PROJECT NO: BJKY38, BJKY40
TITLE: Long-Term Impacts of Manure Application on Production of Wheat and Other Crops
PERSONNEL: Amber Moore, Juliet Marshall, Olga Walsh, and Xi Liang
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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. 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: This study is currently being conducted on two adjacent 2.5 acre sized sprinkler irrigated fields at the USDA ARS NWISRL station in Kimberly, Idaho. The soil is Portneuf silt loam, which is the most commonly farmed soil in Southern Idaho.

This eight-year study is entering its third year. The selected crop rotation for field #1 is wheat-potatoes-barley-sugar beets, and was planted to wheat in 2013 (completed) and will be planted to wheat in 2017. The selected crop rotation for field #2 is barley-sugar beets-wheat-potatoes, and will be planted to wheat in 2015 (this coming season) 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 an 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) is also included, for a total of 8 treatments per field (2 application timings at 3 rates + 1 standard chemical fertilizer trt + 1 control trt). Treatments are replicated four times in a randomized complete block, for a total of 32 treatments per field. Plot size is 40 ft. wide by 60 ft. long.

The manure source will be a dairy manure that has been stockpile. Starting in 2014, the manure for this project will be provided by Magic Valley Compost Inc. to eliminate traceability to a specific dairy. Manure samples are for moisture, soluble salts (EC), pH, organic matter, carbon, nitrogen, ammonium, and other agronomic macro- and micronutrients. Manure is 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 is 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 planted using the USDA ARS small grain planter at standard irrigated rate of 1million seeds per acre. Response variables will include soil tests, tissue tests, disease reactions, and grain quality. 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, 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.

Olga Walsh (Cropping Systems Agronomist, Parma) will investigate factors influencing lodging potential under high-input manure applications. Samples will be collected at harvest for the determination of number of heads per square foot, grains per head, and 1000 kernel weight to determine relationships between these yield components and lodging. Xi Liang (Cropping Systems Agronomist, Aberdeen) is interested in studying the impact of manure applications on root health and canopy reflectance in spring wheat, starting in 2015. Root samples would be taken prior to the final irrigation, washed off, scanned and analyzed using the WinRHIZO image analysis system for measuring root morphological traits (i.e., root length, surface area, etc.). Canopy spectral reflectance (using Greenseeker) and leaf area index (LI 2200 plant canopy analyzer) will be measured at stages of booting, anthesis, and grain-filling in each plot.

DURATION: Third year of an eight year project.

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, Don Morishita, UI weed scientist, weed pressure; Gary Lehrsch, USDA ARS soil physicist, aggregate stability; Rob Dungan, USDA ARS soil microbiologist, nitrifying bacteria populations; April Leytem, USDA ARS soil chemist, downward nitrate movement, nitrous oxide emissions; 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), no effect on yield (Matsi et al., 2003; Lentz et al., 2011), and significant decreases in grain yield (Boman et al., 1996). 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).

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.

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.

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.

IDAHO WHEAT COMMISSION - BUDGET FORM

Allocated by	Idaho Wheat Commission	during FY 2014	$	18,210
Allocated by	Idaho Wheat Commission	during FY 2015	$	19,110

REQUESTED FY 2016 SUPPORT:

	Salary	Temporary Help	Fringe	Travel	OE	Grad Fees	TOTALS
Idaho Wheat Commission	$ 1,870	$ 6,072	$ 2,951	$ 1,131	$ 9,161	$ -	$ 21,185

OTHER RESOURCES (not considered cost sharing or match):

TOTAL OTHER RESOURCES $ -

TOTAL PROJECT ESTIMATE FOR FY 2016:	$ 21,185 *(Requested)*	$ - *(Other)*	$ 21,185 *(Total)*

BREAKDOWN FOR MULTIPLE SUB-BUDGETS:

	Moore	*Marshall*	*Walsh*	*Liang*
Salary	$ 1,600	$ 270	$ -	$ -
Temporary Help	$ 4,000	$ -	$ 450	$ 1,622
Fringe Benefits	$ 2,152	$ 127	$ 41	$ 631
Travel	$ 150	$ 150	$ 300	$ 531
Operating Expenses	$ 8,961	$ -	$ -	$ 200
Graduate Student Fees	$ -	$ -	$ -	$ -
TOTALS	$ 16,863	$ 547	$ 791	$ 2,984

Total Sub-budgets $ 21,185

10.24.2014 - Version

PROJECT No: BJKX58, BJKX59

TITLE: Tailoring nitrogen recommendations by variety: winter wheat response to fertilizer application timings

PERSONNEL: Dr. Juliet Marshall, Ext. Crop Mgmt. Specialist (SC and E Idaho)
Dr. Kurt Schroeder, Cropping Systems Agronomist (Moscow)
Staff: Program staff
Collaborator: Jean-Bruno Beafumé, LimaGrain Cereal Seeds

ADDRESS: Dr. Juliet Marshall, 1776 Science Center Dr, Suite 205, Idaho Falls, ID, 83402; 208-529-8376; jmarshall@uidaho.edu

JUSTIFICATION: Fertilizer recommendations have been standardized for various classes of wheat. In general, nitrogen application rates are recommended based on bushels of expected yield, with soft white winter wheat N applications recommendations being as high as 2.7 times the expected yield, and hard red winter being 3 to 3.5 times the expected yield. (ie. if yield is expected to be 120 bu/A, then the recommended total nitrogen would be 360 to 420 lbs per acre which includes soil test N and mineralized organic N.) With hard red winter wheat, there is great difficulty in consistently producing high protein wheat in many environments. As we move to new varieties with improved genetics, we are very interested in improving nitrogen use efficiencies to reduce input costs as well as reduce excessive use of nitrogen in the environment. The question remains in regards to the need to tailor nitrogen amounts and application timing per variety as well as market class. With new seed companies advancing the genetics of both domestically and internationally developed cultivars, tailoring the fertilizer application to our specific environments may be important in prescription and precision farming. The genetic diversity of wheat can be explored by testing advanced lines and varieties in various environments to improve nitrogen recommendations. The results from the first year's study indicated that varieties with a European pedigree have responded differently than those bred in the PNW. (See the FY 2015 Progress Report.)

HYPOTHESIS & OBJECTIVES: The hypothesis is that with improvements in plant genetics and the genetic diversity of introduced cultivars, we can improve economic efficiency of production by reducing and/or refining nitrogen application not only to the hard red winter wheat market class, but to specific varieties. The objective is to test differential response to fertilizer application and to develop recommendations that specifically address varietal response in our diverse environments. We also want to improve nitrogen use efficiency and target a range of grain protein across all varieties and environments. The specific objectives are:

I) Improve nitrogen application recommendations of currently grown varieties to reduce N losses associated with preplant application.
II) Improve our ability to target a range of grain protein.
III) Determine varietal response of different fertilization regimes.

PROCEDURES: Six varieties of hard red winter wheat will be tested utilizing specific fertilizer regimes at three locations: Moscow (Schroeder), Walla Walla (Beafumé), and Aberdeen (Marshall). Standard varieties across all three experiments will be Norwest 553, Colonia and

Azimut, while the other three will be determined by each researcher (choosing the widely grown varieties per location). There will be six replications per location.

For nitrogen application: we will use the conservative rate of 2.5 lbs N per bushel rate of N application (adjusted for soil inorganic N and mineralized N), with the exception of Moscow that will use 2.7 lbs N per bushel as recommended for annual precipitation over 22 inches. One row of border between main plots will reduce cross contamination of fertilizer between main plots. Expected yield goal (EYG) will vary between location, but for Aberdeen under irrigation the EYG = 160 bu/A.

We will split the spring application to two timings - at tillering, then again two weeks later. If growers have the ability to split applications (especially during fertigation) then they would not apply large quantities all at once. This may not be reflective of Palouse practices, but standardizing treatments across locations increases the statistical power of the test.

University of Idaho, Limagrain Cereal Seeds, LLC
Joint Nitrogen by Variety Experiment

Proposed varieties to change according to location and researcher, with one or two hrw in common

	Suggested varieties:	class
1	Norwest 553	hrw
2	Colonia	hrw
3	Azimut	hrw
4	Yellowstone (TBD by researcher)	hrw
5	WB-Arrowhead (TBD by researcher)	hrw
6	Whetstone (TBD by researcher)	hrw

ALL PLOTS TO RECEIVE PREPLANT 20 LBS KCl AND AT LEAST 40 LBS PHOSPHATE AND 20 LBS SULFATE. The following table represents applied fertilization rates in Aberdeen:

Nitrogen treatments -			lbs N at planting	lbs N at tillering	lbs N at tillering + 2 wks	subplot lbs N at flowering
trt	Total N applied (excluding N for protein)	Application methodology	(minus soil ppm)			
1	375	A	225	75	75	40
2	375	A	225	75	75	60
3	375	A	225	75	75	80
4	375	A	225	75	75	40
5	375	A	225	75	75	60
6	375	A	225	75	75	80
7	375	A	225	75	75	40
8	375	A	225	75	75	60
9	375	A	225	75	75	80
10	375	B	150	112.5	112.5	40
11	375	B	150	112.5	112.5	60
12	375	B	150	112.5	112.5	80

13	375	B	150	112.5	112.5	40
14	375	B	150	112.5	112.5	60
15	375	B	150	112.5	112.5	80
16	375	B	150	112.5	112.5	40
17	375	B	150	112.5	112.5	60
18	375	B	150	112.5	112.5	80

A =	60% preplant	40% at spring tillering
B =	40% preplant	60% at spring tillering

DURATION: Third of three years. FY 2015 experiment is currently in the ground in Moscow, Walla Walla, and Aberdeen. Funding was obtained in an off-year cycle in order to initiate the research. The proposed research is for a third year FY 2016, pending the progress of the current study.

COOPERATION: University of Idaho personnel, (Juliet Marshall and Kurtis Schroeder) are collaborating with Jean-Bruno Beafumé, of LimaGrain Cereal Seeds, as part of the effort to coordinate agronomic recommendations of newly released and currently grown varieties. Each investigator is responsible for replicating the experiment at their research site, maintaining three concurrent varieties and three additional varieties that are site-specific depending on local producer preference.

ANTICIPATED BENEFITS/EXPECTED OUTCOMES/INFORMATION TRANSFER: Idaho wheat producers will receive the most recent wheat variety performance information to improve production efficiency, increase economic returns, and maintain their competitiveness. Information on variety performance and agronomic production is shared with growers and industry personnel through cereal schools, published materials, wheat nurseries, demonstrations, field tours and the Internet.

LITERATURE REVIEW: Irrigated, true dryland, and "rainfed" fertility recommendations change with location. Updates to bulletins and publications produced in the 1990's are needed to reflect genetics of introduced and newly developed varieties. Tables in the Southern Idaho Dryland Winter Wheat Production Guide are based on a requirement of 3.3 lbs N per bushel of spring wheat, which are considered high under irrigated conditions. No consideration is given for varietal differences in nitrogen use efficiencies. Targeting market class and variety differences in Nitrogen Use Efficiency will allow us to tailor fertilizer and production recommendations and improve producers' ability to document sustainable practices.

Kephart, K.D., Stark, J.C., and Robertson, L. 1991. Irrigated Spring Wheat Production Guide for Southern Idaho. University of Idaho Bulletin No. 697.

Cook, R.J. and Veseth, R. 1991. Plant Health Management. APS Press.

Robertson, L.D., Guy, S.O., and Brown, B.D. 2004. Southern Idaho Dryland Winter Wheat Production Guide. University of Idaho Bulletin 827.

IDAHO WHEAT COMMISSION - BUDGET FORM

Allocated by	Idaho Wheat Commission	during FY 2014	$	9,000
Allocated by	Idaho Wheat Commission	during FY 2015	$	9,000

REQUESTED FY 2016 SUPPORT:

	Salary	Temporary Help	Fringe	Travel	OE	Grad Fees	TOTALS
Idaho Wheat Commission	$ -	$ 3,300	$ 1,700	$ 1,300	$ 2,700	$ -	$ 9,000

OTHER RESOURCES (not considered cost sharing or match):

	$	13,500
TOTAL OTHER RESOURCES	$	13,500

TOTAL PROJECT ESTIMATE FOR FY 2016:	$ 9,000	$ 13,500	$ 22,500
	(Requested)	*(Other)*	*(Total)*

BREAKDOWN FOR MULTIPLE SUB-BUDGETS:

	Marshall	*Schroeder*	*Walsh*	*(PI name)*
Salary	$ -	$ -	$ -	$ -
Temporary Help	$ 1,650	$ 1,650	$ -	$ -
Fringe Benefits	$ 850	$ 850	$ -	$ -
Travel	$ 650	$ 650	$ -	$ -
Operating Expenses	$ 1,350	$ 1,350	$ -	$ -
Graduate Student Fees	$ -	$ -	$ -	$ -
TOTALS	$ 4,500	$ 4,500	$ -	$ -

Total Sub-budgets $ 9,000

10.24.2014 - Version