University of California
Agriculture and Natural Resources
Intermountain Research & Extension Center

RESEARCH REPORT
Number 171, 2016

Comparison of nitrogen fixing cover crops and organic amendments for nitrogen fertilization of organically grown potatoes

Rob Wilson, Center Director/Farm Advisor[1]; Daniel Geisseler, UC Davis CE Nutrient Management Specialist; Darrin Culp, IREC Superintendent of Agriculture; Kevin Nicholson & Skyler Peterson, IREC Staff Research Associates. University of California Intermountain Research & Extension Center[1], 2816 Havlina Rd. Tulelake, CA. 96134 Phone: 530/667-5117 Fax: 530/667-5265 Email: rgwilson@ucdavis.edu

Introduction: Certified organic potato acreage in the Tulelake Basin has increased rapidly in recent years. Organic production offers growers a niche market and price premiums. On the flip side, organic producers can encounter many challenges including finding economical ways to fertilize and manage pests. A major fertilization challenge is supplying adequate nitrogen to the potato crop. Many potato varieties require at least 150 lbs N/acre to avoid deficiency, and many organic fields in the Klamath Basin have little residual nitrogen in the soil at the time of potato planting. Organic nitrogen fertilizers including manure and compost can be used to fertilize organic potatoes, but their cost is substantially more than conventional nitrogen fertilizer. In addition to their high cost, it is difficult to determine how much manure and compost to apply as the majority of nitrogen in organic amendments is in organic form (N is bonded to C) not immediately available for plant uptake. Another option to supply nitrogen to organic potatoes is to grow legume cover crops prior to the potato crop. Legumes form a symbiotic relationship with bacteria, which can fix atmospheric nitrogen. When the cover crops are chopped and disked into the soil and decompose, the fixed nitrogen is released and becomes plant available. As is the case with organic amendments, it is challenging to predict how much and when nitrogen is released.

The study consisted of two trials. The first trial evaluated several cover crops planted in mid-summer the year before growing potatoes. The second trial evaluated several organic amendments applied the fall before growing potatoes or at potato planting. Data included nitrate and ammonium in the soil, potato petiole nitrate levels, potato yields, and potato quality. Study objectives included determining which nitrogen-fixing cover crops are best adapted to the Klamath Basin and estimating the nitrogen availability from cover crops and organic amendments when growing a Russet Norkotah potato crop in Tulelake soils.

Methods: Trials were conducted side-by-side at IREC in a field with low residual soil nitrate from growing repeated grain crops. The cover crop trial started in July 2014. Cover crops included multiple vetch species, clover, field peas, and two grasses. A complete list of cover crop treatments is shown in

Table 1. Cover crop treatments were drill seeded in July shortly after spring beardless barley was harvested for hay. Cover crops were irrigated until mid-October and then chopped and disked into the soil shortly after the first killing frost. Cover crop biomass yield was estimated in each plot and a sub-sample was sent to the lab to estimate the total nitrogen content in cover crop biomass the day before cover crop incorporation.

The amendment trial was started in late September 2014 when manure and compost treatments were applied to barley stubble and then disked into the soil. Manure and compost application rates were based on the nitrogen content of the amendment with the goal of achieving 150 lb N per acre across treatments. Manures and compost were independently tested for nutrient content after application to assure nutrient levels were close to manufacturer claims. Soy meal and blood meal were included in the amendment trial as a stand-alone spring-applied fertilizer at potato planting or as a compliment spring fertilizer at reduced rates in combination with fall-applied manure. Urea, a conventional nitrogen fertilizer source, was included at multiple rates to compare with organic fertilizer sources. All fertilizer and amendments applied at planting were broadcast and then immediately rototill incorporated.

Russet Norkotah potatoes were planted over treated areas on May 21st, 2015. Previous research at IREC has shown 150 to 200 lbs applied N/A is needed to maximize Russet Norkotah yield on Tulelake soils. Shortly before planting, soil samples were collected from each plot to determine pre-plant available nitrate, ammonium, and total nitrogen. Crop vigor was visually estimated throughout the growing season and petiole N was measured at early tuber bulking and crop maturity. Residual soil nitrate and ammonium was measured at potato harvest. Potatoes from each plot were harvested and graded to determine tuber yield and tuber quality. Potatoes were grown using solid-set irrigation. Weeds were managed with herbicides and potato diseases were managed with fungicides. No synthetic fertilizers were applied except for the urea fertilizer treatments. Both trials were organized in a randomized complete block design with 4 replications. Plots were 4 rows (12 ft) wide by 40 ft long. Sampling and potato harvest was taken from the middle 6 ft X 30 ft in each plot to avoid edge effects. Soil type was a Tulebasin mucky silty clay loam with 4.5% organic matter.

Table 1. Cover Crop Treatments tested in 2014-2015.

Trt #	Cover crop treatments	Seeding Rate	100% DM Biomass Yield tons/acre [1]	% Nitrogen	Added lbs N/A [2]
1	Fallow (untreated)	n/a	n/a	n/a	0
2	Fallow and 75 lbs N/A urea fertilizer applied at potato planting	n/a	n/a	n/a	75
3	Fallow and 150 lbs N/A urea fertilizer applied at potato planting	n/a	n/a	n/a	150
4	SX17' Sorghum-Sudangrass	30 lbs/A	1.02	1.23%	25
5	Hairy Vetch	50 lbs/A	2.22	4.60%	203
6	AC Greenfix' Chickling Vetch	60 lbs/A	1.97	4.58%	180
7	Lana' Woollypod Vetch	60 lbs/A	2.45	4.63%	226
8	Berseem Clover	20 lbs/A	1.37	2.43%	65
9	Flex' Spring Forage Field Pea	10 seeds/ft ^{2}	2.55	4.10%	208
10	Nutrigreen' Winter Field Pea	10 seeds/ft ^{2}	2.16	4.38%	188
11	Koyote' Winter Field Pea	10 seeds/ft ^{2}	2.16	5.05%	218
12	Journey' Spring Field Pea	10 seeds/ft ^{2}	2.47	3.45%	170
13	Banner' Spring Field Pea	10 seeds/ft ^{2}	2.83	3.58%	204
14	Pro 128-6114' Winter Field Pea	10 seeds/ft ^{2}	1.98	4.45%	174
15	Flex' Spring Field Pea (above ground biomass harvested and removed to simulate silage crop)	10 seeds/ft ^{2}	2.22	4.20%	0
16	Trical 102' Winter Triticale	90 lbs/A	0.39	2.05%	16
	95% Confidence Interval		0.3	0.28%	26

[1] Biomass yield was determined by harvesting a 5ft by 10ft quadrat in each plot the day before chopping.

[2] Added lbs N/A was calculated by multipying the above ground biomass yield * the % nitrogen of the biomass. This calculation does not include the small amount of nitrogen in cover crop roots.

Table 2. Organic Amendments Tested in 2014-2015.

Trt #	Organic amendment treatments [1]	Application Rate	% Nitrogen	Added lbs N/A [2]
1	Control-Grain Only	n/a	n/a	0 lbs
2	75 lbs N/A Urea Fertilizer at potato planting	163 lbs urea/A	46%	75 lbs
3	150 lbs N/A Urea Fertilizer at potato planting	326 lbs urea/A	46%	150 lbs
4	150 lbs N/A Urea split-applied: 75 lbs N/A at potato planting & 37.5 lbs N/A at tuber initiation & 37.5 lbs N/A at mid-bulking	326 lbs urea/A	46%	150 lbs
5	Perfect Organic Blend 4-4-4 FA chicken manure	3750 lbs/A	4.40%	165 lbs
6	Stutzman Nutri-Rich 4-3-2 pelleted chicken manure 1X rate	3750 lbs/A	3.60%	135 lbs
7	Composted steer manure (dried/screened)	10000 lbs/A	0.94%	94 lbs
8	Compost Solutions Compost (green waste & manure) 1X rate	10000 lbs/A	1.50%	150 lbs
9	Compost Solutions Compost (green waste & manure) 0.2X rate	2000 lbs/A	1.50%	30 lbs
10	Explorer Soy fertilizer	1154 lbs/A	13%	150 lbs
11	Pro-Pell-It Bloodmeal	1154 lbs/A	13%	150 lbs
12	Stutzman Nutri-Rich 4-3-2 pelleted chicken manure 0.5X rate	1875 lbs/A	3.60%	68 lbs
13	Stutzman Nutri-Rich 4-3-2 pelleted chicken manure	1875 lbs/A	3.60%	143 lbs
13	Explorer Soy fertilizer	577 lbs/A	13%	
14	Stutzman Nutri-Rich 4-3-2 pelleted chicken manure	1875 lbs/A	3.60%	143 lbs
14	Pro-Pell-It Bloodmeal	577 lbs/A	13%	
15	TRUE 3-1-2 organic liquid fertilizer	750 gal/A	2%	150 lbs

[1] Chicken manure, steer manure, and compost were applied and incorporated in late September the year before growing potatoes. Urea, bloodmeal, soy fertilizer, and TRUE 3-1-2 were applied and mechanically incorporated at potato planting.

[2] Added lbs N/A from amendments was calculated based on the application rate and lab verified % N content.

RESULTS

Cover Crop Biomass Yields and Fall Nitrogen Contribution

Establishment of all cover crops in 2014 was successful. Spring field pea varieties, hairy vetch, and woollypod vetch were the top-yielding legumes (Table 1). Chickling vetch yield and nitrogen contribution was lower than the other vetch species but similar to some field pea varieties (Table 1). Berseem clover growth rate was slow compared to vetches and field peas. Spring field pea varieties had quicker growth rates and high yields compared to winter varieties (personal observation), but differences in added nitrogen between spring and winter field pea varieties was variety specific (Table 1). Grass cover crops had low yields likely due to low soil nitrogen, and the added nitrogen from grasses was not significantly different from the fallow plot.

Influence of Cover Crops and Organic Amendments on Soil Nitrate and Potato Petiole Nitrate

Soil nitrate at the time of potato planting was closely correlated to added nitrogen from cover crops (Table 3). Woollypod vetch and hairy vetch had the highest soil nitrate at potato planting. Many of the field pea varieties also had higher soil nitrate at potato planting compared to the fallow control. Nitrate availability from the legume cover crops remained elevated throughout the growing season demonstrated by higher nitrate in potato petioles and higher soil nitrate at harvest compared to the fallow treatment (Table 3). Triticale and sorghum-sudangrass treatments had lower soil nitrate at potato planting compared to the fallow treatment suggesting decomposition of grass residue reduced mineralized nitrogen at the time of potato planting (Table 3). The reduction in soil nitrate from grass cover crops was temporary as soil nitrate at potato harvest in grass cover crop treatments was higher than the untreated fallow (Table 3). Unfortunately, the rebound in soil nitrate occurred too late in the growing season to significantly influence potato yields since grass cover crop treatments had the lowest petiole nitrate at early bulking (Table 3).

Chicken manure treatments increased soil nitrate at planting compared the untreated with the 1X rate having higher soil nitrate compared to ½X rate of chicken manure (Table 3). Chicken manure treatments also increased potato petiole nitrate at early tuber bulking and vine maturity (Table 3). Blood meal, soy fertilizer, and urea were applied after soil sampling at potato planting, so added plant available nitrogen from these applications is not reflected in the soil nitrate test at planting. Blood meal and soy fertilizer increased potato petiole nitrate at early bulking compared to the untreated (Table 3). Potato petiole nitrate levels in blood meal and soy fertilizer treatments were quite similar to 1X urea fertilizer treatments as they all had similar petiole nitrate at early bulking (Table 3). Adding a ½X rate blood meal or soy fertilizer to a ½X rate of chicken manure did not increase potato petiole nitrate at early bulking compared to the 1X rate of chicken manure (Table 3).

Compost at all rates and composted steer manure did not increase soil nitrate at potato planting compared to the untreated (Table 3). Compost and composted steer manure treatments also did not increase potato petiole nitrate at early bulking and vine maturity compared to the untreated (Table 3) suggesting nitrogen in these amendments is mineralized very slowly.

Influence of Cover Crops and Organic Amendments on Potato Yield, Potato Quality, and Revenue
All three vetch species (woollypod, hairy, and chickling) had the highest total potato yield in the cover crop trial (Table 4). Several field pea varieties also increased total potato yield compared to the fallow control (Table 4). Higher potato yields associated with legume cover crops was not surprising since these treatments increased soil nitrate at planting and increased potato petiole nitrate at early bulking compared to the fallow treatment (Table 3 and 4). There was a strong positive relationship between cover crops total potato yield and potato petiole nitrate at early bulking (Figure 1). Exceptions to this relationship were lower than expected yields for the sorghum-sudangrass treatment and the Flex field pea treatment where tops were removed for hay.

Hairy vetch had higher cull yield compared to other treatments, although none of the treatments had a substantial increase in cull yield or tubers with knobs and growth cracks (Table 4). All treatments in the cover crop trial had higher than normal hollow heart (Table 4), and the incidence of hollow heart was greatest in those treatments with the lowest soil nitrate at planting and petiole nitrate at early bulking except for the fallow control. Hollow heart is often caused by an abrupt change in growing conditions. A possible explanation for the high incidence of hollow heart in cover crop treatments with low mineralized nitrogen is some of the organic nitrogen that was tied up early season was rapidly mineralized late in the growing season. Several of the grass and low N cover crop treatments had higher soil nitrate at harvest compared to the fallow control (Table 3).

There was strong relationship between potato yield and potato petiole nitrate at early bulking for organic amendments (Figure 2). 1X chicken manure treatments, soy fertilizer, and blood meal all had similar total yield compared to the 150 lb N/A urea fertilizer treatments (Table 4). The only organic amendment treatment with a total potato yield higher than expected when comparing it to petiole nitrate was the ½ rate of chicken manure with ½ rate of blood meal. The reason why chicken manure + blood meal had a higher yield is unknown, but it is likely related to higher amounts of mineralized nitrogen being available at times of potato growth not measured in the study. Potato yields for compost and composted steer manure treatments were not different from the untreated (Table 4).

The overall percentage of hollow heart averaged across organic amendment treatments was less than the cover crop treatments, but the trend for increasing incidence of hollow heart in treatments with low mineralized nitrogen was similar in both trials. Compost at the 1X rate, composted steer manure, and the untreated had significantly more hollow heart compared to treatments with higher nitrate availability.

All three vetch species had higher potato revenue compared to the 150 lb N/A urea fertilizer treatments (Table 4). The reason potato yield and potato revenue was higher in the vetch treatments compared to the 150 lb N/A urea fertilizer treatment is likely related to the fact that these cover crops added more than 150 lb N/A to the soil the previous fall. In future trials, the research team plans to include urea fertilizer rates higher than 150 lb N/A to provide a more equal comparison for cover crops that produce more than 150 lb N/A. None of the organic amendments produced statistically higher potato revenue or total potato yield compared to the 1X urea fertilizer treatments suggesting nutrients from amendments were not superior for potato growth compared to conventional urea fertilizer.

An economic analysis will be completed after the study is replicated in 2016-2017. A preliminary cost estimate for growing the cover crops including all production costs (tillage, seed, irrigation, harvest, etc.) is $166/acre. The cost of the organic amendments ranged from $73/acre to $4,000/acre. Using these cost figures, additional revenue generated from most cover crops exceeded the cost to grow the cover crop. Additional revenue from organic amendments was often less than the amendment cost especially for expensive amendments like blood meal and soy fertilizer (data not shown). Chicken manure was the cheapest source per lb of nitrogen especially when factoring in the rapid availability of mineralized nitrogen from chicken manure.

A similar study is planned for 2016-2017 at IREC. Many of the cover crop and amendment treatments shown in this report will be replicated. Additional cover crop treatments will also be tested to determine which ones are best adapted to the Klamath Basin under irrigated and non-irrigated conditions when planted in the spring and irrigated mid-summer and fall planting times. Future studies will also further investigate the influence of cover crops and amendments on potato pests including weeds, insects, and diseases.

Table 3. The Influence of Cover Crops & Organic Amendments on Soil Nitrogen, Potato Petiole Nitrate, Potato Stand, & Potato Vigor.

Trt #	Cover Crop Treatment [1]	Total Nitrate-N in soil at potato planting ppm	Nitrate-N in top **2-10 inches** of soil at potato planting ppm	Nitrate-N in top **10-20 inches** of soil at potato planting ppm	Potato petiole nitrate at early bulking ppm	Potato petiole nitrate at vine maturity ppm	Mid-Season vine vigor 0-10 scale	Potato stand %	Nitrate-N in top **2-10 inches** of soil at harvest ppm	Nitrate-N in top **10-20 inches** of soil at harvest ppm	Total Nitrate-N in soil at harvest ppm
7	Woollypod vetch	55.1	27.7	27.5	20156	6449	7.58	97.3	23.9	11.9	35.8
3	150 lb N/A Urea fertilizer at planting (1X rate)	30.2	13.9	16.4	17536	6894	7.40	97.7	13.6	12.2	25.8
5	Hairy vetch	52.5	26.9	25.6	17164	n/a	7.40	98.8	23.0	12.2	35.1
9	FLEX spring field pea	47.4	24.3	23.1	16835	5578	7.38	96.9	23.1	12.8	35.9
13	Banner spring field pea	39.8	20.7	19.0	16799	n/a	7.20	97.6	17.6	9.1	26.7
6	Chickling vetch	46.2	25.2	21.0	16461	n/a	7.63	97.3	21.4	11.6	33.0
10	Nutrigreen winter field pea	42.9	23.9	19.1	16310	n/a	7.23	97.7	18.1	11.2	29.3
11	Koyote winter field pea	47.8	26.8	21.0	15338	n/a	7.18	96.5	21.7	12.5	34.2
2	75 lbs N/A Urea fertilizer at planting (0.5X rate)	30.9	14.3	16.6	15115	2136	7.43	96.9	13.1	9.4	22.4
14	Pro 128-6114 winter field pea	48.6	25.6	23.0	14676	n/a	7.12	97.5	15.5	11.6	27.1
12	Journey spring field pea	43.8	22.2	21.6	13194	n/a	7.08	98.4	19.1	11.1	30.2
15	Flex field pea (top harvested and removed)	26.5	14.6	12.0	10191	349	6.70	96.9	20.0	12.2	32.2
1	Fallow (no cover crop)	31.3	14.2	17.1	7776	326	6.50	97.3	11.4	8.6	20.0
8	Berseem clover	27.6	15.3	12.3	6212	n/a	6.78	96.9	21.1	10.9	32.0
16	Trical 102 triticale	18.6	10.7	8.0	2612	n/a	6.53	95.7	18.5	11.5	30.0
4	SX17 sorghum-sudangrass hybrid	18.9	10.9	8.0	1074	45	6.65	99.2	19.8	10.6	30.4
	p-value	0.01	0.01	0.01	0.001	0.001	0.000	0.700	0.002	0.72	0.02
	95% CI	5.3	2.8	3.6	2766	1660	0.34		5.0		6.4
Trt #	**Organic Amendments** [2]										
3	150 lb N/A Urea fertilizer at planting (1X rate)	32.4	16.3	16.1	23328	9375	7.50	99.6	14.9	10.6	25.6
4	150 lb N/A Urea fertilizer split-applied (1X rate)	31.4	15.5	15.9	22698	9773	7.43	98.1	24.1	9.7	33.8
5	Perfect Organic Blend Chicken Manure	64.2	35.0	29.2	22254	6687	7.33	98.8	12.6	7.4	20.0
14	Stuzman Chicken Manure + Blood Meal	39.1	19.6	19.4	21086	5417	7.70	98.8	14.0	8.1	22.1
11	Pro-Pell-It Bloodmeal	29.5	14.4	15.1	20733	7441	7.48	98.4	16.3	9.6	25.9
10	Explorer Soy fertilizer	29.9	15.3	14.5	20491	n/a	7.35	98.8	17.4	7.9	25.3
2	75 lb N/A Urea fertilizer at planting (0.5X rate)	31.4	15.0	16.4	19468	2171	7.25	99.2	13.4	6.5	19.9
13	Stutzman Chicken Manure + Explorer Soy fertilizer	38.3	18.3	20.0	19364	n/a	7.23	98.4	13.8	8.2	22.0
6	Stutzman Nutri-Rich Chicken Manure (1X rate)	49.4	24.3	25.1	19070	3169	7.28	99.2	14.6	6.8	21.4
12	Stutzman Nutri-Rich Chicken Manure (0.5X rate)	38.7	18.8	19.9	16593	n/a	7.05	98.1	9.6	5.5	15.2
15	TRUE 3-1-2 organic liquid fertilizer	30.8	14.9	15.9	16020	n/a	7.05	98.1	11.5	7.3	18.8
9	Compost Solutions Compost (0.2X rate)	31.1	14.8	16.3	14295	272	6.63	99.2	12.4	7.0	19.4
1	Untreated (no amendments)	31.1	15.4	15.8	14183	797	6.93	96.5	12.1	7.8	19.9
8	Compost Solutions Compost (1X rate)	29.8	14.4	15.4	13456	2413	6.93	99.2	9.7	7.6	17.3
7	Composted Steer Manure	29.5	14.4	15.1	10158	n/a	6.83	98.8	10.9	5.9	16.8
	p-value	0.001	0.001	0.001	0.001	0.001	0.000	0.141	0.001	0.001	0.001
	95% CI	3.4	2.5	1.4	3294	3188	0.29		3.9	2.0	5.0

[1] Cover Crop Treatments are sorted from highest to lowest petiole nitrate at early tuber bulking.

[2] Organic amendment treatments are sorted from highest to lowest petiole nitrate at early tuber bulking.

Table 4. The Influence of Cover Crops & Organic Amendments on Potato Yield, Potato Quality, and Revenue.

Trt #	Cover Crop Treatment [1]	Total Yield cwt/A	US # 1 Yield cwt/A	2's Yield cwt/A	Culls Yield cwt/A	% US # 1 Yield %	Tuber per Plant #	Average Tuber Size ounces	Tubers with knobs, growth cracks, or irregular shape %	Tubers with hollow heart %	Potato Revenue [3] $/acre
7	Woollypod vetch	428	339	26	29	79	5.1	8.0	11	18	$3,464
5	Hairy vetch	414	307	27	40	74	5.2	7.5	15	20	$2,968
6	Chickling vetch	397	313	25	19	79	5.2	7.3	9	30	$3,033
9	FLEX spring field pea	388	294	24	25	76	5.2	7.0	10	10	$2,782
14	Pro 128-6114 winter field pea	385	296	29	17	76	5.2	7.0	10	15	$2,853
12	Journey spring field pea	385	298	21	22	77	5.3	6.8	10	28	$2,811
3	150 lb N/A Urea fertilizer at planting (1X rate)	383	279	19	28	73	5.8	6.3	9	30	$2,460
2	75 lbs N/A Urea fertilizer at planting (0.5X rate)	382	272	25	23	71	5.9	6.1	9	20	$2,327
10	Nutrigreen winter field pea	381	287	28	23	76	5.2	6.9	10	25	$2,659
13	Banner spring field pea	378	284	19	30	75	5.3	6.8	10	35	$2,599
11	Koyote winter field pea	357	256	24	31	71	4.9	7.0	11	23	$2,347
16	Trical 102 triticale	351	285	18	10	81	5.1	6.7	7	55	$2,682
1	Fallow (no cover crop)	348	254	20	11	73	5.8	5.7	6	20	$2,123
8	Berseem clover	344	267	16	13	78	5.1	6.5	7	50	$2,448
15	Flex field pea (top harvested and removed)	324	225	24	17	68	5.5	5.6	10	48	$1,812
4	SX17 sorghum-sudangrass hybrid	311	247	11	11	79	4.8	6.1	7	65	$2,175
	p-value	0.000	0.020	0.011	0.004	0.040	0.000	0.000	0.005	0.000	0.007
	95% CI	31	38	6	10	5	0.3	0.6	2	14	$499
Trt #	**Organic Amendments [2]**										
14	Stuzman Chicken Manure + Blood Meal	446	312	22	67	70	5.7	7.3	15	8	$2,844
4	150 lb N/A Urea fertilizer split-applied (1X rate)	426	289	18	76	68	5.5	7.3	15	8	$2,554
3	150 lb N/A Urea fertilizer at planting (1X rate)	426	290	14	72	68	5.7	6.9	15	5	$2,561
10	Explorer Soy fertilizer	424	286	18	73	67	5.6	7.1	16	0	$2,548
11	Pro-Pell-It Bloodmeal	423	290	26	66	68	5.5	7.2	17	0	$2,582
5	Perfect Organic Blend Chicken Manure	423	274	29	76	65	5.5	7.3	17	8	$2,367
6	Stutzman Nutri-Rich Chicken Manure (1X rate)	416	283	22	61	68	5.8	6.7	15	5	$2,464
2	75 lb N/A Urea fertilizer at planting (0.5X rate)	413	285	21	56	69	5.7	6.8	15	15	$2,542
12	Stutzman Nutri-Rich Chicken Manure (0.5X rate)	412	285	26	57	69	5.7	6.8	15	13	$2,413
13	Stutzman Chicken Manure + Explorer Soy fertilizer	405	264	16	73	65	5.7	6.7	16	3	$2,266
15	TRUE 3-1-2 organic liquid fertilizer	402	282	25	43	70	5.8	6.5	12	13	$2,427
8	Compost Solutions Compost (1X rate)	397	284	18	43	71	5.7	6.5	13	23	$2,479
7	Composted Steer Manure	394	285	13	46	72	5.7	6.5	12	25	$2,494
1	Untreated (no amendments)	384	269	20	46	70	5.7	6.5	13	23	$2,261
9	Compost Solutions Compost (0.2X rate)	383	263	23	42	69	5.9	6.1	13	15	$2,096
	p-value	0.039	0.864	0.077	0.035	0.838	0.955	0.069	0.234	0.090	0.791
	95% CI	25	32	7	18			0.5	3	13	$427

[1] Cover Crop Treatments are sorted from highest to lowest total yield.

[2] Organic amendment treatments are sorted from highest to lowest total yield.

[3] Potato revenue was calculated as: 8 to >16 oz potatoes selling for $18.90 per CWT; 80 % of 4-8 oz potatoes selling for $10.80 per CWT and 20% for $18.90 per CWT; culls, 2's, and undersized potatoes selling for $3.75 per CWT. A shed cost of $6.25 CWT was subtracted from revenue.

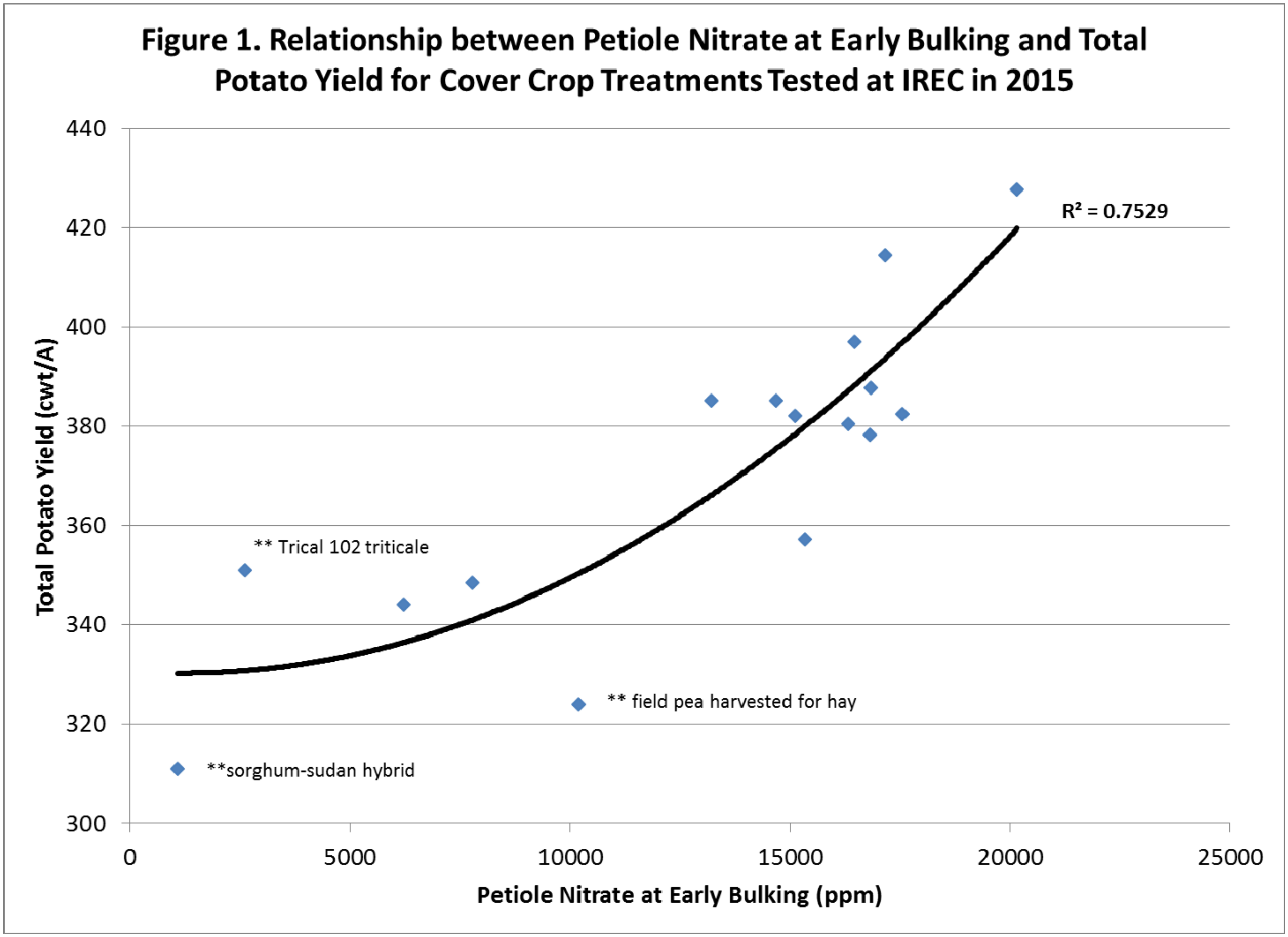

Figure 1. Relationship between Petiole Nitrate at Early Bulking and Total Potato Yield for Cover Crop Treatments Tested at IREC in 2015
R² = 0.7529
** Trical 102 triticale
** field pea harvested for hay
**sorghum-sudan hybrid
Total Potato Yield (cwt/A)
Petiole Nitrate at Early Bulking (ppm)
440
420
400
380
360
340
320
300
0
5000
10000
15000
20000
25000

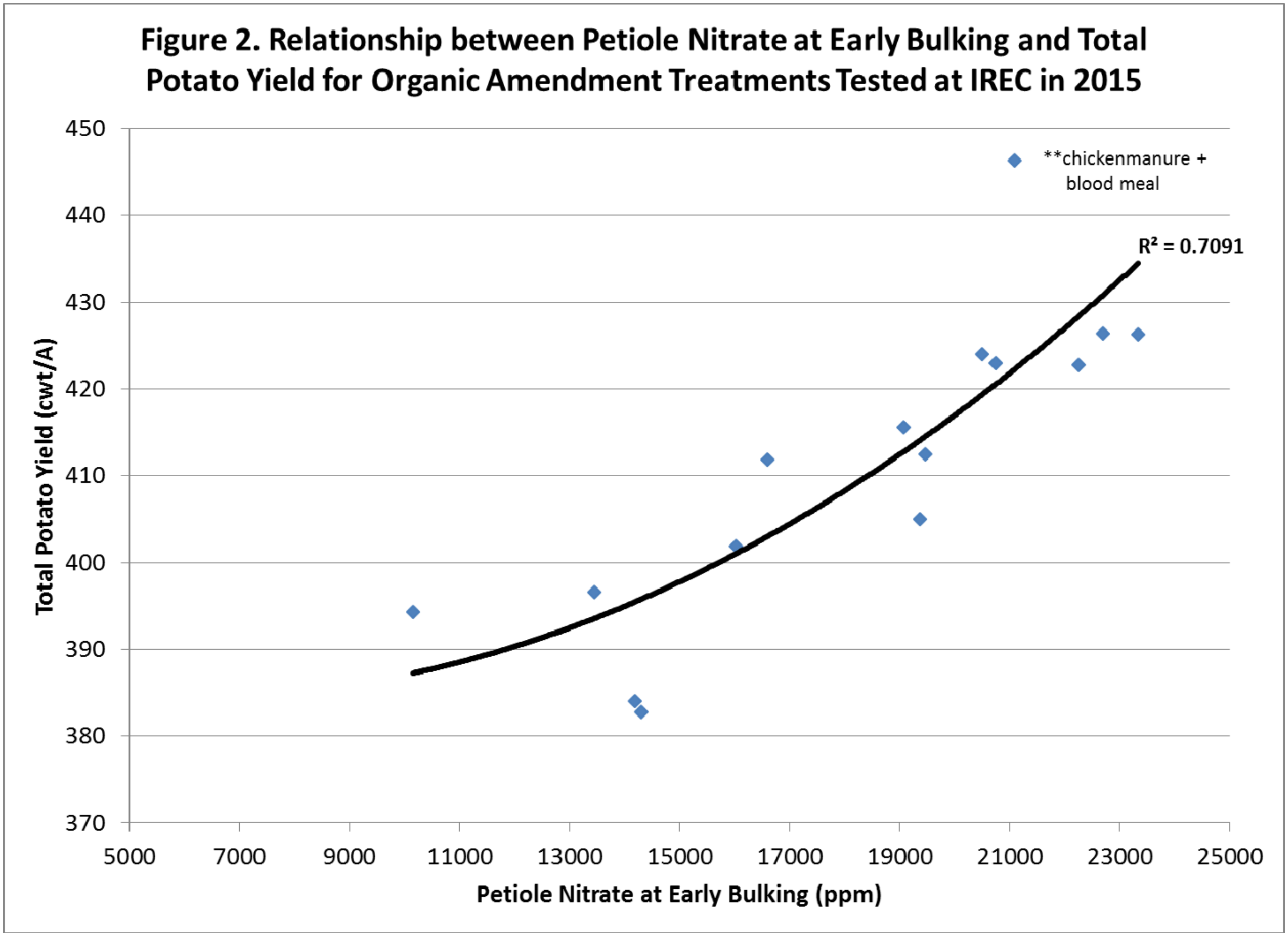
Figure 2. Relationship between Petiole Nitrate at Early Bulking and Total Potato Yield for Organic Amendment Treatments Tested at IREC in 2015
450
440
430
420
410
400
390
380
370
Total Potato Yield (cwt/A)
**chickenmanure + blood meal
R² = 0.7091
5000
7000
9000
11000
13000
15000
17000
19000
21000
23000
25000
Petiole Nitrate at Early Bulking (ppm)