AGRICULTURAL RESEARCH FOUNDATION
FINAL REPORT
FUNDING CYCLE 2017 – 2019

TITLE: Nitrogen Release from Cover Crops

RESEARCH LEADER: Amber Moore

COOPERATORS: Dan Sullivan, Tracy Wilson, and Joshua Neuman

EXECUTIVE SUMMARY: A field trial was conducted to determine the effect of single-planted winter brassica and small grain cover crops with different rates of nitrogen (N) fertilizer added on yield and quality of a subsequent irrigated soft white spring wheat cash crop. Increasing rates of urea fertilizer simulated varying levels of residual N that could be taken up by these cover crops when serving the function of N catch crop preceding a spring wheat crop. A laboratory incubation of cover crop residues combined with soils from the same plots was also performed to quantify the amount of mineralized N released from decomposing cover crop residues at 4 and 8 weeks of incubation.

OBJECTIVES: The objective of the field trial was to observe the effect of N rate and cover crop species on yield and protein content of wheat at harvest. The objectives of the laboratory residue incubation were to observe the effect of N rate on cover crop N concentration, and to evaluate the N mineralization rate of cover crops varying in N concentrations due to species type and varying fertilizer N application rates.

PROCEDURES: Both the field trial and the laboratory incubation were conducted at the Central Oregon Agricultural Center (COARC) in Madras, Oregon. Field treatments included four cover crop types and four fall preplant N fertilizer rates. The cover crops were: bare ground, brown mustard (*Brassica juncea* “Caliente 199”), forage oats (*Avena sativa* “Charisma”), and oilseed radish (*Raphanus sativus* L. var. oleiformis). The four N fertilizer rates were: 0, 40, 80, and 120 lb N/acre. The experimental design was a randomized complete block with four replications. Subplots were 29 ft. in length and 16 ft. in width.

Representative soil samples for each plot were collected on 28 August 2017 at 0-6 and 6-12 inch depths and analyzed for NH_4-N and NO_3-N concentration. Cover crops were planted by a no-till seeder on 7 September 2017. Treatment plots were fertilized with granular urea fertilizer that was hand-spread immediately after cover crop seeding. Even fertilizer distribution was attained by walking up and down the plots in a north-to-south orientation and then east-to-west, shaking the fertilizer out of the hand along each pass. The cover crops were terminated by tillage incorporation in the following spring on 26 March 2018, and representative soil samples per plot were collected on the same day for nitrate-N and ammonium-N at the 0-6 inch soil depth.

Because the cover crops did not establish evenly or in sufficient quantity for biomass sampling and collection for the lab incubation study, the decision was made to establish the cover crops in soils collected from each individual plot in a greenhouse setting at the COARC station, allowing for enough tissue to be produced in order to support the lab incubation study. Cover crops were seeded in the greenhouse on 29 March 2018. The cover crop seed were sown in 2.1 ft^2 seeding trays with seeding rates corresponding to seeding rates that were used in the field in the fall of 2017. As the soils originated from the plots, they contained varying residual levels of N created by the fall N fertilizer applications described above. Cover crop tissue was destructively sampled on 11 June 2018 and stored in a standard freezer until use in the lab cover crop incubation study.

Table 1: Cover Crop Seeding Rates

Cover crop		Seeding rate	
Common name	Scientific name	Field (lb/acre)	Greenhouse (g/2.1 ft^2 tray)
Brown mustard	*Brassica juncea* "Caliente 199"	12.0	0.3
Forage oats	*Avena sativa* "Charisma"	90.0	2.0
Tillage radish	*Raphanus sativus* L. var. oleiformis	8.0	0.2

Soft white spring wheat (*Triticum aestivum* var. "Alturas") was planted in the field plots on 28 March 2018 and was harvested on 9 August 2018 with a small plot combine. Kernels were bagged and weighed immediately after harvest to determine grain yield for each plot. Harvested wheat grain was analyzed for test weight, moisture content, and total N concentration for the estimation of protein content.

The laboratory experiment was an aerobic incubation of the cover crop residues grown in the greenhouse. Field moist soil collected from each subplot on 26 March 2018 was stored in zippered plastic bags in a walk-in cooler until the experiment was initiated on 27 June 2018. Cover crop residue samples corresponding to each subplot were taken out of the freezer and chopped finely into 0.6 inch long pieces and then hand-mixed into the respective bag of field soil corresponding to the cover crop x fertilizer treatment. The ratio of cover crop residue to soil was approximately 1:100 on a dry weight basis. Soil was assumed to be at field capacity when the experiment began and was watered by misting the bags each week and massaging the water into the soil by kneading the bags. A plastic straw was placed in the corner of each bag to allow aerobic respiration.

A soil sample was taken from each bag at 4 and 8 weeks after the start of the experiment. The sample was air dried, ground, and analyzed for ammonium and nitrate concentration. A subsample of cover crop residue from each cover crop x fertilizer treatment was analyzed for total N content.

Percent available nitrogen (PAN), meaning the amount of plant-available NO_3-N at 4- and 8-weeks, was determined using the following equation:

$$\text{PAN (\%)} = \frac{[\text{soil } NO_3\text{-N with cover crop (mg/kg)} - \text{soil-only control } NO_3\text{-N (mg/kg)}]}{\text{Cover crop total N added to incubation bag (mg/kg)}} \times 100$$

Dates of field activities are shown in the following table.

Table 2: Dates of Field Activities

Date	Activity
28 August 2017	Pre-cover crop planting soil N sampling
7 September 2017	Cover crop planting
26 March 2018	Cover crop tillage & post-cover crop soil N sampling
28 March 2018	Wheat planting
9 August 2018	Wheat harvest
12-14 August 2018	Post-wheat harvest soil sampling

SIGNIFICANT ACCOMPLISHMENTS: Both experiments have been completed. The data are currently being analyzed, however we are able to show preliminary data from the field data in this report. The incubation data is still being processed and therefore will not be included in this report. We will share the final project report with ARF once the project is completed.

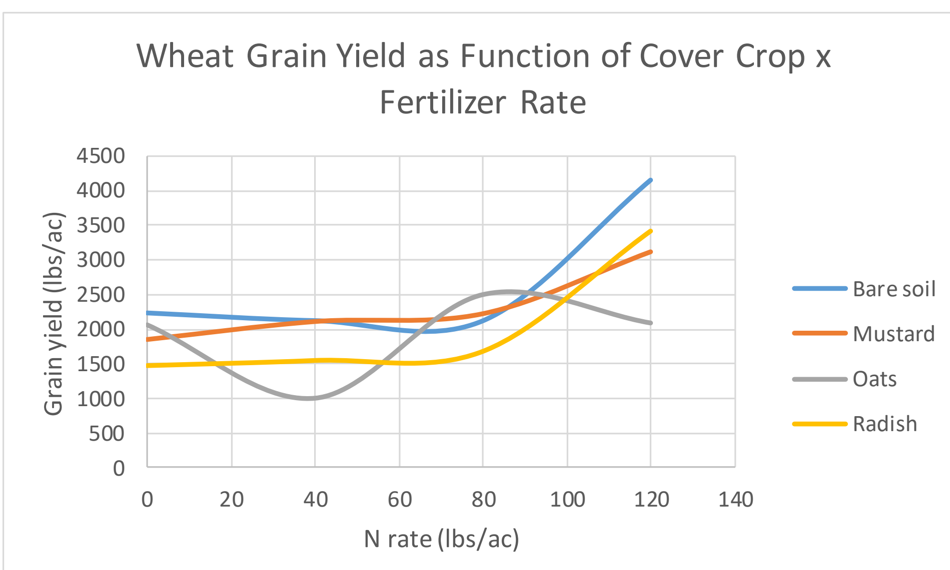

Figure 1. Wheat grain yield as a function of cover crop by N fertilizer rate.

The following comments are based on observations of treatment means, and are not yet supported by statistical analysis. Wheat grain yield increased with increasing N rate from 80 to 120 lb N/acre for bare soil, mustard, and radish treatments (figure 1). At the highest N rate of 120 lb N/acre, it appears that some N may have been tied up in the mustard and radish plant tissue, which would potentially decrease yields due to a lack of N availability. Allelopathic compounds in the radish and mustard may have also been suppressing wheat grain yield in comparison to the bare soil treatment. Oat residues may be immobilizing N at the N rate of 40 lb N/acre, where the lowest mean yields in the study occurred.

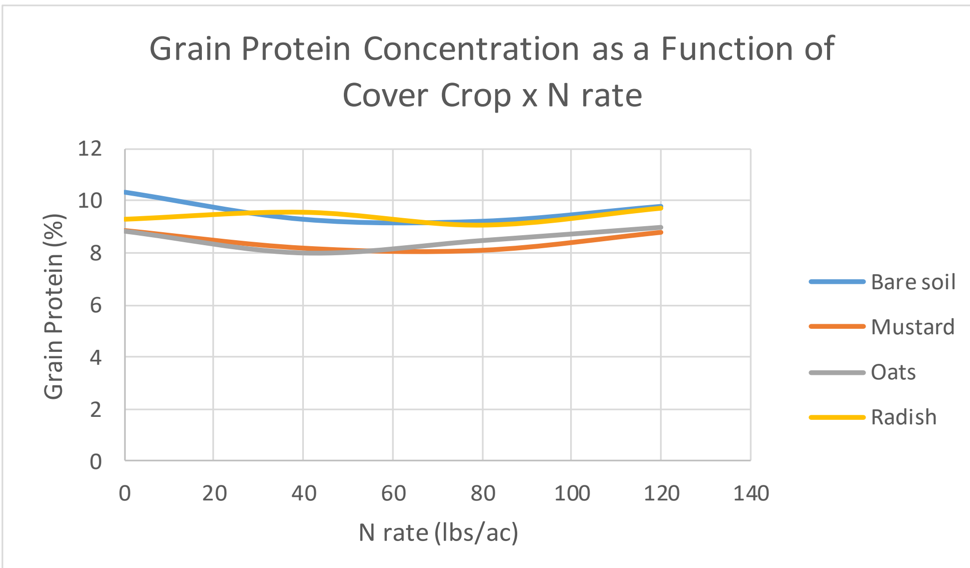

Figure 2. Grain protein concentration as a function of cover crop by N fertilizer rate.

Nitrogen rate appeared to have a minimal effect on grain protein levels, although grain proteins following mustard and oats trended lower than bare soil or radish (figure 2). This is somewhat expected for the bare soil treatment, as there was no preceding cover crop to potentially tie up N and therefore protein levels could be higher than treatments that followed a cover crop.

BENEFITS & IMPACT: Findings from this study may be used to inform wheat growers in Central Oregon on nutrient management practices for preceding fall cover crops, and to help them understand some of the potential advantages (reduced wind erosion losses) and disadvantages (limited time for stand establishment preceding early spring planted crops) of adding a fall planted brassica or oat cover crop to their crop rotation.

ADDITIONAL FUNDING RECEIVED DURING PROJECT TERM: ARF grant money supplied all needs for the conduct of the experiments. No additional funding was needed.

FUTURE FUNDING POSSIBILITIES: The study has been completed. No additional funding is being sought.