FERTILIZING POTATOES IN IDAHO WITH DAIRY MANURE

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INTRODUCTION

There is a tremendous need by the dairy industry to utilize more agricultural areas for manure application. With rising fertilizer costs, increased production of dairy manure, and raised interest in organic farming, there seems to be greater potential for applying dairy manures as a preplant fertilizer for potatoes. Following USDA recommendations for both organic and Good Agricultural Practices (GAP) certification, dairy manure may be applied at a minimum of 120 days prior to potato harvest although some potato processing companies require a minimum of a one year period between manure application and potato planting.

There are a variety of potential issues to consider for manure application to potatoes. Growers are unsure as to how much nitrogen (N), phosphorus (P), and potassium (K) will be available from the manure to the plant during critical periods of emergence, tuberization, tuber bulking, and maturation. In addition, nutrient release and accumulation rates are likely to differ greatly depending on the timing of application. Another concern is the potential for tuber quality losses related to various disorders and diseases. Finally, concerns persist in regards to the survival time of pathogens in the soil originating from raw manure. These issues may prevent growers from considering dairy or livestock manure application, and thereby not taking advantage of a product which could potentially reduce input costs, improve soil quality, and increase tuber yields.

The focus of our research was to 1) determine the effect of using fields with a history of manure, compost, and chemical fertilizer application on Russet Burbank tuber yield, tuber quality, nutrient uptake, and soil nutrient concentrations, as well as various potato disorders and diseases, and 2) evaluate potato variety responses to organically approved fertilizers from dairy manure and other sources.

ORGANIC POTATO VARIETY TRIAL

To evaluate how different varieties respond under an organic potato production system, certified seed of “Defender”, “Alturas”, “Russet Norkotah”, “Russet Norkotah 8”, “Yukon Gold”, and “Dark Red Norland” potatoes were planted April 22, 2008 in an ISDA Organic approved field at the University of Idaho Kimberly Research and Extension Center. Compost was applied over the entire plot at 6 tons/A. Organic production methods were followed. Potatoes were harvested September 15, 2008. Subsamples for specific gravity, disease and disorders present, glucose and sucrose concentrations and processing quality were taken when appropriate. The rate of emergence varied greatly between varieties with Defender, Norkotah and Dark Red Norland exhibited rapid emergence compared to Norkotah-8, Yukon Gold and Alturas (data not shown). Yukon Gold was extremely slow to emerge and did not reach 80+% emergence for 50 days after planting. Some varieties’ growth appeared retarded due to the inadequate fertility under the

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organic system and prematurely died earlier in the season compromising yield and quality (data not shown). Defender and Alturas had green and vigorous vines near the end of the growing season indicating that these two varieties would be appropriate for an organic system with the potential of lower fertility conditions. Yields were relatively lower for this areas of Idaho although Defender, Yukon Gold and Alturas yielded over 200 cwt/A under these organic conditions whereas Norkotah and Norkotah-8 yielded less than 140 cwt/A (Table 1). Yukon Gold plots produced large tubers (55% >10 oz. of US#1; data not shown). Processing quality for Defender and Alturas harvested tubers were acceptable for processing quality as indicated by specific gravity (1.089 and 1.079 respectively) and fry color and sugar profiles (data not shown). External and internal visual evaluations for disease and disorders were made. Primary issues observed were black scurf, wireworm damage, vascular discoloration and hollow heart. Very little damage was evident and no significant differences between cultivars in scab, silver scurf, wet rot, black dot, growth cracks/malformed, skin sluff, soft rot, pink eye, jelly end rot, black heart, brown center, internal discoloration, net necrosis, Pythium leak, pink rot and dry rot (data not shown).

Table 1. Total yield, marketable yield, culls, and yield of US#2 grade (cwt/A). Values in the same column followed by the same letters are not significantly different at $p \leq 0.05$

Variety	Total Yield (cwt/A)	US#1 (cwt/A)	<4 oz (cwt/A)	US#2 (cwt/A)
Alturas	236 a	203 a	33 b	26
Yukon Gold	216 a	207 a	9 c	14
Defender	208 a	161 ab	47 a	36
Dark Red Norland	198 ab	179 a	19 c	13
Norkotah	139 bc	105 bc	34 b	20
Norkotah8	121 c	102 c	19 c	13

NUTRIENT MANAGEMENT FOR ORGANIC POTATO PRODUCTION

Russet Burbank potatoes were planted into a field that had been in alfalfa for two years prior. The field was also in its third and final year of transition into a certified organic field. Fresh dairy manure and composted dairy manure were incorporated to a 6-inch soil depth two weeks prior to planting at rates of 0 (control), 50, and 100 lb N/acre, comparable to rates used by organic potato growers in the Magic Valley. A fish emulsion was applied to selected plots at a rate of 10 lb total N/acre on July 15th, July 21st, and August 5th, 2008. Plants began senescing several weeks before potato plants on neighboring fields receiving chemical fertilizers, which may have resulted from an overall lack of plant available nitrogen as well as stress from Colorado Beetle infestations. Petiole nitrate concentrations throughout the season ranged from 5,000 to 11,000 ppm during tuber initiation, significantly lower than the 20,000 to 25,000, as recommended by UI fertilizer guides for Russet Burbank potatoes. Beetle infestations were controlled with Spinosad and Pyrethrum, but still caused significant damage to plants. Applying fresh manure at the high rate with no fish applications significantly increased tuber yields over all of the other treatments, including the fresh manure high rate treatment with fish applications (Table 2). Fresh manure typically has more ammonium and more readily mineralizeable forms of organic nitrogen than composted manure, which likely boosted early plant growth and tuber bulking later in the season. There was no significant treatment effect on grade, size, or petiole nitrate concentrations. The primary issues observed with tubers harvested from these plots were black scurf, malformation, vascular discoloration, jelly end rot, wireworm damage and dry rot. There were no significant differences between treatments or with other disease and disorder assessments (eg. scab, silver scurf, pink eye, wet rot, hollow heart or soft rot; data not shown). There were no significant differences between treatments related to fry color and sugar (glucose and sucrose concentrations; data not shown). This lack of difference may indicate limited variability between treatments in terms of vine and tuber maturity at the time of vine kill and harvest.

Table 2. Total yield, marketable yield, culls, and yield of US#2 grade (cwt/A). Values in the same column followed by the same letters are not significantly different at $p \leq 0.05$.

Preplant treatment	Preplant rate (Total lb. N/acre)	Fish added as Inseason N source?	Total Yield (cwt/A)	US#1 (cwt/A)	<4 oz (cwt/A)	US#2 (cwt/A)
Fresh Dairy Manure	100	No	414a	244	58	111
		Yes	283b	173	32	78
	50	No	293b	188	33	72
		Yes	233b	142	35	57
Composted Dairy Manure	100	No	245b	156	29	60
		Yes	234b	152	38	43
	50	No	237b	125	35	76
		Yes	275b	143	45	87
Control	0	No	272b	138	36	98
LSD $p \leq 0.05$			88	NS	NS	NS

LONG-TERM EFFECTS OF DAIRY MANURE APPLICATIONS ON POTATO PRODUCTION

Russet Burbanks potatoes were planted into a 2 acre ARS agricultural field that received applications of fresh solid dairy waste, composted solid dairy waste, inorganic P fertilizers, and/or no P source in the fall of 2003, 2004, and 2005. Chemical sources of N, P, and K were applied to fields in 2006, 2007, and 2008, based on the needs of the crop. Tuber yields were significantly greater for plots that had received fresh and composted dairy manure applications from 2003 to 2005, in comparison to plots that had received P chemical fertilizers or no P source over the same period (Table 3). The causes for the yield difference appear to be nitrate and potassium concentrations in the soil. Phosphorus concentrations in the soil were not significantly different among the P source treatments.

Table 3. Total yield, marketable yield, culls, and yield of US#2 grade (cwt/A). Values in the same column followed by the same letters are not significantly different at $p \leq 0.05$

Treatment	Total Yield (cwt/A)	US#1 (cwt/A)	<4 oz (cwt/A)	US#2 (cwt/A)
Manure	494a	333	42	126
Compost	487a	319	42	120
Fertilizer	412b	271	45	96
Control	349b	199	39	111
LSD $p \leq 0.05$	70.9	NS	NS	NS

Table 4. Effects of historical nutrient field treatments on soil chemical properties.

Treatment	NO3	P	K	Na	EC	pH
	----------------------------ppm----------------------				mmhos/cm	
Manure	43.3 a	19.8 a	204 a	88.8 a	0.62 a	8.20
Compost	31.0 b	17.3 a	170 a	71.8 ab	0.55 ab	8.20
Fertilizer	26.3 b	22.3 a	130 b	60.0 b	0.51 b	8.18
Control	22.5 b	5.0 b	128 b	54.5 b	0.48 b	8.18
LSD $p \leq 0.05$	12.0	11.2	34.3	18.5	0.083	NS

The presence of *E. coli* was detected on the surface of potatoes tested for all treatments in both the AO and the ARS studies. Strains were not identified, so it is still unknown if there is harmful strains present. According to the CDC (Center for Disease Control, under the department of Health and Human Services) *E. coli* 0157 is the primary strain to cause illness in humans.

The control treatment had a significantly higher incidence of jelly end rot compared to the other treatments (Table 5). This may be due to sub-optimal fertility and uneven growth in this treatment. There was a trend ($p \leq 0.10$) for less wireworm damage in the control plots compared to the other plots. There were no significant differences between treatments for any other disorder or disease evaluated (data not shown). The control plots also high significantly higher glucose levels and darker fry color compared to the other treatments (data not shown). There was a trend ($p \leq 0.10$) for greater sugar end development in the control and compost treatments compared to the others. This may indicate an early season stress in both treatments causing higher sugar end development.

Table 5. Internal visual evaluation for potato diseases and disorders for Russet Burbank in historic fertility treatments (ARS Manure Study)

Treatment	Wireworm	Scab	Vascular Discoloration	Brown Center	Jelly End	Black scurf	Growth Crack	Dry Rot
Manure	38	0	5	0	3	63	8	0
Compost	40	3	10	3	5	83	3	3
Fertilizer	35	5	10	0	0	73	8	0
Control	15	0	3	0	18	85	5	5
LSD $p \leq 0.05$	NS	NS	NS	NS	12	NS	NS	NS
LSD $p \leq 0.10$	21							