72505

Winter Rye Cover Crop Biomass Production, Degradation, and N Re-Cycling

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INTRODUCTION

Winter rye (*Secale cereal* L.) as a cover crop can take up residual inorganic N between annual row crops and therefore be used to help reduce NO_3^-–N loss from fields and movement to water systems. Price incentives to grow corn (*Zea mays* L.) are resulting in more corn production and greater N application. However, it is unclear if rye N uptake can significantly affect N re-cycling to soil and subsequent N fertilization rate for corn. The C:N ratio from the rye biomass could also influence N re-cycling. The objectives of this study were to evaluate rye biomass degradation and N re-cycling after spring rye control in a no-till corn-soybean [*Glycine max.* (L.) Merr.] rotation.

MATERIALS AND METHODS

A two year experiment (2010-2011) was conducted at four Iowa sites in a corn-soybean rotation, with a winter rye cover crop (c.v. Wheeler) each year.

- In the spring and before chemical control, rye cover crop aboveground biomass was collected following corn that had received 0, 135, and 225 kg N ha^{-1}.
- Rye biomass sampling was conducted by replicate following soybean (no N treatment).
- Samples were also collected to estimate aboveground rye biomass dry matter (DM) production, and C and N accumulation (Tables 1 and 2).
- The collected rye was split into sub-samples, fresh weight measured, placed into nylon mesh bags, and the bags placed on the soil surface of corresponding previous-year corn plots or soybean replicates.
- One set of bags was collected at 1, 3, 9, and 15 wk, with determination of remaining rye residue DM, C, and N.

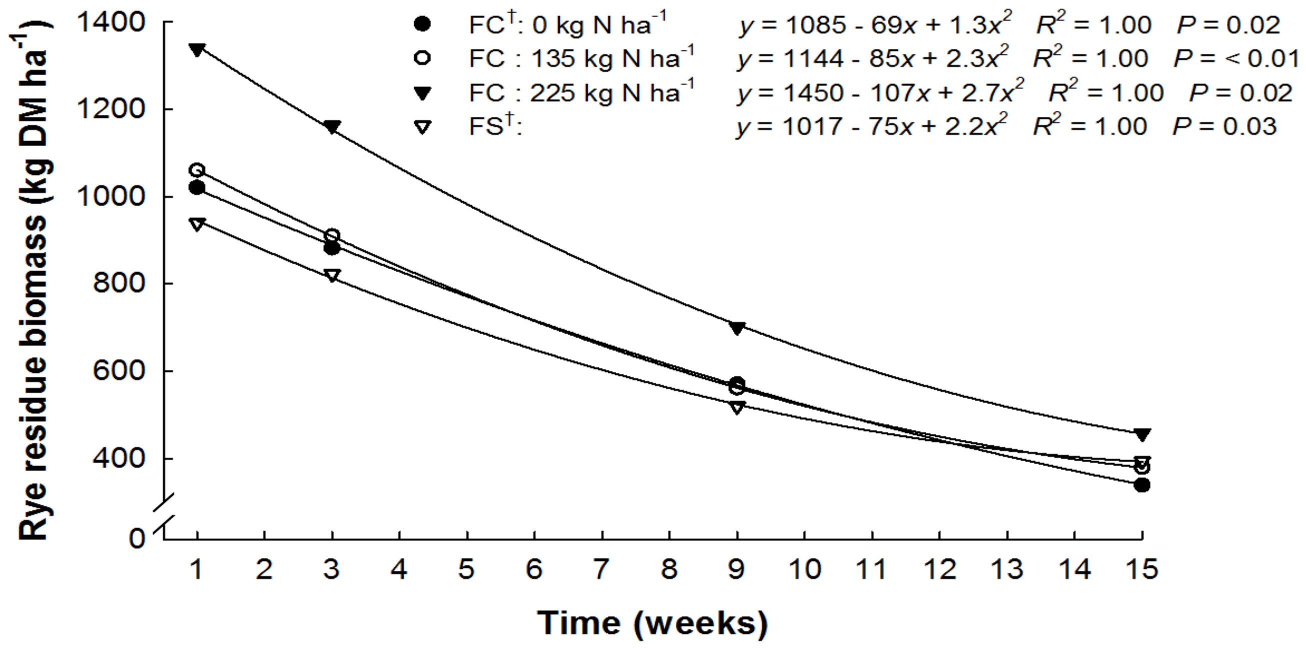

Fig. 1. Rye residue biomass dry matter (DM) remaining with time after spring control, across sites and years. The N rates for the rye following corn were applied to the prior year corn.
† FC, following corn; FS, following soybean.

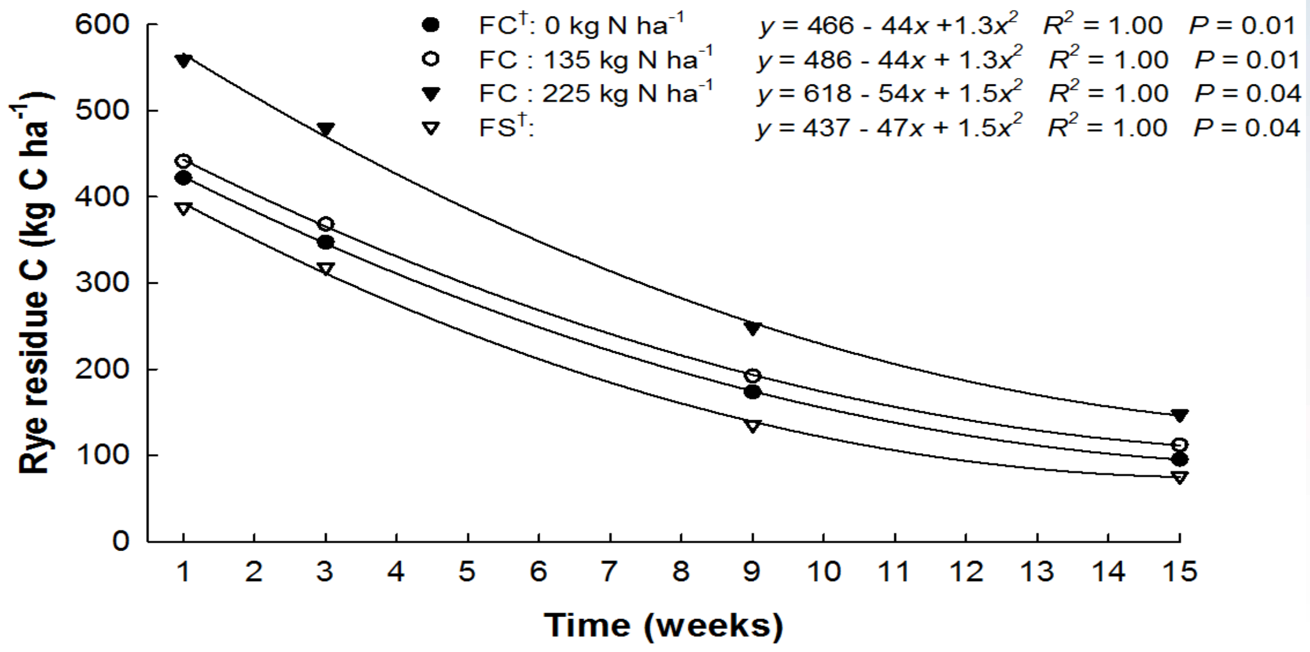

Fig. 2. Rye residue C remaining with time after spring control, across sites and years. The N rates for the rye following corn were applied to the prior year corn.
† FC, following corn; FS, following soybean.

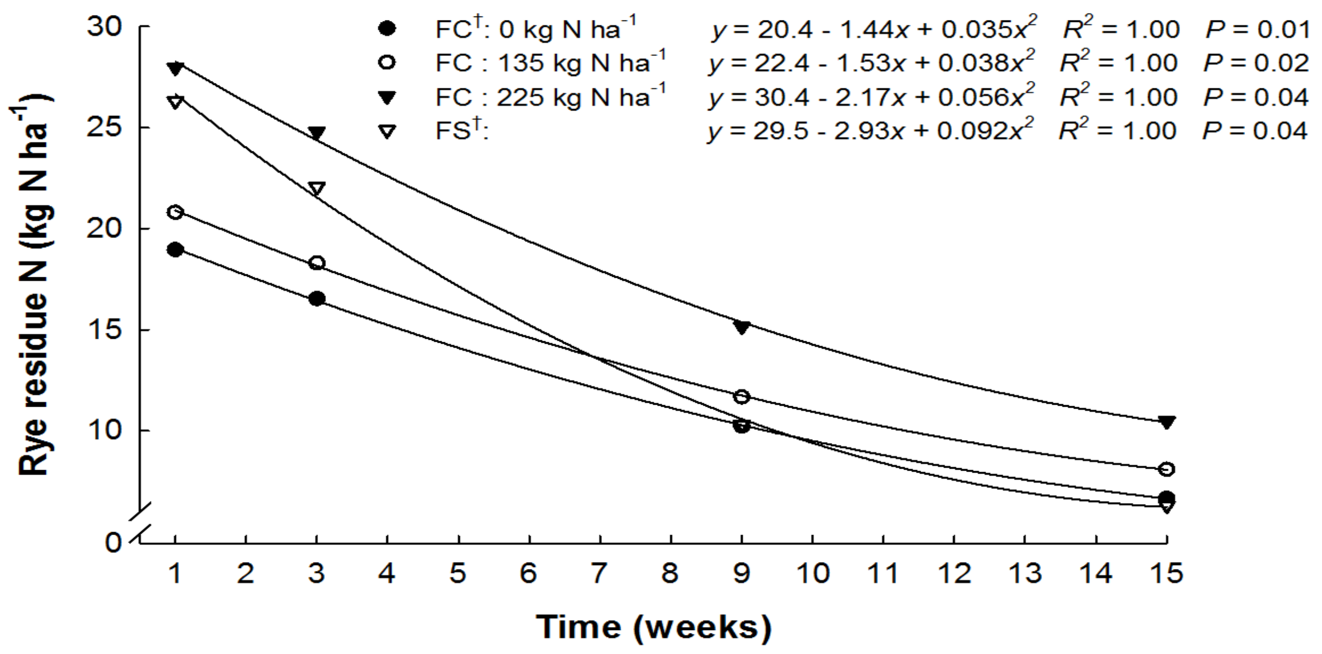

Fig. 3. Rye residue N remaining with time after spring control, across sites and years. The N rates for the rye following corn were applied to the prior year corn.
† FC, following corn; FS, following soybean.

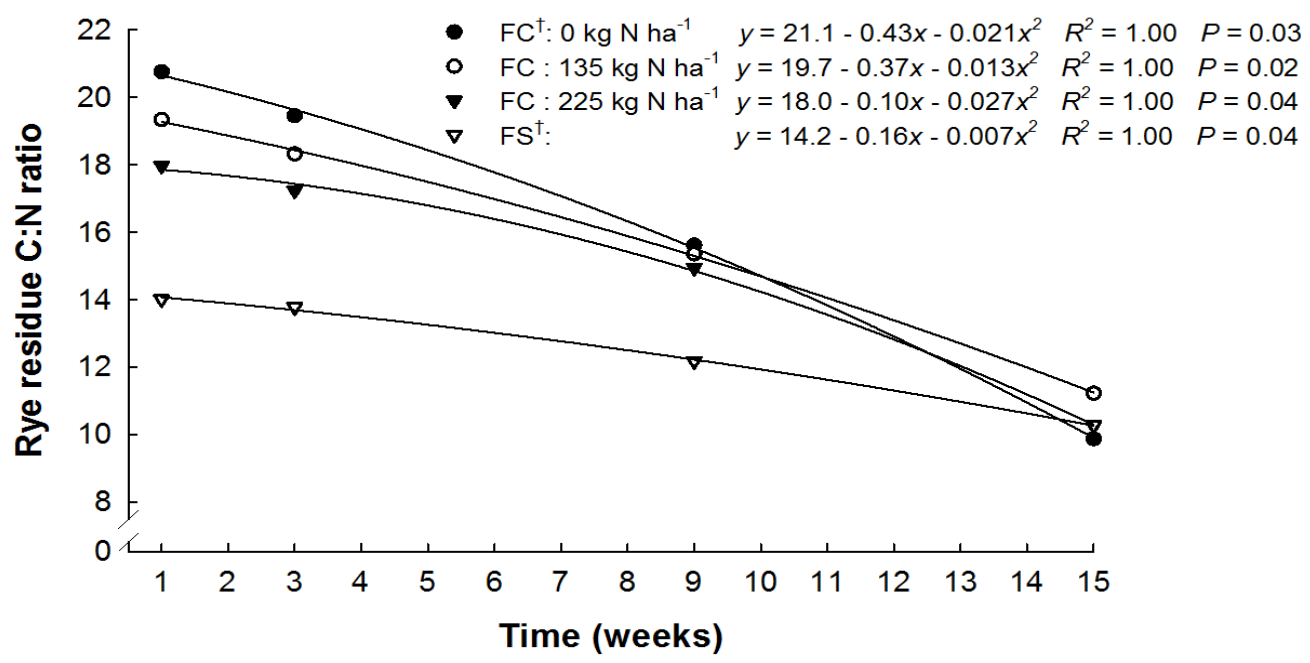

Fig. 4. Rye residue C:N ratio with time after spring control across sites and years. The N rates for the rye following corn are rates applied to the prior year corn.
† FC, following corn; FS, following soybean.

Table 1. At the time of rye control in the spring, influence of N rate applied to the previous corn crop on aboveground rye biomass dry matter (DM), total C, and total N. Mean across years at each site.

	Ames			Crawfordsville			Lewis			Nashua		
N rate	DM	C	N	DM	C	N	DM	C	N	DM	C	N
kg N ha^{-1}	kg ha^{-1}											
0	760 a†	310 a	16 b	1,920 b	800 b	28 b	700 a	280 a	15 a	500 b	210 b	12 b
135	770 a	320 a	18 b	2,130 ab	880 b	31 b	690 a	280 a	16 a	510 b	210 b	13 b
225	930 a	380 a	25 a	2,910 a	1,220 a	44 a	560 a	230 a	15 a	710 a	290 a	20 a

† Means followed with the same letter within a column are not different ($P > 0.05$).

Table 2. At the time of rye control in the spring, aboveground rye biomass dry matter (DM), total C, and total N following soybean. Mean across years at each site.

Ames			Crawfordsville			Lewis			Nashua		
DM	C	N	DM	C	N	DM	C	N	DM	C	N
kg ha^{-1}											
1,125	460	30	1,230	500	29	910	370	27	710	280	23

RESULTS AND DISCUSSION

Rye biomass production was low due to seeding after row crop harvest, cold temperatures in the fall, and short springtime for rye growth (Tables 1 and 2). Rye biomass production was the same when following corn receiving 0 or 135 kg N ha^{-1} and when following soybean (average 1000 kg DM ha^{-1}), but was 28% greater with 225 kg N ha^{-1} application to the prior corn (1280 kg DM ha^{-1}). Nitrogen accumulation was low as a result of the low biomass production. Nitrogen uptake was < 45 kg N ha^{-1} in all cases (average 21 kg N ha^{-1} following corn, and 27 kg N ha^{-1} following soybean). Biomass DM, C, and N remaining in the rye residue decreased across the 15 wk (Figs. 1, 2, and 3), with the rate of degradation slower as time progressed and with the majority of N re-cycled by 9 wk. The amount of N remaining in the rye residue following soybean decreased faster than the N in the rye following corn. Across sites and years, the rye following corn released < 3 kg N ha^{-1} by 3 wk, and the rye following soybean released 5 kg N ha^{-1} during the 3 wk period. An average of 64% (650 kg ha^{-1}) rye biomass when following corn and 60% (640 kg ha^{-1}) when following soybean was degraded after 15 wk. The release of N from the degrading rye residue was 60% (13 kg N ha^{-1}) when following corn and 77% (21 kg N ha^{-1}) when following soybean after 15 wk. The more rapid release of N in the rye following soybean could be a result of its lower C:N ratio compared to the rye following corn (Fig. 4). The rye was controlled on average 2 wk before the rye following corn, and hence had less time to grow and accumulate C rich compounds. The 225 kg N ha^{-1} application rate to the prior corn resulted in a lower rye C:N ratio and an increased amount of N re-cycling compared to the rye following corn with no N or the 135 kg N ha^{-1} rate.

CONCLUSIONS

Rye biomass production and N uptake were low. Application of 225 kg N ha^{-1} to the prior corn had the highest rye biomass production and the greatest N uptake. That rate also had more N re-cycled across the 15 wk than the rye with no N or the 135 kg N ha^{-1} rate. This indicates larger residual profile NO_3^--N with the high N application, and resultant greater rye N uptake. Rate of rye biomass degradation and N release were consistent across the 15 wk after rye control when rye followed corn, but N release was faster when rye followed soybean. This difference appeared related to the lower C:N ratio of the rye following soybean. Only 13 kg N ha^{-1} of the N from the rye following corn and 21 kg N ha^{-1} from the rye following soybean re-cycled after 15 wk. This indicates only a small influence would be expected on available soil N during the growing season or influence on optimal N fertilization rate for corn.

APPRECIATION IS EXTENDED TO THE ISU RESEARCH AND DEMONSTRATION FARMS PERSONNEL FOR ASSISTANCE WITH FIELD SITES AND COLLECTING OF SAMPLES

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This research is part of a regional collaborative project supported by the USDA-NIFA, Award No. 2011-68002-30190 “Cropping Systems Coordinated Agricultural Project (CAP): Climate Change, Mitigation, and Adaptation in Corn-based Cropping Systems”.
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