USDA-ARS-PWA
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SUMMARY OF BIOFUEL AND SOIL SYSTEMS RESEARCH ACCOMPLISHMENTS 2007-2011

by
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2012

Impact of Deficit Irrigation on Potato Yield and Quality *(Dr. Ashok K. Alva, 509-786-9205)*
Cost of potato irrigation the Columbia basin in approximately 10% of total cost of production. Yield production in Ranger Russet and Umatilla Russet cultivars was 7 to 10% with 14 to 17% deficit irrigation as compared to the yield with irrigation to replenish full evapotranspiration. Major yield loss with deficit irrigation was associated with reduction of >8 oz size tubers.

Controlled Release Fertilizers for Potato *(Dr. Ashok K. Alva, 509-786-9205)*
Pre-plant application of 200 lbs N/acre as polymer coated urea PCU, (Complete or 50/50 mix of PCU/urea) produced similar tuber yield (about 35 tons/acre) of Umatilla Russet cultivar as compared to that with conventional fertilization practices, i.e. 100 lbs N/acre urea pre-plant and five fertigations of UAN at 200 lbs N/acre.

Improved Nitrogen efficiency for Potatoes *(Dr. Ashok K. Alva, 509-786-9205)*
Nitrogen products with urease and/or nitrification inhibitors appear to increase N uptake efficiency by minimizing nitrate leaching and/or gaseous loss of N. The economics of using these alternate products need to be evaluated.

Soil Amendment as Source of N for Potatoes. *(Dr. Ashok K. Alva, 509-786-9205)*

Pre-plant application of canola or camelina mulch or dry distillers grain (at 200 to 400 lbs of total N/acre rates) provides source of N for potato plants and may provide additional soil quality benefits.

Transformation of Nitrogen from Crop Residues. ***(Dr. Ashok K. Alva, 509-786-9205)***
Nitrogen mineralized (as plant available forms, i.e. ammonium or nitrate) in the top 12 inch depth soil from crop residues after the harrowing of either sweet corn, alfalfa, field corn, wheat, or potato varied from 40 to 80 mg/kg/year. The above transformation was peak during May through August.

Sensors for Real-Time Monitoring of Soil Water Content to Improve Irrigation Scheduling. ***(Dr. Ashok K. Alva, 509-786-9205)***
Capacitance probes provide an in-site, automated technique for real-time monitoring of soil water content within and below the potato rootzone. The target set points of water content in the top 24 inch range of soil depth, from 2.1 to 2.8 inches. Irrigation to maintain the above soil water content appears to minimize water leaching below the rootzone while providing adequate water for the plant to avoid any water stress.

Frequency of In-Season fertigation for Potatoes. ***(Dr. Ashok K. Alva, 509-786-9205)***
Under conventional nitrogen management for potatoes in the lower Columbia Basin, the optimal N management is 100 lbs N/acre as urea pre-plant soil applied plus 200 lbs N/acre as five fertigations as UAN at two weeks interval, four weeks after seedling emergence. Increased frequency of in-season fertilization failed to provide any additional benefits.

2011

Mustard Seed Meal for Weed Management in Organic Onion ***(Dr. Rick Boydston, 509-786-9267)***
Weed management represents the major cost of production for organic onions and hand weeding can cost up to $2,000 per acre. Alternative methods of weed control that reduce the amount of hand weeding are needed. We identified the herbicidal compounds in mustard (Sinapis alba) meal and refined the use patterns of mustard meal to obtain weed suppression without harming the onion

crop. We demonstrated that mustard seed meals that contain high levels of sinalbin suppressed weeds when applied after the two leaf stage of onions and significantly reduced the amount of hand weeding required. The use of mustard seed meal may be useful to producers of organic crops for weed suppression and help reduce excessive costs of hand weeding.

Remediation of Phosphorus from Dairy Lagoon Waters using Biochar *(Dr. Harold Collins, 509-768-9250)*

Estimates of animal manures produced in the United States by feedlot cattle, dairy cattle and swine exceeds 78 million tons annually. These manures contain 12.5 million tons of nitrogen (N) and 2.5 million tons of phosphorus (P) in addition to many other important plant nutrients. We developed an approach to utilize dairy waste as an alternative energy and fertilizer source. The fiber component exiting a GHD Plug Flow anaerobic digester was used as a feedstock to produce bio-gas or bio-oil under low temperature pyrolysis. The co-product, biochar was applied to dairy waste water to remove nutrients. Our approach resulted in the removal of >32% of the P from the dairy effluent within 15 days of treatment. Sorption of nutrients by biochar from storage lagoons prior to field application of the effluent will reduce the nutrient loading of soils and contamination of ground and surface waters adjacent to dairies. In addition, the sale of the nutrient enriched biochar off-farm as a fertilizer will increase dairy revenues. The current price of biochar is $200-300 per ton. Dairies in Washington State could produce 230,000 tons of biochar a year from manure.

2010

Development of technology to utilize dairy waste as an alternative energy and fertilizer source *(Dr. Harold Collins, 509-768-9250)*

Estimates of animal manures produced in the United States by feedlot cattle, dairy cattle and swine exceeds 78 million tons annually. These manures contain 12.5 million tons of nitrogen (N) and 2.5 million tons of phosphorus (P) in addition to many other important plant nutrients. We are developing technology to utilize dairy waste as an alternative energy and fertilizer source. The fiber component exiting a GHD™ Plugged Flow anaerobic digester as well as softwood feedstocks was used to produce bio-gas or bio-oil under low temperature pyrolysis. The co-product, biochar was applied to dairy waste water to remove nutrients. Sorption of nutrients by biochar from storage lagoons prior to field application of the effluent will reduce the nutrient loading of soils and contamination of ground and surface waters adjacent to dairies. In addition, the sale of the nutrient enriched biochar off-farm as a fertilizer will increase dairy revenues.

2009

Control of Volunteer Potato in Reduced Tillage Sweet Corn *(Dr. Rick Boydston, 509-786-9267)*
Volunteer potato is a recurring weed problem in regions where winter soil temperatures fail to drop below the -1.5 C threshold necessary to kill tubers remaining in the soil after potato harvest. Volunteer potato control with fluroxypyr was incomplete in sweet corn under reduced tillage, which could lead to new tuber production and continued problems in subsequent years. Mesotrione controlled volunteer potatoes greater than 98% and reduced tuber number and weight greater than or equal to all other herbicide treatments, regardless of tillage level. Identification of effective volunteer potato control measures in reduced tillage systems allows producers to reap the benefits of increased profitability and reduced soil erosion in reduced tillage systems while maintaining weed control

Mustard seed meals inhibit weeds *(Dr. Rick Boydston, 509-786-9267)*
Weeds are the primary limitation and expense to organic onion and peppermint production. Mustard (Sinapis alba) seed meal, byproducts of oil extraction from the seeds, contain glucosinolates that release compounds that inhibit weed germination and establishment. Mustard seed meal applied at 1 ton/acre at specific stages of organic onion and peppermint growth controlled annual weeds for about 3 weeks without significant injury to either crop. Use of mustard seed meal may be useful to producers of organic crops for weed suppression and help reduce excessive costs of hand weeding which can range from $500 to $2,000 per acre.

Carbon Sequestration under Irrigated Switchgrass *(Dr. Harold Collins, 509-768-9250)*
Current USDA initiatives and research opportunities (Biomass Research and Development Initiative, 2007 (USDA/DOE) show the need for new research evaluating the impacts of producing bioenergy biomass crops or removing select crop residue components for bio-fuel production. Perennial herbaceous bioenergy crops have the potential to sequester soil C, supply a portion of U.S. energy needs and reduce atmospheric CO2 enrichment when used as a fuel. This research showed that switchgrass (Panicum virgatum) production in the warmer irrigated regions of the PNW is a viable bioenergy feedstock, can improve soil quality and sequester C in soil. Aboveground biomass yields averaged 20.4, 16.9, and 14.5 metric tonnes dry matter per hectare per year for Kanlow, Shawnee, and Cave in Rock cultivars, respectively. The C-sequestration potential of switchgrass and its belowground productivity averaged 3.0 metric tonnes per hectare with an average 15% increase in soil C after three years. This

data will be useful in the development of secondary markets such as C-credit trading or by ethanol producers interested in nutrient recovery for production of fertilizers or animal feed supplements.

2008

Trace Gas Fluxes from an Irrigated Sandy Soil under Vegetable Cropping Systems. ***(Dr. Harold Collins, 509-768-9250)***

The effect of N-fertilization, fertilizer type and cropping systems on N2O emissions from agricultural soils under rain-fed agriculture has been widely reviewed in recent years. However, there is little information concerning trace gas fluxes from irrigated soils. This research was undertaken to determine trace gas emissions from irrigated cropping systems. Objectives were to 1) describe cropping season patterns of N2O emissions and periods of peak losses following fertigation practices in a high-value irrigated potato rotation; 2) estimate season losses of N2O and amount of fertilizer losses as N2O; and 3) contrast field measured N2O losses against predicted losses using IPCC methodology. Dr. Collins conducted and supervised a Post-doctorate in independent research to determine the effects of tillage on SOM and trace gas fluxes in irrigated production systems. The IPCC methodology for estimating direct N2O emissions from fertilized agricultural soils assumes a N2O emission factor of 1.25% ±1 of the fertilizer N applied. However emission from potato and corn fields were lower, where emissions from the 24 h and 48 h field studies without crops were higher, indicating that there is significant variability due to timing of sampling and rates of N fertilization. These data will refine estimates of trace gas emissions from irrigated croplands. Growers can now account for 1 to 7% of the N-fertilizer applied as a gaseous N2O loss depending on the form of fertilizer applied.

2007

Importance of controlling hairy nightshade weeds to minimize the impact of root-knot nematode damage on potatoes. ***(Dr. Rick Boydston, 509-786-9267)***

Columbia root-knot nematode is a major pest of potato in the Pacific Northwest and is controlled by costly soil fumigation. Potato breeding lines have been developed with resistance to the predominant race 1 (CRKN-1) of Columbia root-knot nematode, but some potato lines had nematode damaged tubers in field trials. Nematode resistant potato breeding lines segregated in response to nematode damage on tubers only when grown in the presence of hairy nightshade in field trials. Some lines possessing root resistance were found to lack tuber resistance, which was only evident when grown in the presence of hairy nightshade, a host of the nematode. These findings demonstrate how weed hosts of root-knot nematodes may negate the positive impact of growing resistant potatoes that lack tuber resistance and the importance of weed control on managing plant parasitic nematode populations. Potato breeders can use this information to select for both root and tuber resistance in breeding materials.

Trace Gas Fluxes from an Irrigated Sandy Soil under Vegetable Cropping Systems. ***(Dr. Harold Collins, 509-768-9250)***

The effect of N-fertilization, fertilizer type and cropping systems on N_2O emissions from agricultural soils under rain-fed agriculture has been widely reviewed in recent years. However, there is little information concerning trace gas fluxes from irrigated soils. This research was undertaken to determine trace gas emissions from irrigated cropping systems. Objectives were to 1) describe cropping season patterns of N_2O emissions and periods of peak losses following fertigation practices in a high-value irrigated potato rotation; 2) estimate season losses of N_2O and amount of fertilizer losses as N_2O; and 3) contrast field measured N_2O losses against predicted losses using IPCC methodology. Dr. Collins conducted and supervised a Post-doctorate in independent research to determine the effects of tillage on SOM and trace gas fluxes in irrigated production systems. The IPCC methodology for estimating direct N_2O emissions from fertilized agricultural soils assumes a N_2O emission factor of 1.25% ±1 of the fertilizer N applied. However emission from potato and corn fields were lower, where emissions from the 24 h and 48 h field studies without crops were higher, indicating that there is significant variability due to timing of sampling and rates of N fertilization. These data will refine estimates of trace gas emissions from irrigated croplands. Growers can now account for 1 to 7% of the N-fertilizer applied as a gaseous N_2O loss depending on the form of fertilizer applied.

Nitrogen Transformation from Mustard Cover Crop and Availability to Potatoes. ***(Dr. Harold Collins, 509-768-9250)***
Farmers in the Pacific Northwest are using cover crops such as white and brown mustards in rotation with potatoes because it reduces potential wind erosion and serves as a biocontrol method for a number of plant pathogens. In order to understand the efficiency of N availability to a subsequent potato crop it is important to quantify the fate of N contained in cover crop residues. Dr. Collins and team used a ^{15}N isotopic crop residue exchange technique to assess N cycling potential in the field. They showed that a mustard cover crop recovered 34 to 51% of the 50 lbs of ^{15}N fertilizer applied. Nearly, 30 % of the N in the cover crop was cycled and absorbed by the following potato crop. This research found that the mustard cover crop can contribute about 27 to 36 lbs N acre^{-1} towards the N requirement of a subsequent potato crop, saving farmers $14-18 acre^{-1} at current fertilizer prices.

Prediction of Volunteer Potato Problems in Rotation Crops Based on Monitoring Winter Soil Temperatures. ***(Dr. Rick Boydston, 509-786-9267)***
Volunteer potato is a difficult weed to manage in potato production regions with mild winters and is a major source of late blight disease, leaf roll virus, and nematodes. No previous studies have reported the freezing behavior of potato tubers in soil. Potato tuber freezing behavior was determined in soil columns and in field trials. Potato tubers were killed or severely injured when soil temperatures surrounding the tuber reached -1.4 to -1.9 C in hydrated soil. Potato tubers in dry soil were able to supercool to -3 to -7 C without injury. In field trials, extensive tuber death occurred when soil temperatures reached -2.8 or lower at tuber depth. Knowledge of soil temperatures required to kill potato tubers allows the prediction of volunteer potato severity by monitoring winter soil temperatures at several depths. This allows growers to make earlier management decisions and provides greater flexibility and ability to manage volunteer potatoes and plan rotation crops accordingly.