Hochmuth et al. (1993) led to the current University of Florida potato N fertilization recommendations (Hochmuth et al., 2003). The current recommendations suggest that no N be applied before planting, but that 60 to 90 lb/acre N be applied at planting.

The management of preplant N is important for reducing N leaching in irrigated potato production systems (Whitley and Davenport, 2003). N management also is critical in the sandy-soil production areas of Florida to minimize N losses to the environment. This issue has come to the forefront in the Middle Suwannee River Basin in northern Florida where nitrates have been found in the springs and river in concentrations above 10 ppm nitrate-N (Suwannee River Water Management District, 2003). Nitrogen also is a concern in the St. Johns River Tri-County Agricultural Area (Livingston-Way et al. (no date); St. Johns River Water Management District, 2000) where BMPs have been described for potato production (Hutchinson et al., 2002). Part of managing N for potato production in environmentally sensitive areas would be to implement fertilization practices that minimize potential N losses due to leaching before the young plant can absorb fertilizer N. This study was conducted over several seasons to test the hypothesis that the initial large application of N could be withheld until the plants had emerged and had a developing root system for N absorption.

Materials and Methods

The research was conducted from 2002 through 2004 spring production seasons at the North Florida Research and Education Center-Suwannee Valley near Live Oak, Fla. in Suwannee County. The fields used for this research contained Lakeland fine sand, thermic, coated, typic, Quartzipsamment. The soil was plowed and disked each year in preparation for bed formation and fumigation. Preplant soil tests (Mehlich-1) showed that no P or micronutrients were needed for potatoes growing on the soil in these fields, but that K would be needed. The soil was fumigated in the spring each year about three weeks before planting by broadcast injecting Telone II C-35 (1,3 dichloropropene plus chloropicrin-Dow AgroSciences, Indianapolis, Ind.) 8 inches deep at 15 gal/acre into the soil. Sprinkler irrigation was used to seal in the fumigant. Beds were prepared 6 inches in height with 40 inches between adjacent bed centers, and were 150 ft long.

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Two time-of-application treatments for initial nitrogen were compared in this research. The treatments were: application at planting or application at plant emergence. On 27 Feb. 2002, 24 Feb. 2003, and 10 Mar. 2004 the at-planting fertilizer N treatment was applied by banding by hand 60 lb/acre N from ammonium nitrate in the center of the area where the bed would be formed. The soil was formed into the bed directly above the fertilizer band so the fertilizer band was about 3 to 4 inches below the seed piece once planted. A furrow, three inches deep was made in the center of the top surface of the bed in which to plant the seed pieces. Ammonium nitrate at 15 lb/acre N was sprinkled in the furrow to supply starter-N for the sprouting seed pieces. Seed pieces of 'Red La Soda' potatoes, cut to about 2-ounce size, were obtained from a commercial potato producer in Suwannee County and placed by hand in the planting furrow at 6-inch spacing. The furrow was closed by reforming the bed with single-disk hillers on a tractor-drawn tool bar. The beds in the plots assigned the plant emergence N treatment were planted with potatoes in the same manner as those with the at-planting N treatment, including the starter-N application.

Potato plant emergence occurred 14 to 16 d after planting in all years. When plants to receive the emergence N treatment were cracking through the soil surface (some plants were 1 inch tall), N at 60 lb/acre from ammonium nitrate was banded 3 inches deep and 3 inches to both sides on the plant row. This application mimicked typical commercial practices of banding liquid N by knifing it into the sides of the bed. At this time all potatoes received the first application of potassium, 40 lb/acre K, by banding potassium chloride to both sides of the plant row. All fertilizers were covered by re-forming the beds with a single-disk hiller. When the plants reached 3 to 4 inches in height (two weeks after emergence), the second applications of N (65 lb/acre) and K (40 lb/acre) were made to plants in all plots. When the plants were 4 to 6 inches tall (30 d after emergence) the final applications of N (65 lb/acre) and K (40 lb/acre) were made to plants in all plots. The total amounts of N and K were 200 and 120 lb/acre, respectively.

The potato crop was irrigated with sprinklers to maintain soil moisture potential 8 inches deep in the beds in the range or -8 to -12 cb monitored with tensiometers. This resulted in irrigations of one inch of water two to three times each week. The importance of water management to potato production and N management has been shown by Feibert et al., (1998). Weeds were controlled with manual cultivation. At early bloom (20% of plants with blooms) in 2004, most-recently-matured whole leaves were sampled for total kjeldahl nitrogen analyses by a commercial analytical laboratory. Harvesting was done manually from 25-ft plots randomly selected in each treatment plot when the potato tops fell over and had begun to senesce. Dates for harvesting were 4 June 2002, 2 June 2003, and 15 June 2004. Tubers were washed and manually (2002 and 2003) or mechanically (2004) sized into the following tuber size categories: A1 (1.88 to 2.5 inches), A2 (2.5 to 3.0 inches), A3 (3.0 to 3.75 inches), B (1.5 to 1.88 inches), C (less than 1.5 inch). Tubers were evaluated for misshapen tubers, rots, internal vein browning, and hollow-heart. Tubers with enlarged lenticels were separated out as another cull category.

The experiments consisted of two treatments with 4 replicates in completely randomized design. Data were analyzed by ANOVA in SAS (SAS Institute, 1993) to determine significance of treatment effects.

Results and Discussion

Potato yields in all years were excellent by Florida commercial red potato production standards and no production problems or diseases were encountered in either year. Yield of marketable tubers in all years averaged 357 cwt/acre. Tuber yields of more than 300 cwt/acre of marketable red potatoes are also excellent by University of Florida variety trial standards. In a trial of red and purple potato cultivars in 2001, the average yield was 175 cwt/acre with yields ranging from 4 to 341 cwt/acre. Yield of 'Red La Soda' in that trial was 279 cwt/acre (Olson and Maynard, 2003). N timing treatment had no effect on tuber yield in any category in any year, except for Size A tubers in 2002 (Table 1). In the first season, 2002, yield of Size A (the largest size category) was greater with N applied at emergence compared to yield with N applied at planting. Potatoes in these trials had negligible unmarketable tubers except for 2002, when culling due to soft rot affected 7% of the crop and culling due to enlarged lenticels affected 10% of the crop. The disorder was not influenced by N timing. This is the first known report that waiting until potato plants have emerged to make the first main N application will not negatively affect tuber yield. Waiting until plant emergence to apply N will ensure the presence of roots to absorb N and minimize the risk of N leaching to groundwater if heavy rainfall occurs soon after planting, a common occurrence in northern Florida in the late winter planting

Table 1. Potato tuber yield and size responses to timing of initial nitrogen application.

		Yield (cwt/acre)						Size A average tuber wt (oz)
Year	N treatment	Size A	Size B	Size C	Cull	Tubers with enlarged lenticels	Total marketable yield	
2002	At planting	205	62	17	26	39	284	5.6
	Plant emergence	268	49	20	21	31	337	6.3
	Significance[z]	*	ns	ns	ns	ns	ns	ns
2003	At planting	230	123	42	11	0	395	4.8
	Plant emergence	242	107	32	7	0	381	5.0
	Significance	ns	ns	ns	ns	ns	ns	ns
2004	At planting	337	31	0	4	0	369	4.4
	Plant emergence	344	34	0	5	0	378	3.7
	Significance	ns	ns	ns	ns	ns	ns	ns

[z]F-Test for treatment significant at 5% level (*) or not significant (ns).

season. Although the rate of N applied is a major component of a nutrient best management practice, management of applied N also needs to be considered in a BMP.

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