NITROGEN SOURCES AND FERTILITY PRACTICES WHAT DO WE KNOW

by
Gail S. Lee and Norris Holstad
Department of Horticulture and Landscape Architecture
Washington State University

This paper is one in a series which has explored the effects of various sources of nitrogen fertilizer on potato yield and quality (4, 2, 5, 1). Kunkel (4) found that the type of nitrogen fertilizer did not effect yield. At the 1977 Potato Conference, Kunkel (4) also reviewed the chemical properties of various sources of nitrogen fertilizers. Studies on fumigation interactions with nitrogen sources showed that in the Shano silt loam soil of Othello there was no difference in yields when fumigated soils had either aqua ammonium or ammonium nitrate used as the nitrogen source (1). The Timmerman coarse sandy loams of Quincy in contrast showed that the aqua ammonium did significantly increase yields irrespective of the fumigation treatment (1).

The effect of various sources of nitrogen fertilizers on potato growth and development was studied during the past three years on non-fumigated silt loam soils. The data from this research will provide the baseline data to predict potato growth responses when the rotation crop or cultivar is varied.

Our initial studies have focused on using alfalfa as the previous rotation crop. Three forms of nitrogen were selected because of their diverse nature: (1) Ammonium nitrate (50% NO_3^- and 50% NH_4^+) which is moderately acid in its residual effect and has a high salt index; (2) Calcium nitrate (100% NO_3^-) which is neutral to moderately alkaline with a mid-salt index; and (3) Aqua ammonium (100% NH_4^+) which is slightly acid and has the lowest salt index.

The goal of using preplant N fertilizer is the early establishment of the canopy to intercept the maximum daily sunlight available in June. A method to measure the production potential of the canopy is to measure the leaf area per unit of land area which is called the Leaf Area Index of LAI. Kleinkopf and Westerman (3) in Idaho determined that maximum early tuber growth occurred when the LAI was between 2.5 and 3.2 at the beginning of the rapid linear growth phase for tubers. A LAI of 3-4 will intercept about 80% of the available solar radiation. If we could maintain active photosynthetic leaves with a LAI of 4, we should be able to obtain maximum yields. In the Russet Burbank cultivar (and other large vined cultivars) the older leaves become less efficient and eventually die due to shading of the older leaves by the vigorous new leaves or to competition for nutrients.

This Presentation is part of the Proceedings of the 1986 Washington State Potato Conference & Trade Fair.

Thus the key to maximum yields is the early establishment of the canopy to intercept the maximum sunlight available in June then to maintain high photosynthetic activity by either increasing the active life span of existing leaves or increasing the growth rate of new leaves to maintain an active LAI of approximately 4 during July and early August.

In our studies we sampled from late April through July to follow the development of the canopy and the initiation and early growth of the tubers. Prior to tuber initiation plant growth was significantly greater when aqua ammonium was used (Figure 1 and 2). As tubers were initiated during mid to late June (Figure 3), the tuber rate of initiation and early growth was also significantly greater when the preplant nitrogen was the aqua ammonia source. The rate of tuber growth between June 22 and July 6 was 12.5 cwt/A/day for the aqua plots compared to 9.29 cwt/A/day for the ammonium nitrate and calcium nitrate plots. Between July 6 and July 23 the rate of growth had slowed for all sources of N tested with the aqua dropping to 7.4 cwt/A/day and the ammonium nitrate and calcium nitrate dropping to 6.5. This significant early season growth of tubers could be an advantage for the grower since there seems to be a concurrent significant increase in specific gravity (Figure 4) during July. By October when the potatoes were harvested there was no significant difference in final yield though the aqua ammonium source for three years had the highest yields and specific gravities.

In 1985 we increased the nitrogen sources to also include urea (45% N as an organic N source), ammonium sulfate (21% N as NH_4^+), and Solution 32 (50% urea and 50% ammonium nitrate). All sources of nitrogen had similar patterns of leaf area development (Figure 5). The maximum LAI was reached by July 9 with the Soln 32 and urea sources being significantly higher with LAIs exceeding 6. As was discussed above, the early establishment of the canopy seems to increase the chances for an earlier tuber set and faster tuber growth rate. On July 9 both the aqua ammonia and Soln 32 treated plots showed significantly higher yields in the 2-4 oz. tubers in comparison to the other N fertilizer sources (Figure 6).

At final harvest we were looking at the effect of nitrogen source on total tuber yield, tuber size distribution and specific gravity. Though not statistically significant some trends were observed which indicated that some sources were more effective in producing higher tuber yields of over 4 oz. (Figure 7).

While the overall effect of N sources on specific gravity was small, an interesting trend did develop in the uniformity of specific gravity between size classes. N sources containing 50% or more NH_4^+-N produced tubers which were more uniform between size classes (Figure 8). For example at final harvest in 1985 plots fertilized with ammonium nitrate had a specific gravity of 1.0806 in the 4-10 oz size and 1.0808 for the over 10 oz size for a difference of 0.0002 while urea produced specific gravities of 1.0773 and 1.0807 for a difference between the two size classes of 0.0034.

From this research it seems that cultural practices can influence the uniformity of specific gravity between size classes and from tuber to tuber. N nutrition, as well as other cultural practices, may play a role in reducing the production problem of producing a uniform processed product. Further research is needed in this area and should be beneficial to the industry.

Another study we conducted in 1985 consisted of comparing ammonium nitrate and aqua ammonium when the previous rotation crop was wheat stubble instead of alfalfa. The soil contained an average organic matter of 1.07% for the wheat stubble fields and 0.96% for the alfalfa fields. The residual nitrate-N was 27.8 pounds/A for the wheat fields and 7.5 for the alfalfa fields. The carbon to nitrogen ratio for the residue of wheat stubble and alfalfa are different. In alfalfa residue there is approximately 2% N while wheat stubble has only 0.6% N. The seasonal tuber development illustrated in Figure 9 shows the differential effect of using aqua ammonia as opposed to using ammonium nitrate when the rotation crop changes from alfalfa to wheat stubble. A large reduction in yield was found in the aqua ammonia plots with wheat stubble as the rotation crop.

In summary:

1. Early season canopy establishment, tuber initiation and tuber growth rate were significantly greater when aqua ammonia was used preplant and alfalfa was the rotation crop.

2. N cultural practices can effect the uniformity of specific gravity between yield size classes.

3. One year's research indicates that aqua ammonia is not the N source to use when the rotation crop is wheat.

REFERENCES

1. Davis, J. M., W. H. Loescher, M. W. Hammond, and R. E. Thornton. 1986. Response of Russet Burbank potatoes to soil fumigation and nitrogen fertilizers. American Potato Journal 63:71-79.

2. Hammond, M. W. 1981. Nitrogen source and fumigation interaction in potato production. Proc. 20th Wash. Potato Conf., Moses Lake, Washington. p.45-50.

3. Kleinkopf, G. E. and D. T. Westerman. 1985. Nitrogen requirements of potatoes. American Potato Journal 62:432.

4. Kunkel, R., N. M. Holstad and B. L. McNeal. 1977. Comparison of some nitrogen sources for potatoes. Proc. 16th Ann. Wash. Potato Conf. p. 31-37.

5. Loescher, W. 1981. Nitrogen source as it affects potato growth. Proc. 20th Wash. Potato Conf., Moses Lake, Washington. p. 89-92.

Figure 1.

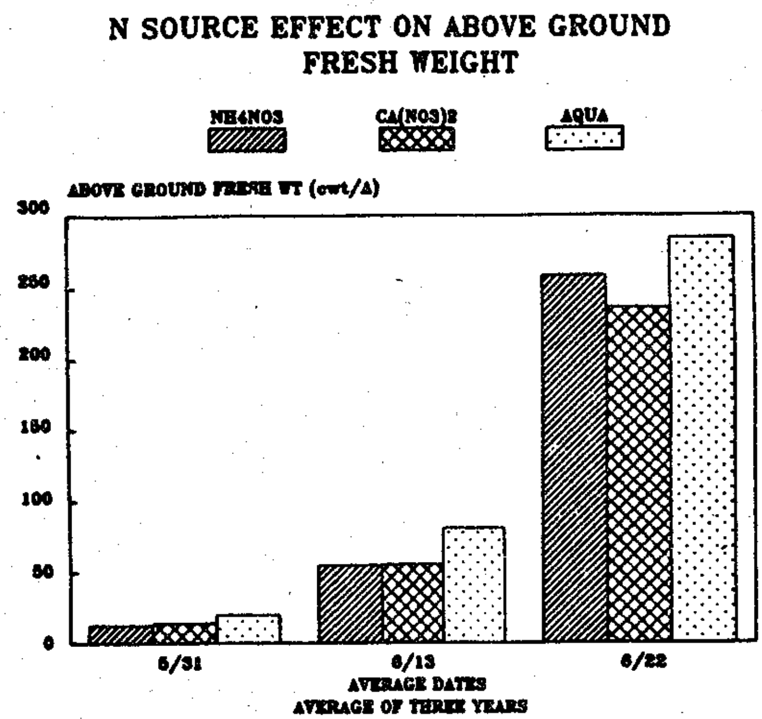


Figure 2.

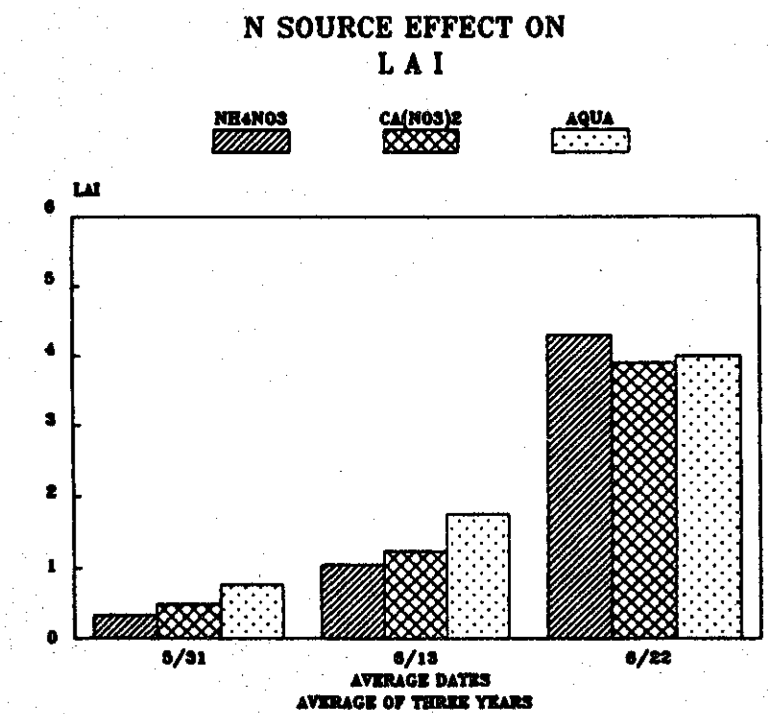


Figure 3.

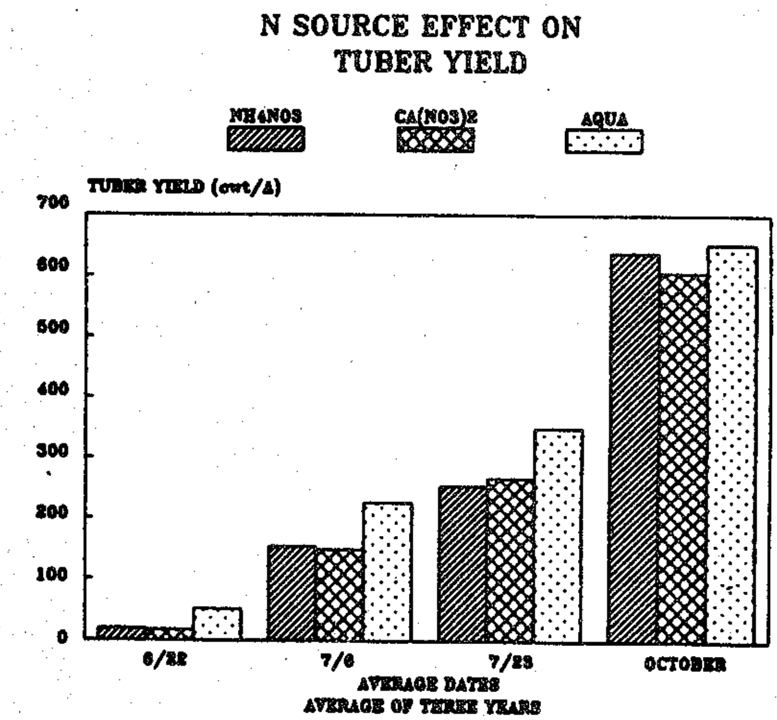


Figure 4.

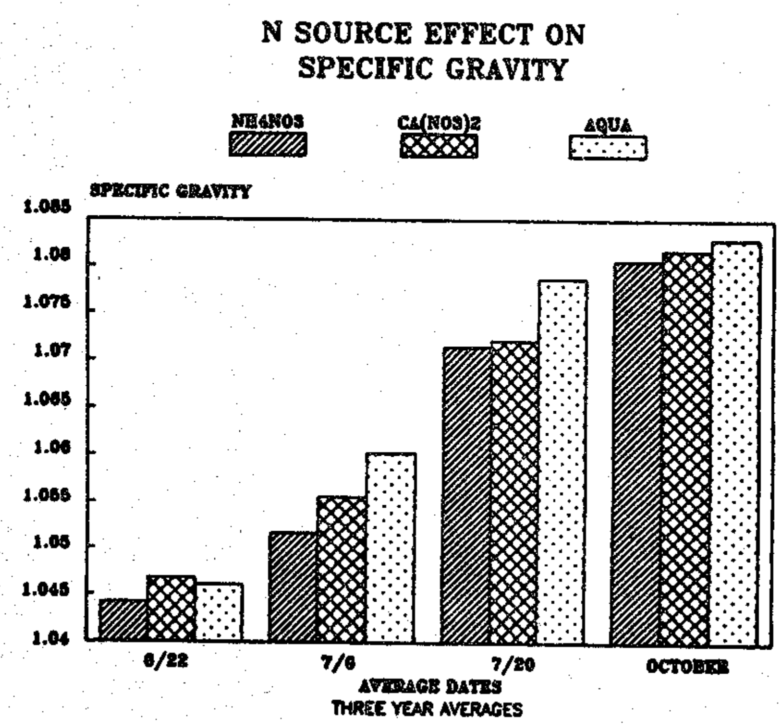


Figure 5.

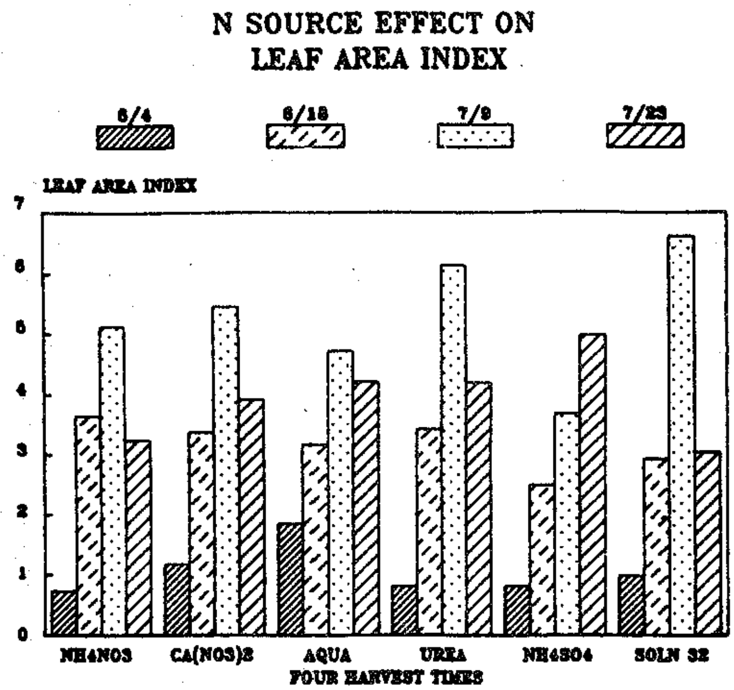


Figure 6.

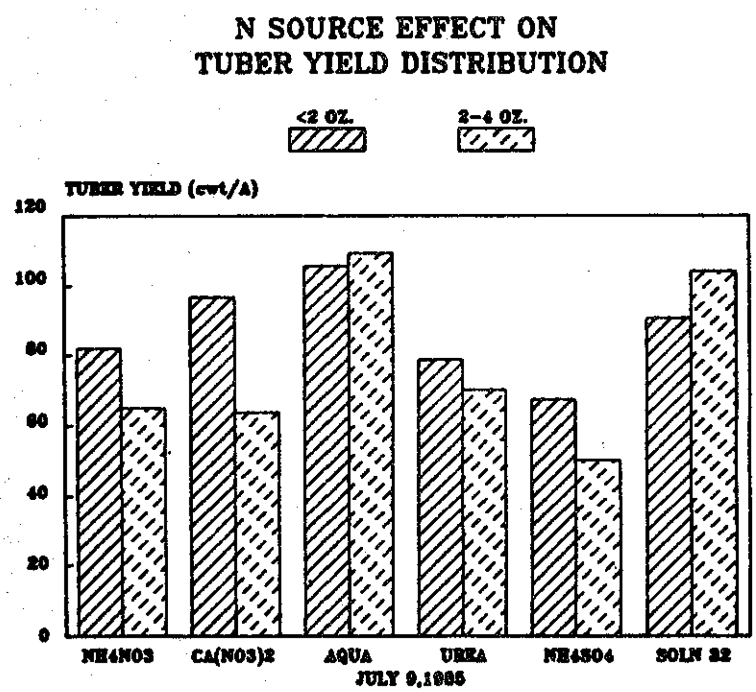


Figure 7.

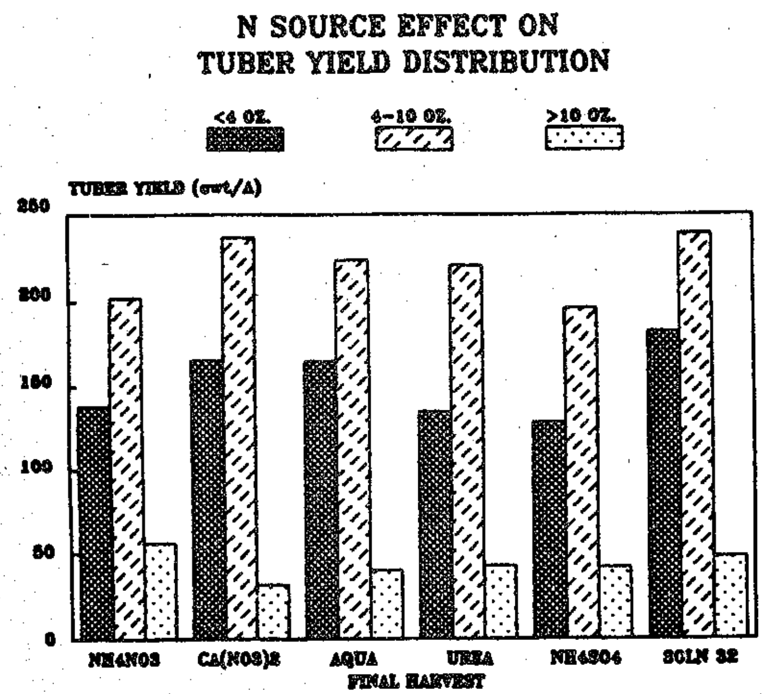


Figure 8.

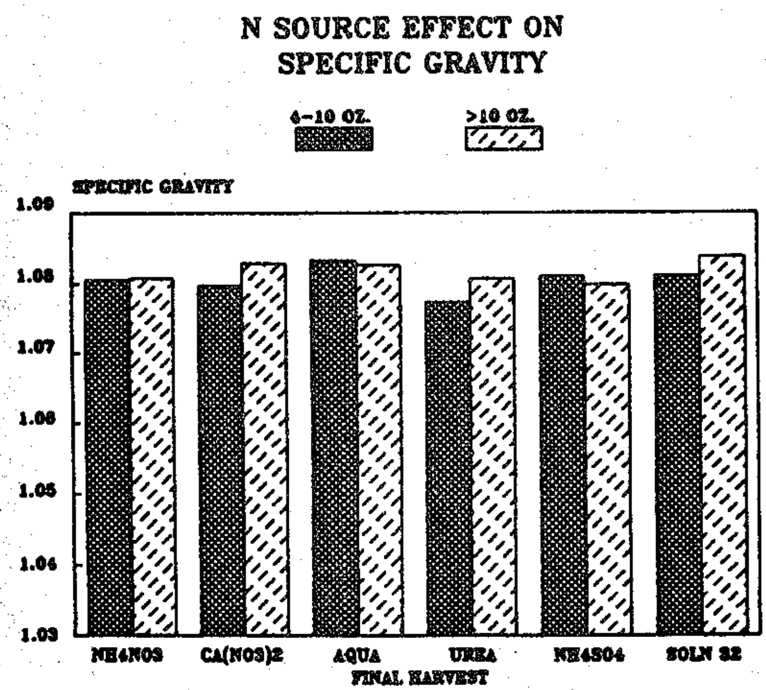
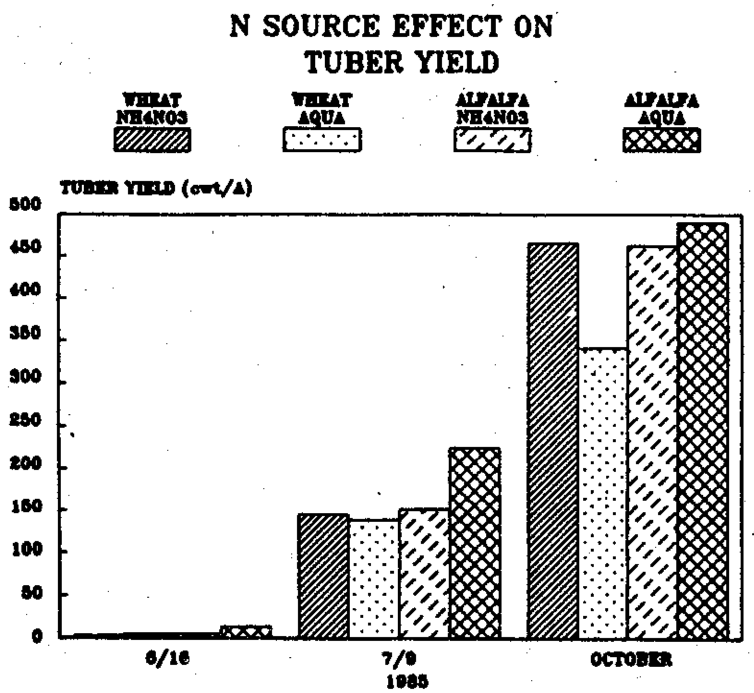


Figure 9.


N SOURCE EFFECT ON
TUBER YIELD
WHEAT NH4NO3
WHEAT AQUA
ALFALFA NH4NO3
ALFALFA AQUA
TUBER YIELD (cwt/A)
500
450
400
350
300
250
200
150
100
50
0
6/16
7/9
1985
OCTOBER