EFFECTS OF VARIOUS NITROGEN MANAGEMENT PRACTICES FOR POTATO ON PLANT AND SOIL NITROGEN STATUS

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INTRODUCTION

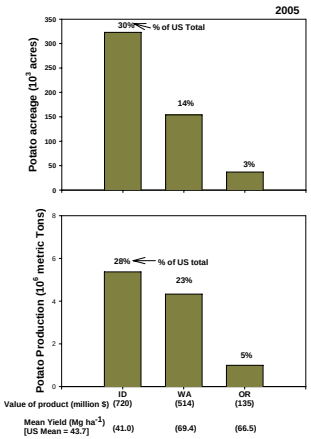
- Pacific Northwest (PNW) states in the U.S., i.e. Washington, Oregon, and Idaho, represent an important potato production region in the country. This region contributes to 56% of the total potato production (19.2 million metric Tons, 2006) in the country. The U.S. potato production ranks fifth in the world (359 million metric tons) behind Russia, China, India, and Ukraine.
- Potato industry in the PNW has changed considerably over the years. Along with the changes in production practices, the cultivar composition of the industry has also changed. The percent of total potato acreage planted with 'Russet Burbank' culitvar decreased from 80 to 63, 50 to 40 and 31 to 15 in ID, WA, and OR, respectively. The percent acreage under 'Ranger Russet' increased from 4 to 15 in ID and 2 to 25 in OR, remained steady at 16 percent in WA.
- Monitoring N status in soil and/or plant provides a basis for evaluating the N pool in the soil as well as an index of plant N status. The above information can then be used to evaluate the optimal crop N requirement aimed to improve N uptake efficiency and minimize N losses. For potatoes, petiole NO_3-N analysis has been evaluated as an index of N status in the plants

OBJECTIVE

The objective of this study was to evaluate the petiole NO_3-N status in 'Ranger Russet' cultivar and soil N pools in a sandy soil under a range of nitrogen management programs in a typical PNW potato production condition with high tuber yields.

MATERIALS AND METHODS

- A field experiment was conducted in a Quincy fine sand (mixed, mesic, Xeric Torripsamments), a representative soil in the major potato growing region in the Columbia Basin across Washington and Oregon. This site has been under potato rotation system since 1992.
- The site was irrigated by a center pivot equipped with Nelson N-3000 rotators sprinkler package at 3.05 m spacing with delivery rate of 10 gallons per minute at 50 psi. Nitrogen treatments included the following pre-plant (urea) and in-season (UAN, 32%N) applications (kg ha^{-1} N), with four replications:
  - i. 56+280 (5 in-season appl. at 2 wks interval);
  - ii. 112+224 (5 in-season appl. at 2 wks interval);
  - iii. 112 + 224 (10 in-season appl. weekly);
  - iv. 112+336, in 2004, or 112+112, in 2005 (5 in-season appl. at 2 wks interval);
- The N rate was delivered during May 12 through July 14, 2004 or May 23 through July 25, 2005.
- Petiole samples were taken beginning from 36 DAE in 2004 and 30 DAE in 2005. Within a plot, 15 to 20 plants were randomly sampled. Fourth fully expanded leaf was used for petiole sampling, concentration of NO_3- N was measured.
- Soil samples were taken at various interval during the growing season (at 0-15, 15-30, 30-60, and 60-90 cm depth) for analyses of extractable NO_3-N and NH_4-N.



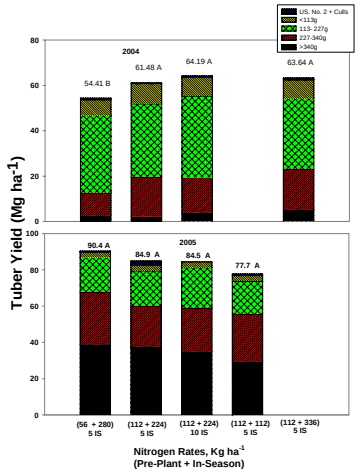


Figure 1. Effects of different pre-plant and in-season nitrogen applications to 'Ranger Russet' potato cultivar grown in a Quincy fine sand, 2004 and 2005. Total tuber yield and yields of tubers in different size grades are shown. The mean yield followed by similar letters by each year are not significantly different at P=0.05.

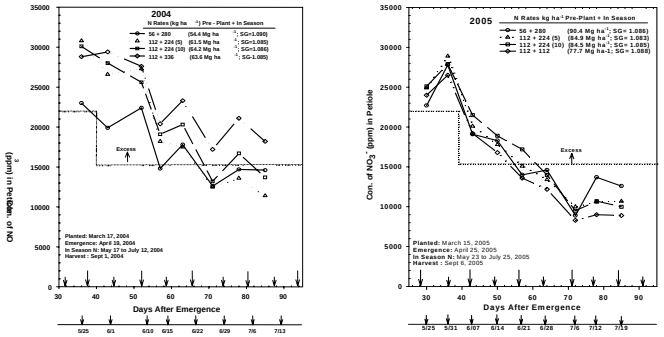


Figure 2. Petiole NO_3- concentrations for 'Ranger Russet' potato cultivar grown in a Quincy fine sand with different pre-plant and in-season nitrogen applications in 2004(a) and 2005(b). Total tuber yield and tuber specific gravity (SG) for each nitrogen management treatments are shown in the respective figures. The arrows along the x-axis represent the timing (in relation to days after emergence) of in-season nitrogen applications: (i) long arrows for 5 in-season applications; and (ii) long and short arrows for 10 in-season applications.

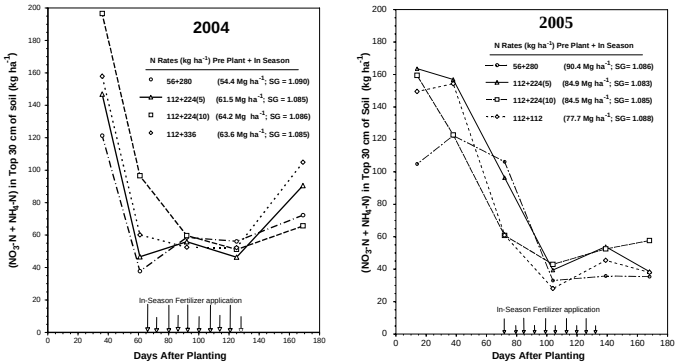


Figure 3. Nitrogen status in a Quincy fine sand sampled during the growing season of 'Ranger Russet' potato cultivar as influenced by different pre-plant and in-season nitrogen applications in 2004(a) and 2005(b). Arrows along the x-axis indicate timing of in-season nitrogen applications. Tuber yield response and tuber specific gravity (SG) for each N management treatments are also shown.

RESULTS AND DISCUSSION

- At a given N rate, frequency of in-season N application (5 vs. 10) had no significant affects on total tuber yield and/or distribution of tubers in different size grade classes, both years.
- In 2005, the petiole NO_3- concentrations were generally lower than those in 2004 and showed a rapid decline in concentrations during latter part of the growing season.
- Available soil N in the top 30 cm soil declined rapidly about 40 days after planting.
- Petiole NO_3- levels continued to decline towards later part of the growing season, which is an indication of low N demand toward the end of the growing season. Therefore, low available soil N status during the latter part of the growing season is highly desirable.

SUMMARY AND CONCLUSIONS

- Adequate availability of nitrogen (N) to satisfy potato crop N requirement is critical for production of optimal tuber yields with high processing qualities, which will contribute to maximum net returns.
- Best management of N fertilization is important to increase N uptake efficiency and to minimize N losses. Monitoring soil and petiole N provides a basis to evaluate available N in the soil and N status in the plants.
- This study was conducted on a Quincy fine sand using 'Ranger Russet' potato cultivar, (potato followed by 2 years of sweet corn rotation) with different pre-plant (PP) and in-season (IS) N rates
- Total tuber yield ranged from 54 to 64, and 78 to 90 Mg ha^{-1}, respectively in 2004 and 2005.
- Total tuber yields as well as yield of tubers >227g were greater in 2005 as compared to those in 2004. This is associated with lower petiole NO_3-N as well as rapid decline in petiole and soil NO_3-N concentrations towards the latter growing season in 2005 than in 2004.