PROJECT NO: BJKX38, BJKX40

TITLE: Long-Term Impacts of Manure Application on Production of Wheat and Other Crops

PERSONNEL: Amber Moore, Juliet Marshall, and Paul Patterson

ADDRESS: Amber Moore, Twin Falls R&E Center, PO Box 1827, Twin Falls, ID 83303-1827, 208 736-3629, amberm@uidaho.edu,

JUSTIFICATION: Dairy manure is commonly applied to irrigated crops in Southern Idaho. Fields that are nearer dairies commonly receive the highest rates of applications, as a means to dispose of the manure while avoiding expensive transportation costs to move the manure to fields further away from the dairies. Alternatively, many Idaho growers are realizing the benefit of manure/compost as a nutrient source and soil amendment, and are applying manure to their fields as an affordable source of phosphorus, potassium, and micronutrients. However, there are concerns that manure does not contain P and/or K to replace fertilizers at lower application rates. At the higher rates used for waste disposal, there are concerns with degraded soil quality due to salt and copper accumulations, degraded water quality due to phosphorus accumulation and nitrate leaching, crop yield losses, and crop nutrient toxicities. At low and high rates, growers are concerned about pathogen persistence, and increased disease, insect, and weed pressure. To avoid some of the issues related pest and pathogen pressure, sugar beet and potato growers commonly apply manures prior to establishing the grain crop in their rotation, and not before sugar beets or potatoes, due to the perception that root crops are more susceptible to pathogen and disease issues than grain crops. Some fields near dairies continue to receive manure applications on a yearly basis, regardless of crop.

The majority of the research regarding manure applications and plant growth in southern Idaho has been focused on only one, two, or three annual manure applications (Moore et al., 2011; Lentz et al., 2011; Leytem and Bjorneberg, 2009;). While this research is very useful for understanding the immediate impacts of manure applications, it does not capture the impact of repeated manure applications over several years (8 years or more). These types of applications are more realistic to the common practices of a dairy operation, and will better reflect soil quality, soil nutrient, crop yield, crop quality, microbial, and pest pressure responses than shorter-term manure applications.

HYPOTHESIS & OBJECTIVES:

Objective – Develop recommendations for optimal manure application rates and timing (annual or biennial, for a few years or several years of manure application), on the basis of yield potential, grain quality, soil quality, disease pressure, and nutrient uptake.

Hypothesis – Manure applications at agronomic rates that meet plant requirements for optimum economic yield will improve grain yields, due to the adequate concentrations of nitrogen, phosphorus, potassium, and increase of organic matter in the soil. Applications at rates in excess of plant nutrient requirements may lower crop quality.

PROCEDURES: The complete study will be conducted on two adjacent 2.5 acre sized sprinkler irrigated fields at the USDA ARS NWISRL station in Kimberly, Idaho. The soil type is Portneuf silt loam, which is the most commonly farmed soil type in Southern Idaho.

This eight year study is entering its second year. The selected crop rotation for field #1 is wheat-potatoes-barley-sugar beets, and will be planted to wheat in 2013 (completed) and 2017. The selected crop rotation for field #2 is barley-sugar beets-wheat-potatoes, and will be planted to wheat in 2015 and 2019. Having two fields with the same experimental designs will allow us to gather data for wheat (and other specific crops) every other year instead of once every four years. Treatments are application timing (manure will be applied prior to grain establishment every year or every other year) and rate ((9, 18, and 27 ton/acre, dry weight basis). The lower rates (9 and 18 ton/acre) are typical rates used by sugar beet growers, based on a internal survey conducted by the Snake River Sugar Beet Growers. The higher rate (27 ton/acre) is intended to simulate a waste disposal scenario, similar to what is commonly seen on fields that are near dairies. Additional fertilizer treatment (chemical sources applied at agronomic rates based on UI fertilizer guides) and a control treatment (no nutrient source applied) will also be included, for a total of 8 treatments per field (2 application timings at 3 rates + 1 standard chemical fertilizer trt + 1 control trt). Treatments will be replicated four times in a randomized complete block, for a total of 32 treatments per field. Plot size will be 40 ft. wide by 60 ft. long, allowing for both relatively uniform irrigation from solid set sprinklers and enough space for other disciplines to collect samples without compromising yield rows. A spacing of 80 feet between fields will be established to avoid irrigation drift from the adjacent field.

The manure source will be a partially dried dairy manure that has been stockpiled at least one year, representing a dairy manure source that is commonly applied to wheat, barley, potato, and sugar beet fields in Southern Idaho. Triplicate manure samples will be analyzed by a Minnesota Department of Agriculture certified manure testing lab for moisture, soluble salts (EC), pH, organic matter, carbon (C), nitrogen (N), ammonium, phosphorus (P), potassium (K), sulfur (S), magnesium (Mg), calcium (Ca), copper (Cu), iron (Fe), zinc (Zn), manganese (Mn), and boron (B) content. The manure will also be analyzed for fecal coliform counts, *E.coli* counts, *Salmonella* evaluation, carbon dioxide and ammonium evolution, bulk density, bioassay germination, toxic metals, and particle size analysis. To minimize variability in manure characteristics from year to year, we will collect similarly aged manure from the same dairy every year. Also, we will be able to quantify approximately how much of a specific nutrient was applied each year, using the analysis information described above. Manure will be applied in October by pre-weighing the amount of manure equivalent to the treatment rate, and applying the manure using a small-plot manure spreader from the USDA ARS Kimberly station. Manure will be spread around plots using rakes to insure maximum possible uniformity within each plot. Manure will be incorporated on the same day as application to avoid ammonia volatilization losses. Hard Red Spring wheat (Jefferson) will be planted into field #2 in 2015 as soon as the ground is safely workable in early April. Seed will be purchased through USDA ARS, and will be planted using the USDA ARS small grain planter.

Response variables will include soil tests, tissue tests, disease reactions, and grain quality for wheat grown in field #2 in 2015. Soil tests will include a spring comprehensive soil test prior to fertilization and planting at 0-12 and 12-24 inch depths. The tests will allow us to follow the change in soil properties through time. Soil testing will be conducted at the UI Analytical Sciences Lab in Moscow, Idaho.

Wheat plant uptake of N, P, K, and other macro/micronutrients will be analyzed through destructive sampling of above soil-line plant biomass near harvest. Approximately one week prior to harvest, whole plant samples will be collected from a 3 ft. X 5 ft. section in non-yield rows in each plot. Plants will be clipped at the soil surface and weighed. A subsample will be

collected, dried at the USDA ARS Kimberly drying ovens, and weighed again. Dried tissue subsamples will be analyzed for total N, P, and K content. These values will be used to estimate nutrient removal potential, and how it is affected by the manure application treatments. Disease pressure will be monitored throughout the growing season, with samples collected in the seedling stage prior to tillering and at harvest to measure soil-borne disease pressure. Foliar diseases will be controlled with an appropriate fungicide in order to protect economic yield, to reflect standard BMP. Plots will be harvested in mid-August using the UI Wintersteiger harvester, harvesting 5-foot wide by 30-foot length. Test weight and moisture will be measured using the Juniper System Grain Gauge on the combine. Protein analysis of grain will be conducted at the UI Aberdeen Wheat Quality Lab. Yield will be determined using designated row areas in each plot, and will not be sampled or disturbed as not to compromise yield potential or quality traits.

In future years, we will also include the evaluation of yield components (number of seeds in seedheads, number of tillers, etc.). Brad Brown visited our sites and commented that we could understand the causes of the lodging effects better if we had collected yield component data. Jianli Chen showed interest in helping us to collect this information. Also, Jianli Chen has shown great interest in evaluating the wheat grain in future years for cadmium content and low falling numbers.

Paul Patterson is interested in developing a manure calculator with our team that growers could use to estimate the economic value of a specific manure source. We are adding an additional $1,000 to our requested funding to compensate a temporary staff person to assist Paul and myself with this project.

DURATION: Eight years, with six years remaining starting in FY 2015

COOPERATION: David Bjorneberg, April Leytem, and David Tarkalson from USDA ARS will facilitate with experimental design, experimental setup, and maintenance of this project. A wide variety of scientists will be invited to collect data from non-yield areas within these plots, using funding from their own projects to support data collection and analysis, Erik Wenninger, UI entomologist, insect pressure; Don Morishita, UI weed scientist, weed pressure; Jodi-Johnson-Maynard, UI soil biologist, earthworm counts; Gary Lehrsch, USDA ARS soil physicist, aggregate stability; bulk density, infiltration; Rob Dungan, USDA ARS soil microbiologist, nitrifying bacteria populations; April Leytem, USDA ARS soil chemist, downward nitrate movement, nitrous oxide emissions; David Tarkalson, USDA ARS soil fertility scientist, in-season plant destruction to determine in-season N needs; Dan Strawn, UI soil chemist, speciation of soil P; Jianli Chen, UI Wheat Breeder, low falling numbers and cadmium uptake.

ANTICIPATED BENEFITS/EXPECTED OUTCOMES/INFORMATION TRANSFER: Provide accurate and up-to-date recommendations for rates and timing of manure application for growers working on silt loam or loam soils, to improve best management practices for maximum economic yield, improve seed quality, improve soil quality, reduce disease pressure, avoid salt accumulations, avoid excessive P buildup, avoid nitrate leaching, and improve nutrient uptake. This information will be relayed through popular press articles and at small grain commodity schools. We will develop an extensive UI extension guide on the long-term impacts of manure applications on small grain production, and will update the bulletin biennially to include results and changes to existing recommendations, based on our findings from this study. At the eight-

year conclusion of this study, this research will be published in several peer-reviewed research journal articles.

LITERATURE REVIEW: Influence of manure applications on small grain yield in comparison to fertilizers applied at comparable rates vary from increased yields (Lentz et al., 2011; Montemurro, 2009), no effect on yield (Matsi et al., 2003; Lentz et al., 2011), and significant decreases in grain yield (Boman et al., 1996; Gagnon et al., 1997). In regards to decreased grain yields, some researchers have shown that cattle manure can decrease germination of barley seeds, due to high concentrations of bile salts in the manure (Bell, 1976; Adriano et al., 1973). Others have attributed the reduced yields to lower nitrogen recovery potential from manure nitrogen than fertilizer nitrogen, especially for systems that do not apply additional N fertilizers in addition to manure applications (Gagnon et al., 1997).

Bell, R.G. 1977. Characterization of an agent in aqueous extracts of beef cattle manure that inhibits the germination of barley seeds. *Journal of Environmental Quality*. 6:163-164.

Boman, R.K., S.L. Taylor, W.R. Rau, G.V. Johnson, D.J. Bernardo, and L.L. Singleton. 1996. The Magruder plots: A century of wheat research in Oklahoma. Department of Agronomy, Oklahoma State University, Stillwater, Oklahoma.

Gagnon, B., R.R. Simard, R. Robitalille, M. Boulet, and R. Rioux. 1997. Effect of composts and inorganic fertilizers on spring wheat growth and N uptake. *Canadian Journal of Soil Science*. 77:487-495.

Lentz, R.D., G.A. Lehrsch, B. Brown, J. Johnson-Maynard, and A.B. Leytem. 2011. Dairy manure nitrogen availability in eroded and non-eroded soil for sugar beet followed by small grains. *Agronomy Journal*. 103:628-643.

Leytem, A.B. and D. Bjorneberg. 2009. Changes in soil test phosphorus and phosphorus in runoff from calcareous soils receiving manure, compost, and fertilizer application with and without alum. *Soil Science*. 174:445-455.

Matsi, T., A.S. Lithourgidis, and A.A. Gagianas. 2003. Effects of injected liquid cattle manure on growth and yield of winter wheat and soil characteristics. *Agronomy Journal*. 95:592-596.

Montemurro, F. 2009. Different nitrogen fertilization sources, soil tillage, and crop rotations in winter wheat: Effect on yield, quality, and nitrogen utilization. *Journal of Plant Nutrition*. 32:1-18.

Moore, A.D., N.L. Olsen, A.M. Carey, and A.B. Leytem. 2011. Residual effects of fresh and composted dairy manure applications on potato production. *American Journal of Potato Research*. 88:324-332.

COMMODITY COMMISSION BUDGET FORM

Allocated by	Idaho Wheat Commission	during FY 2013	$ 17,000
Allocated by	Idaho Wheat Commission	during FY 2014	$ 18,210

REQUESTED FY 2015 SUPPORT:

	Salary	Temporary Help	Fringe	Travel	OE	CO	Grad Fees	TOTALS
Idaho Wheat Commission	$ 1,870	$ 4,700	$ 2,479	$ 300	$ 9,761	$ -	$ -	$ 19,110

OTHER RESOURCES (not considered cost sharing or match):

a) Industry	$ 74,000
b) UI (salaries, operating)	$ 20,000
c) Other (local, state)	$ 20,000
d)	$ -
e)	$ -
TOTAL OTHER RESOURCES	$ 114,000

TOTAL PROJECT ESTIMATE FOR FY 2015:	$ 19,110 *(Requested)*	$ 114,000 *(Other)*	$ 133,110 *(Total)*

BREAKDOWN FOR MULTIPLE SUB-BUDGETS:

	Moore	*Marshall*	*Patterson*
Salary	$ 1,600	$ 270	$ -
Temporary Help	$ 4,000	$ -	$ 700
Fringe Benefits	$ 2,152	$ 127	$ 200
Travel	$ 150	$ 150	$ -
Operating Expenses	$ 9,761	$ -	$ -
Capital Outlay	$ -	$ -	$ -
Graduate Student Fees	$ -	$ -	$ -
TOTALS	$ 17,663	$ 547	$ 900

Total Sub-budgets $ 19,110

10.29.2013 - Version

CURRENT AND PENDING SUPPORT Form:

Name: Amber Moore

NAME (List PI/PD #1 First)	SUPPORTING AGENCY AND AGENCY NUMBER	TOTAL $ AMOUNT	EFFECTIVE AND EXPIRATION DATES	% OF TIME COMMITT-ED	TITLE OF PROJECT
	Current:				
Moore, A.	Idaho Sugar Beet Commission	$15,000	2013-2014	5%	Long-Term Impacts of Manure Application on Production of Sugar Beets and Other Crops
Moore, A. and J. Marshall	Idaho Barley Commission	$16,000	2013-2014	5%	Long-Term Impacts of Manure Application on Production of Barley and Other Crops
Moore, A. and J. Marshall	Idaho Wheat Commission	$18,210	2013-2014	5%	Long-Term Impacts of Manure Application on Production of Wheat and Other Crops
Hunter, L. and A. Moore	Idaho Barley Commission	$1,720	2013-2014	2%	Compost soil fertility trial
Moore, A.	Idaho Potato Commission	$18,000	2013-2014	5%	Long-Term Impacts of Manure Application on Production of Potato and Other Crops
Moore, A. and A. Leytem	Idaho Dairymen's Association	$20,000	2013	5%	Long-Term Impacts of Manure Application on Idaho Crop Production
Morra, M., A. Moore, E. Top, J. Hammel, J. Nagler, and I. Popova	USDA NIFA	$499,460	2013-2016	5%	Chemicals of Emerging Concern in the Eastern Snake River Plain of Idaho: A Threat to Irrigated Agriculture, Dairy, and Aquaculture?

Strawn, D. and A. Moore	USDA NIFA	$149,609	2013-2015	5%	Linking phosphorus availability from dairy manure amended fields with molecular reaction processes
Hines, S., J. Packham, and A. Moore	ISDA Specialty Crop Grant	$13,360	2014-2015	5%	Slow release nitrogen trials for dry bean production.
	Pending:				
Moore, A. and C. Falen	Idaho Sugar Beet Commission	$10,285	2014-2015	5%	Evaluating Nitrogen Release from Dairy Manure to Prevent Sugar Loss in Sugar Beets
Moore, A. and J. Marshall	Idaho Wheat Commission	$19,210	2014-2015	5%	Long-Term Impacts of Manure Application on Production of Wheat and Other Crops
Moore, A., J. Harper, N. Olsen, P. Wharton, and E. Wenninger	Northwest Potato Coalition	$47,923	2014-2015	5%	Long-Term Impacts of Manure Application on Production of Potato and Other Crops
Moore, A. and C. Strausbaugh	Idaho Sugar Beet Commission	$15,000	2014-2015	5%	Long-Term Impacts of Manure Application on Production of Sugar Beets and Other Crops
Moore, A. and J. Marshall	Idaho Barley Commission	$16,000	2014-2015	5%	Long-Term Impacts of Manure Application on Production of Barley and Other Crops
Moore, A. and A. Leytem	Idaho Dairymen's Association	$20,000	2014	5%	Long-Term Impacts of Manure Application on Idaho Crop Production

Moore, A.	Idaho Sugar Beet Commission	$15,000	2013-2014	5%	Long-Term Impacts of Manure Application on Production of Sugar Beets and Other Crops

CURRENT AND PENDING SUPPORT Form:

Name: Juliet Marshall

NAME (List PI/PD #1 first)	SUPPORTING AGENCY AND AGENCY NUMBER	TOTAL $ AMOUNT	EFFECTIVE AND EXPIRATION DATES	% OF TIME COMMITT-ED	TITLE OF PROJECT
	Current:				
Marshall, J.M., and Johnson (Schroeder)	Idaho Wheat Commission	$29,090	7/1/13 - 6/30/14	10	Extension Wheat Nurseries
Marshall, J.M. and Johnson (Schroeder)	Idaho Barley Commission	$13,000	7/1/13 - 6/30/14	8	Education for Barley Production / Extension Nurseries
Marshall, J.M. and Patterson, P.	Idaho Wheat Commission	$9,746	7/1/13 - 6/30/14	7	Production Systems and Wheat Varieties for Dryland Grain
Marshall, J.M.	USDA-ARS SCA	$9,000	10/1/13 - 9/31/14	10	Management of Wheat and Barley Root Pathogens in Idaho
Marshall, J.M.	Monsanto, Syngenta, Limagrain, etc	$28,250	7/1/13 - 6/30/14	2	Private breeding company entries into the Extension Variety Trials
Marshall, J.M.	Bayer Crop Sciences, BASF, Syngenta, etc	$53,092	8/1/13- 7/31/14	8	Seed Treatment / Specialty Trials / Product Evaluation
Marshall, J.M.	Federal 047	$1800		1	South Idaho Crop Management
Marshall, J.M.	Idaho State Funding	$17,847	7/1/13 – 6/30/14	10	Barley Enhancement

Marshall, J.M.	Hatch Funding	$1118	10/1/13 - 9/31/14	10	Foot Rot
Rashed, A. and Marshall, J.M.	Idaho Wheat Commission	$7,800	7/1/13 – 6/30/14	2	Variety Screening for BYDV Resistance in Idaho
Marshall, J.M. and Schroeder, K.	Idaho Wheat Commission	$9,000	7/1/13 – 6/30/14	5	Collaborative Nitrogen by Variety Interaction Study with LCS
Marshall, J.M. and Schroeder, J.	Idaho Wheat Commission	$14,000	7/1/13 – 6/30/14	5	Biostimulant Efficacy Field Trial
Moore, A., and Marshall, J.M.	Idaho Barley Commission	$16,000 (SA $547)	2013-2014	1	Long-Term Impacts of Manure Application on Production of Barley and Other Crops
Moore, A. and Marshall, J.M.	Idaho Wheat Commission	$18,210 (SA $547)	2013-2014	1	Long-Term Impacts of Manure Application on Production of Wheat and Other Crops
Chen J., Wang, Y., and Marshall, J.M.	Idaho Wheat Commission	$44,973 (SA $7462.35)	7/1/13 – 6/30/14	2	Digging the genetic factors underlying LMA in wheat
Murray, T., Carter, A., and Marshall, J.M.	Idaho Wheat Commission	$52,980 (SA $4000)	7/1/13 – 6/30/14	1	Enhancing Resistance to Snow Mold Diseases in Winter Wheat
Marshall, J.M.	Idaho Wheat Commission	$12,888	7/1/13- 6/30/15	1	Endowment funding
	Pending:				
Marshall, J.M., and Schroeder, K,	Idaho Wheat Commission	$31,437	7/1/14 - 6/30/15	10	Extension Wheat Nurseries
Marshall, J.M. and Schroeder, K.	Idaho Barley Commission	$14,672	7/1/14 - 6/30/15	8	Education for Barley Production / Extension Nurseries

Marshall, J.M. and Patterson, P.	Idaho Wheat Commission	$9,746	7/1/14 - 6/30/15	7	Production Systems and Wheat Varieties for Dryland Grain
Marshall, J.M.	USDA-ARS SCA	$6,042	10/1/14 - 9/31/15	10	Management of Wheat and Barley Root Pathogens in Idaho
Rashed, Marshall, Bosque-Perez, Pappu, Wallis, Eigenbrode	Idaho Wheat Commission	$19,069	7/1/14 - 6/30/15	2	Wheat variety response to BYDV infection at different developmental stages
Rashed, A and Marshall, J.M.	Idaho Wheat Commission	$36,400	7/1/14 - 6/30/15	2	A survey of central and eastern Idaho wireworm species and evaluating ecological and chemical approaches to maximize cereal production
Rashed, A and Marshall, J.M.	Idaho Barley Commission	$15,540	7/1/14 - 6/30/15	2	A survey of central and eastern Idaho wireworm species and evaluating combinations of ecological and chemical approaches to limit damage to barley crops
Marshall, J.M. and Schroeder, K.	Idaho Wheat Commission	$9,000	7/1/14 – 6/30/15	5	Collaborative Nitrogen by Variety Interaction Study with LCS
Marshall, J.M. and Schroeder, K.	Idaho Wheat Commission	$14,000	7/1/43 – 6/30/15	5	Biostimulant Efficacy Field Trial
Moore, A. and Marshall, J.M.	Idaho Wheat Commission	$19,110 (SA $547)	2014-2015	5	Long-Term Impacts of Manure Application on Production of Wheat and Other Crops

Moore, A. and Marshall, J.M.	Idaho Barley Commission	$16,000 (SA $547)	2014-2015	5	Long-Term Impacts of Manure Application on Production of Barley and Other Crops
Rashed, Marshall, Bosque-Perez, Pappu, Wallis, Eigenbrode	Idaho Wheat Commission	$19,069	2014-2016	3	Wheat variety response to BYDV infection at different developmental stages
Strawn, D., Chen, J., McDaniel, P., and Marshall, J.M.	Idaho Wheat Commission	$73,907	7/1/14-6/30/15	2	Field-based study of factors affecting cadmium uptake by wheat from Idaho Soils
Chen, J., Wang, Y., and Marshall, J.M.	Idaho Wheat Commission	$64,205	7/1/14 – 6/30/15	2	Digging the genetic factors underlying LMA in wheat

CURRENT AND PENDING SUPPORT Form:

Name: Paul Patterson

NAME (List PI/PD #1 First)	SUPPORTING AGENCY AND AGENCY NUMBER	TOTAL $ AMOUNT	EFFECTIVE AND EXPIRATION DATES	% OF TIME COMMITT-ED	TITLE OF PROJECT
	Current:				
Dandurand, Knudsen, Caplan, Hutchinson and Patterson	USDA-NIFA	$436,529 ($15,945)	2013-2016	2%	Sustainable Production of New Varieties from the PNW Potato Variety Development Program
Marshall, J.M. and Patterson, P.	Idaho Wheat Commission	$9,746	7/1/12 - 6/30/13	5%	Production Systems and Wheat Varieties for Dryland Grain
Patterson, P.E.	Idaho Potato Commission	$7,670	7/1/12 – 6/30/13	2%	Cost of Potato Production in Idaho
	Pending:				

Patterson, P.E.	Idaho Potato Commission	$7,025	2014-2015	10%	Cost of Potato Production in Idaho
Marshall, J.M. and Patterson, P.	Idaho Wheat Commission	$9,746	7/1/13 - 6/30/14	5%	Production Systems and Wheat Varieties for Dryland Grain
Moore, A., J. Marshall, and P. Patterson	Idaho Wheat Commission	$19,110	2014-2015	5%	Long-Term Impacts of Manure Application on Production of Wheat and Other Crops

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INTERNAL PEER REVIEW/PRINCIPAL INVESTIGATOR VERIFICATION FORM

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INTERNAL PEER REVIEW VERIFICATION

Commodity commissions/organizations require internal peer review by colleagues familiar with the subject matter. This proposal has been peer reviewed by the following individuals:

Reviewer 1: Lide Chen _____ 1/2/14

(Type/Print name) (Signature) (Date)

Reviewer 2: C. Wilson Gray _____ 02 JAN 13

(Type/Print name) (Signature) (Date)

Dept. Head/ Paul McDaniel _____ 1/6/14

Unit Administrator (Type/Print name) (Signature) (Date)

IWC PROGRESS REPORT

PROJECT NO: BJKX38, BJKX40

TITLE: Long-Term Impacts of Manure Application on Production of Wheat and Other Crops

PERSONNEL: Amber Moore, Nutrient Management Specialist, Twin Falls
Juliet Marshall, Smalls Grains Specialist, Aberdeen

ADDRESS: Amber Moore, Twin Falls R & E Center, P.O. Box 1827, Twin Falls, 83303, 208-736-3629, amberm@uidaho.edu

ACCOMPLISHMENTS:

We have completed the first year of this eight year dairy manure application study at the USDA ARS research station in Kimberly, Idaho. While wheat yields increased with manure applications at all rate (18-54 ton manure/acre), increases were not significant (Table 1). Lack of significance was primarily a result of lodging, which severely compromised the ability of the harvester to collect grain from the plots. This is a common issue for grain growers working with lodged grain crops. In future years, we may use growth regulators and reduce watering to lessen lodging, although this important effect will help to improve recommendations to growers in regards to lodge risks associated with manure applications. Manure applications had no significant effect on weed counts, stand counts, nematode populations, or disease pressure.

Table 1. Hard red spring yields (Jefferson variety) from year 1 of an eight year long term dairy manure application study.

Treatment	Yield (bu/acre)	Lodging Rate (1-9)	Protein (%)	Moisture (%)	Test Wt.
Control	96.6	1.0 c	10.8 c	8.5	62.9 a
Fertilizer	95.9	1.8 bc	12.5 b	8.4	62.7 a
18 tons manure/acre	112.1	2.8 b	12.7 b	8.3	62.8 a
36 tons manure/acre	113.1	5.3 a	13.9 a	8.2	62.1 ab
54 tons manure/acre	110.3	6.0 a	14.4 a	8.2	61.3 b
p-value	*0.1355*	*<0.0001*	*<0.0001*	*0.6138*	*0.0284*

Grain proteins significantly increased with increasing manure application rate, with proteins increasing to 14.4 % for the high manure rate (Table 1). As a reference, protein targets are below 14.5 % for hard red spring wheat, suggesting that proteins were approaching levels that would be too high for the industry at the high manure rate.

Plant nutrient concentrations were significantly greater for the high manure treatment (54 ton/acre) than control or fertilizer treatments for potassium only (data not shown). There was no

evidence of decreasing nutrient concentrations or nutrient uptake associated with manure applications. There was also no evidence of nutrient deficiencies associated with any of the treatments.

Phosphorus drawdown is important on high P soils that exceed regulatory threshold soil test P concentrations. Phosphorus removal for hard red spring wheat varied slightly from 70.6 lb P_2O_5/acre (fertilizer) to 79.0 lb P_2O_5/acre (54 ton manure/acre) (data not shown). For comparison, corn silage typically removes 97 lb P_2O_5/acre in Southern Idaho (Hines et al., 2012). Knowing the P removal potential of other Idaho crops beyond corn silage may help growers to consider alternative crops in their cropping systems to help with P drawdown.

One component that we will add in future years is the evaluation of yield components (number of seeds in seedheads, number of tillers, etc.). Brad Brown visited our sites and commented that the causes of the lodging effects would be better understood if we had collected this data, therefore we will be including this evaluation in future years of this study.

Manure applications did have significant effect on most of the preplant soil properties that were analyzed, as outlined in Table 2. There were significant increases of organic matter, nitrates, phosphorus, potassium, boron, manganese, and zinc in the first foot of soil. Increases in organic matter will likely impact other biological processes, such as insect populations, fungal growth, and disease pressure. Decreases in soil pH with increasing manure rate suggest significant acidification potential with manure applications, which could allow for increasing availability of soil nutrients like phosphorus, iron, and zinc. Free lime (aka calcium carbonate) percent decreased from 12.1 to 8.4% at the 12-24 inch soil depth (table 2). Dissolving calcium carbonates in the subsoil would be extremely beneficial to general crop growth in Idaho. It appears that Idaho growers may have suspected that manure applications lowered lime levels, as manure is routinely applied to "white soil" in Idaho to help remediate the soil and to give a boost to low crop yields. We will continue to monitor lime closely over the course of this study to see if lime concentrations continue to decrease on manured plots.

The presidedress nitrate test proved to be a poor predictor of inseason N release from manure for wheat, as the significant N uptake of the wheat crop in mid-June prevent plant available nitrogen from accumulating in the soil. Brad Brown confirmed that this was an inappropriate test for grain crops, and more effective to use for row crops. We will drop the PSNT component from the grain years of this study.

PROJECTIONS:

Results from these studies will allow us to develop clear recommendations for Idaho wheat growers on how to get the most out of their manure application without compromising crop production or soil quality.

PUBLICATIONS

No publications in the initial year of the study.

Table 2. Spring 2013 preplant soil test results, following fall manure applications. March 19th, 2013, prior to spring fertilizer application and planting.

Soil Depth (inches)	Dairy Manure rate (ton/acre)	Organic matter (%)	Free Lime (%)	Soil pH	Nitrate (ppm)	Olsen P (ppm)	Olsen K (ppm)	Electrical Conductivity (dS/m)	Sodium Adsorption Ratio (SAR)
0-12	0	1.32 d	5.9	7.81 a	23.3 c	11.6 d	114 d	0.91 d	0.67 d
	17.9	1.48 c	6.8	7.75 b	26.3 c	18.7 c	189 c	1.47 c	0.92 c
	36.0	1.62 b	6.7	7.65 c	31.1 b	27.0 b	284 b	2.01 b	1.16 b
	54.0	1.71 a	5.8	7.61 c	36.0 a	31.6 a	372 a	2.43 a	1.35 a
	LSD	*0.07*	*2.7*	*0.05*	*3.3*	*3.7*	*37*	*0.23*	*0.08*
	p-value	*<0.0001*	*0.8285*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*
12-24	0	0.785 b	12.1 a	7.79 a	22.0	3.1 b	77 c	0.92 d	0.77 b
	17.9	0.849 a	10.3 ab	7.73 b	21.4	6.4 a	92 bc	1.16 c	0.84 ab
	36.0	0.846 ab	10.3 ab	7.70 bc	21.2	6.3 a	97 b	1.30 b	0.79 b
	54.0	0.897 a	8.4 b	7.65 c	20.6	7.9 a	119 a	1.44 a	0.92 a
	LSD	*0.063*	*3.7*	*0.06*	*3.2*	*1.9*	*18*	*0.14*	*0.09*
	p-value	*0.0100*	*0.2584*	*0.0003*	*0.8448*	*<0.0001*	*0.0003*	*<0.0001*	*0.0136*

1.75