Increasing irrigated organic potato yields with liquid nitrogen fertilizers

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Introduction

- Inseason applications of N for potatoes
  - Repeated applications of nitrogen (N) necessary throughout growing season.
  - Conventional farmers typically use a 10% urea ammonium nitrate solution (UAN) through existing irrigation systems.
  - Organic farmers face the challenge of finding nitrogen sources comparable to UAN in nitrogen concentration, nitrogen availability, ease of application, and cost.
- Certified organic nitrogen fertilizers for inseason application
  - Chilean nitrate (NaNO3).
    - The most commonly used nitrogen source for certified organic fertigation
    - Inexpensive, applied through irrigation, and transported as a solid material.
    - Sodification issues - Organic certification restricts farmers to apply only 20% of N as NaNO3 (find reference in USDA organic certification manual).
  - Other options
    - Fish byproducts, liquid urea derived from plant and animal wastes, and feather teas from fermented poultry feather compost.
    - Little information to support the effectiveness of these products.
  - Certified organic and conventional nitrogen fertilizers for preplant application
    - Conventional farmers – Urea
      - Inexpensive, rich in N, easy to apply, and readily available to plant roots.
    - Certified organic growers - Composts and manures
      - Release nitrogen at a slower rate than chemical N fertilizers,
      - Could meet N needs of potatoes without the addition of inseason fertilizers.

Objective

To compare tuber yields and nitrogen recovery of potato plants with preplant manure fertilizers and in-season organically-certified fertilizers to conventional preplant and inseason fertilizers.

Methods and Materials

- Soil properties
  - Quincy fine sand (Mixed, mesic Xeric Torripsamments), soil pH = 7.8
- N source treatments (Table 1)
  - Target rate for all preplant/inseason combinations = 392 kg Plant Available Nitrogen (PAN) ha-1.
  - Preplant applications:
    - Poultry litter, poultry litter mixed with dairy manure compost, and urea were applied as preplant N source treatments.
      - Litter was combined with compost at a 2:1 ratio (by weight) based on total N content, as recommend by consultants in the organic vegetable cropping industry.
    - Plant available N was assumed to be 60% for poultry litter and 25% for the 2:1 litter/compost mixture.
  - Inseason Applications:
    - Inseason N was applied at a rate of 17 kg PAN ha-1 for 10 consecutive weeks starting 3 weeks after germination.
      - Treatments were applied at 224 kg PAN ha-1 for preplant and 168 kg PAN ha-1 for inseason using the following media, following standard recommendations for nitrogen application to: Salmon extract, Biolink liquid urea 14-0-0, feather tea, 10 % Urea Ammonium Nitrate solution
      - Chilean nitrate (NaNO3)
        - To adhere to the 20% requirement of total N application, litter was applied at a rate of 314 kg PAN ha-1 as preplant and NaNO3 at a rate of 78 kg N ha-1 as inseason.
      - Preplant treatments with litter and litter/compost were included without an inseason fertilizer.

Table 1. Preplant and inseason N source treatments for potatoes.

Treatment i.d.	1	2	3	4	5	6	7	8
Preplant N source *Rate*	Poultry litter *264 kg PAN ha-1*	Poultry litter *264 kg PAN ha-1*	Poultry litter *264 kg PAN ha-1*	Poultry litter *264 kg PAN ha-1*	Urea *264 kg total N ha-1*	Poultry litter *314 kg PAN ha-1*	Poultry litter *392 kg PAN ha-1*	Poultry litter /dairy manure compost *392 kg PAN ha-1*
Inseason N source *Rate*	Salmon extract *168 kg N ha-1*	Organic liquid urea *168 kg N ha-1*	Feather tea *168 kg N ha-1*	UAN *168 kg N ha-1*	UAN *168 kg N ha-1*	NaNO3 *78 kg N ha-1*	No inseason N applied	No inseason N applied

Methods and Materials (cont.)

- Experimental design
  - Five replications – randomized complete block design (RCBD)
  - Two varieties – Umatilla and Alturas
  - Eight fertilizer treatments (described above and listed in table 1)
  - One nitrogen rate (392 kg PAN ha-1)
  - One potato plant per pot
- Tissue and soil analysis
  - Destructive sampling after plants began to senesce (5 months after planting)
    - Fresh and dry weights were determined for tubers, roots, primary stem, petioles and leaves, and fruits.
    - Tuber counts were determined for each plant.
    - Total C, N, P, K, Ca, Mg, Fe, Zn, Cu, and Mn are to be determined.
- Soils
  - Soil pH, NO3, and NH4 concentrations determined at conclusion of experiment
- Statistical analysis
  - Multiple comparison with Tukey's for tuber yields, alpha = 0.05

Results and Discussion

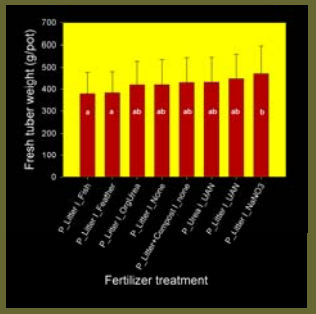
- Tuber yields
  - Yields significantly greater for NaNO3 than for feather meal or salmon extract
    - A large percentage of nitrogen in the meal and the extract is likely tied up in stable organic forms, and therefore not readily available to plants.
    - Nitrate in NaNO3 is readily available to plants, increasing tuber bulking
    - Larger proportion of litter used for NaNO3, may have influenced higher yields
  - Skipping the inseason nitrogen application did not have a significant effect on yield
    - Slow release of nitrogen from organic N in litter and litter/compost may be sufficient enough to provide nutrients to plants throughout the season
    - Although not statistically significant, higher yields were achieved with the NaNO3 inseason application.
  - Adding compost to litter did not significantly improve yields
    - The dairy manure compost used had an estimated 3 % N availability over a 5 month period (Moore et al.)
    - Compost may continue to slowly release N, but too slowly to have a significant effect on tuber growth in the first growing season.
  - Yields from conventional fertilizers (Urea/UAN and Litter/UAN) were not significantly greater than yields from organic fertilizers applied at the same rate
    - Illustrates the potential for farmers to use manures and/or organically certified commercial fertilizers to achieve competitive yields to their conventional farmer counterparts.
  - No variety X trt effects
    - Mechanism for adsorbing nutrients is likely similar among varieties
- Nitrogen recovery
  - Data currently being processed

Alturas and Umatilla potato plants in a Quincy sand, four months after planting

Table 2. Percent total N in preplant and inseason treatments.

	Amendment	% total N
Inseason fertilizers	Salmon extract	4.8
	Feather meal	1.5
	Organic urea	14.0
	NaNO3	16.5
	UAN	32.0
Preplant fertilizers	Litter	4.5
	Litter/compost	2.4
	Urea	45.0

Figure 1. Effect of N source(s) on fresh tuber weight. P=Preplant N source; I=Inseason N source. Target rate for all preplant/inseason combinations = 392 kg PAN ha-1.



Conclusions

1. Applying 20% of N inseason as organically certified NaNO3 significantly increases tuber yields in comparison to applying 40% of N inseason with organically certified feather meal and salmon extract, using poultry litter as the preplant N source.
2. Applying nitrogen inseason to poultry litter (with the same combined N rate) did not significantly increase tuber yields, although did increase means for NaNO3.
3. Supplementing poultry litter with dairy manure compost at a 2:1 N ratio did not significantly increase tuber yields.

References

Moore, A.D., Alva, A.K., Collins, H.P, and R.A. Boydston. Transformation of nitrogen from biofuel byproducts and animal manures amended to a sandy soil. *In internal review.*