RESIDUE DECOMPOSITION OF SURFACE AND INCORPORATED BARLEY, CORN, AND WHEAT AT VARYING FERTILIZER-N RATES

C.W. Rogers[1], G. Thurgood[2], B. Dari[3], J.M. Marshall[4], O.S. Walsh[4], K. Schroeder[4], and G. Loomis[4]

[1]USDA-ARS, NW Irrigation and Soil Lab, Kimberly, ID; [2]CSS Farms, Winnemucca, NV; [3]Oregon State University, Corvallis, OR; [4]University of Idaho, Moscow, ID

Cereal crops are commonly grown in southern Idaho and most parts of the western United States. These cereal crops are routinely harvested for their grain with the remaining plant material (chaff, stems, leaves, etc.) left in the field to decompose prior to planting of following spring crops. Understanding the effects of post-harvest residue management on barley (*Hordeum vulgare* L.), corn (*Zea mays* L.), and wheat (*Triticum aestivum* L.) residue is important for optimizing agronomic and economic performance and minimizing negative environmental impacts in cropping systems. Research studies were conducted from Fall of 2018 to Fall of 2020 at the University of Idaho, Aberdeen Research and Extension Center, Aberdeen, ID. Research was focused on cultivar or crop type (Voyager (malt barley), Transit (food barley), Mycogen 2v489a (field corn) Alturas (soft white wheat), and WestBred (WB) 9668 (hard red wheat), residue management (surface and incorporated residue), and fertilizer-N rates (0, 50 and 100 lb N/ac). Cereal residues were applied in the Fall of 2018 and 2019 at a rate of 9000 kg/ha in non-reactive mesh bags in a randomized complete block design. Residue bags were collected, washed and dried, and re-weighed in Spring 2019 and 2020. Samples were then analyzed for total carbon (C) on an elemental analyzer. Results from the study indicated that incorporated cereal residue generally resulted in increased breakdown compared to surface applied cereal residue, corn residue broke down faster than barley and/or wheat residue, and fertilizer-N application had no effect on cereal residue decomposition amounts and carbon losses from the Fall to the Spring. The results of the current study indicate effective (incorporation) and non-effective (N fertilizer additions) methods to increase the rate of breakdown of cereal residue in irrigated production in the region from the time of harvest to planting in the Spring.

INTRODUCTION

Cereal crops (barley, corn, and wheat) rotated each season after harvest leave behind residue in the field which can tie up nitrogen (N) for the subsequent crop. Management of residue for cereal crops in Idaho currently recommends 15 lb N/ac for every ton of straw up to 50 lb N/ac as per the University of Idaho Extension recommendation despite known variations in the C:N ratio among crop residues. The objective of the study was to utilize residual cereal crop biomass to assess variation of in-field residue decomposition as affected by N fertilizer rates and residue placement (surface vs. incorporated) between fall and springtime.

METHODS

This study was conducted during 2018 to 2019 and 2019 to 2020 from October to March. The field study was located at the University of Idaho Research Extension Center, Aberdeen, ID on a sandy-loam soil. Soil samples were taken from the field at the initiation of the study in 2018 and 2019 to record initial nutrients as shown in (Table 1). Samples were from the 0- to 6-, 6- to 12-, and 12- to 24-in depths for soil pH, soil organic matter (SOM), and inorganic N (Miller et al., 2013). Residue was grown, collected, and dried for Voyager (malt barley (MB)), Transit (food barley (FB)), Mycogen 2v489a (field corn (FC)), Alturas (soft white wheat (SWW)), and WB 9668 (hard red wheat (HRW)) for use in the study (Table 2). Tissue composition of the barley, corn, and wheat was determined prior to field application (Table 4.2). Residues were put into non-reactive nylon mesh bags to represent 8000 lb/ac of residue being left on the field. The study design included residue placement (incorporated vs. surface), 3 different rates of ammonium sulfate $(NH_4)_2SO_4$ fertilizer (0, 50, and 100 lb N/ac), and 1 extraction period (spring) for a total of 120 plots. The study was a factorial of cultivar/crop, fertilizer rate, and residue placement arranged in a RCB.

Table 1. Initial soil fertility status of field study conducted during the 2018-2019 fall-spring season at the Aberdeen Research and Extension Center, Aberdeen, ID.

Depth (in)	Soil pH	OM (%)	NH_4-N	NO_3-N
2018			---------------mg/kg-----------	
0-6	8.3	1.1	BDL	3.6
6-12	8.3	0.9	BDL	3.2
12-24	8.6	1.1	BDL	3.2
2019				
0-6	7.9	1.1	BDL	3.6
6-12	8.5	0.9	BDL	3.2
12-24	8.4	1.1	BDL	3.2

† Below detection limit (BDL) values were <1.25 mg/kg

Application and Extraction of Residue Samples in the Field

Incorporated trials were buried at approximately 6 in within the soil representing a disc tillage in the field. Surface trials were held in place by using metal landscape pins to avoid being blown away or moved. Collection of samples were taken in the 1st week of spring between March 18th and March 21st for both years. Samples were extracted from the field washed and hang dried for 24 hours and oven dried at 140 °F to a constant weight. Dried samples were then weighed, and the weight from the initiation of the study was subtracted from the final collected weight to record any loss of residue. Following sample weight determination, samples were ground using a Wiley mill grinder (Thomas Scientific, Swedesboro, NJ, USA). Tissue was then analyzed using high temperature via a VarioMax CN analyzer (Elementar Americas, Inc. Mt Laurel, NJ) to determine the amount of C and N in the samples.

Statistical Analyses

Statistical analyses were performed using the Proc MIXED procedure of SAS (SAS Institute, 2011) where cultivar, residue placement, and fertilizer N rate were fixed effects and year and block were treated as random effects.

RESULTS AND DISCUSSION

Initial C:N ratios used within the study were 70:1 for barley, 67:1 for corn, and 96:1 for wheat on average (Table 2). Cultivar X Application Method was the highest-level interaction for both weight and carbon loss where N rate interactions and its main effect were not significant. Measurements of percent weight loss in general were greater from incorporated treatments, however Mycogen (surface) was comparable to both Alturas and WB9668 (incorporated) (Fig. 4.3). Mycogen (incorporated) measured the greatest weight loss at 37% which was followed by Voyager at 30%. Mycogen (incorporated) and Voyager (incorporated) differed in weight loss and were greater in residue weight loss compared to all other incorporated treatments (Fig. 1). Comparable measurements of incorporated treatments were seen between incorporated Alturas, Transit, and WB9668. In contrast, Mycogen surface differed to all other surface residue treatments but comparable weight loss of surface residue treatments was measured between surface applied Alturas, Transit, Voyager, and WB9668.

Table 2. **Initial mean chemical composition of barley, corn, and wheat used in 2018 and 2019.**

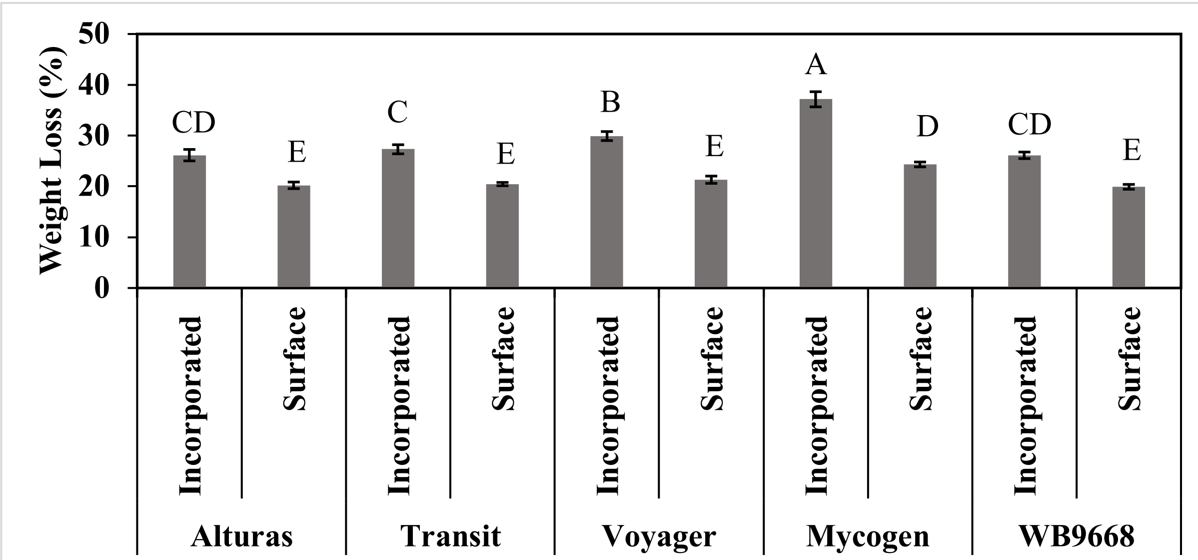
Crop	Cultivar	C/N
Barley	Transit	69
Barley	Voyager	71
Corn	Mycogen	67
Wheat	WB9668	90
Wheat	Alturas	103

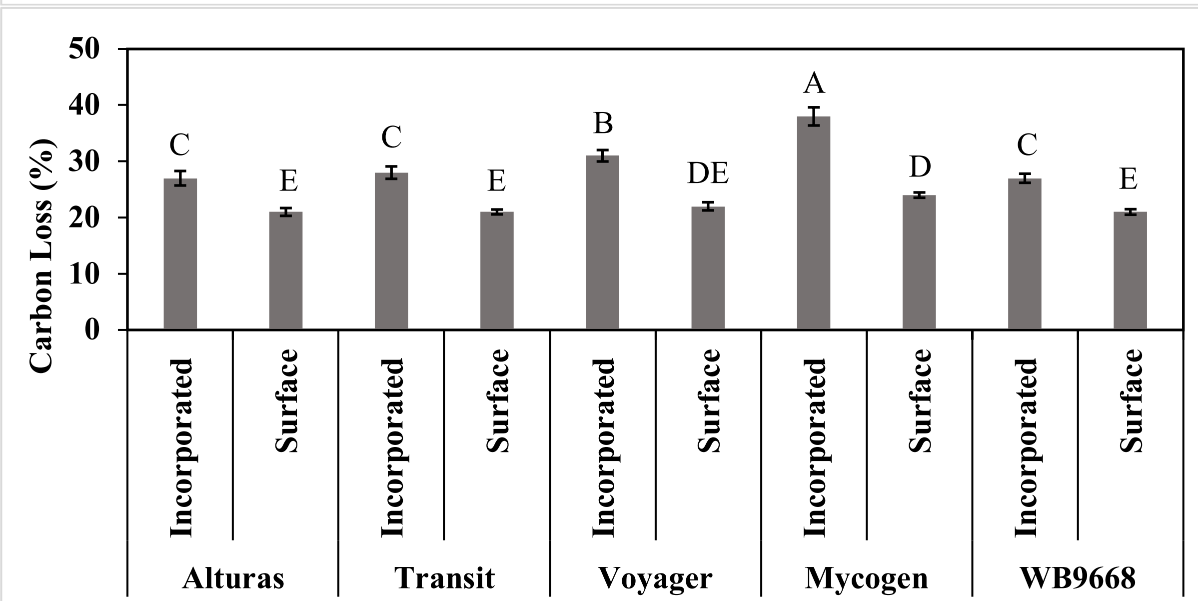
Carbon Loss

Carbon loss only differed based on cultivar by application and interactions between N rates were not significant. All incorporated residue treatments showed greater carbon loss than all surface applied treatments within the field study (Fig. 4). Effects from incorporated Voyager and Mycogen measured the highest carbon loss compared to all others where incorporated treatments with Mycogen showed the greatest carbon loss at 38 percent. Comparable measurements of carbon loss were seen between incorporated residue of Alturas, Transit, and WB9668. In contrast, the greatest carbon loss measured for surface applied treatments was Mycogen at 24 percent followed by Voyager at 22 percent carbon loss. All surface treatments of the field study measured comparable carbon losses, but in this case Mycogen surface differed from all other surface applied residue. Variation in the surface v. incorporated environment and the C:N ratios of the crops as well as changes in microbial communities responsible for decomposition likely impacted the rates of breakdown.

The findings from this study showed greater carbon and weight loss in all incorporated treatments compared to surface applied residue and the general pattern of corn > barley > wheat in terms of residue decomposition. Effects from N applications were not significant. To increase carbon decomposition between fall and spring, it would be recommended to incorporate residue into the soil. Nitrogen applications to increase carbon or weight loss would not be recommended due to the non-significant effects shown within the study.

Figure 1. Residue weight loss and carbon loss of barley, corn, and wheat that was incorporated or left on the surface averaged across three N application rates for research conducted at the Aberdeen Research and Extension Center, Aberdeen, ID from 2018 to 2020.





†Different letters for each parameter indicate significant differences between cultivars and application methods.