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Winter Rye Cover Crop Biomass Production, Degradation, and N Recycling

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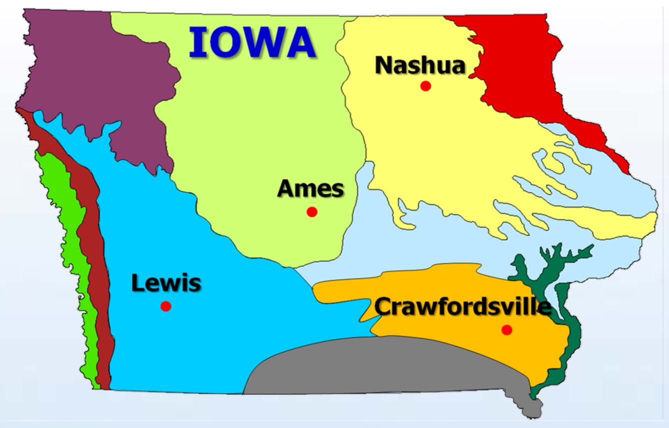

INTRODUCTION

Price incentives to grow corn (*Zea mays* L.) for the ethanol industry have increased corn acres and use of N fertilizers. This results in greater potential for nitrate increase in water systems. Since a winter rye (*Secale cereale* L.) cover crop can utilize residual soil N, it can help reduce nitrate loss. A question, however, is what impact does the rye N uptake have on N recycling and needed fertilization rate for corn. The objective was to evaluate rye biomass degradation and N recycling after spring rye termination following corn and soybean [*Glycine max.* (L.) Merr.].

MATERIALS AND METHODS

There were four sites in a corn-soybean rotation, with a winter rye cover crop each year.

- In the spring of 2010 and 2011 following corn and before rye control, rye aboveground biomass samples were randomly collected from plots receiving 0, 120, and 200 lb N/acre.
- Rye sampling was conducted by replicate after soybean (no N treatment).
- Samples were also collected to estimate aboveground rye biomass production and N content.
- Individual rye samples were split into four sub-samples, fresh weight measured, placed into nylon mesh bags, and bags placed on the soil surface of corresponding plots/replicates and away from traffic patterns.
- One set of bags was collected at 1, 3, 9, and 15 weeks, and then remaining rye dry matter and N content were determined.

Table 1. Calendar dates of rye cover crop seeding, sampling, and control.

Year	Field activity	Ames	Crawfordsville	Lewis	Nashua
2009	Seeding FS†	Sept. 25	Sept. 29	Sept. 25	Oct. 09
	Seeding FC†	Oct. 09	Sept. 30	Oct. 13	Oct. 28
2010	Biomass sampling FS	Apr. 21	Apr. 19	Apr. 22	Apr. 23
	Biomass sampling FC	Apr. 28	May 09	Apr. 29	May 04
	Seeding FS	Oct. 05	Oct. 01	Sept. 30	Oct. 07
	Seeding FC	Oct. 05	Sept. 17	Sept. 30	Oct. 07
2011	Biomass sampling FS	Apr. 29	Apr. 29	Apr. 20	Apr. 28
	Biomass sampling FC	May 08	May 06	May 05	May 07

† FS: following soybean, FC: following corn.

Table 2. Aboveground rye biomass dry matter and N uptake following corn as affected by N rate.

		Ames		Crawfordsville		Lewis		Nashua	
Year	Nrate	DM†	TN†	DM	TN	DM	TN	DM	TN
		lb/acre							
2010	0	690 b‡	14 b	2,080 a	28 a	570 a	12 b	580 b	11 c
	120	740 b	17 b	2,360 a	32 a	620 a	13 ab	660 b	15 b
	200	1,120 a	31 a	2,840 a	39 a	640 a	15 a	870 a	20 a
2011	0	670 a	14 a	1,350 b	22 b	680 a	15 a	310 ab	10 b
	120	620 ab	14 a	1,440 b	23 b	600 a	16 a	250 b	9 b
	200	540 b	13 a	2,360 a	40 a	360 b	12 a	400 a	15 a

† DM: dry matter, TN: total nitrogen.
‡ Means in a column and within a year followed with the same letter are not different ($P > 0.05$).

Table 3. Aboveground rye biomass dry matter and N uptake following soybean.

	Ames		Crawfordsville		Lewis		Nashua	
Year	DM†	TN†	DM	TN	DM	TN	DM	TN
	lb/acre							
2010	1,460	36	1,000	24	1,250	33	1,020	30
2011	550	18	1,200	27	380	15	240	10

† DM: dry matter, TN: total nitrogen.

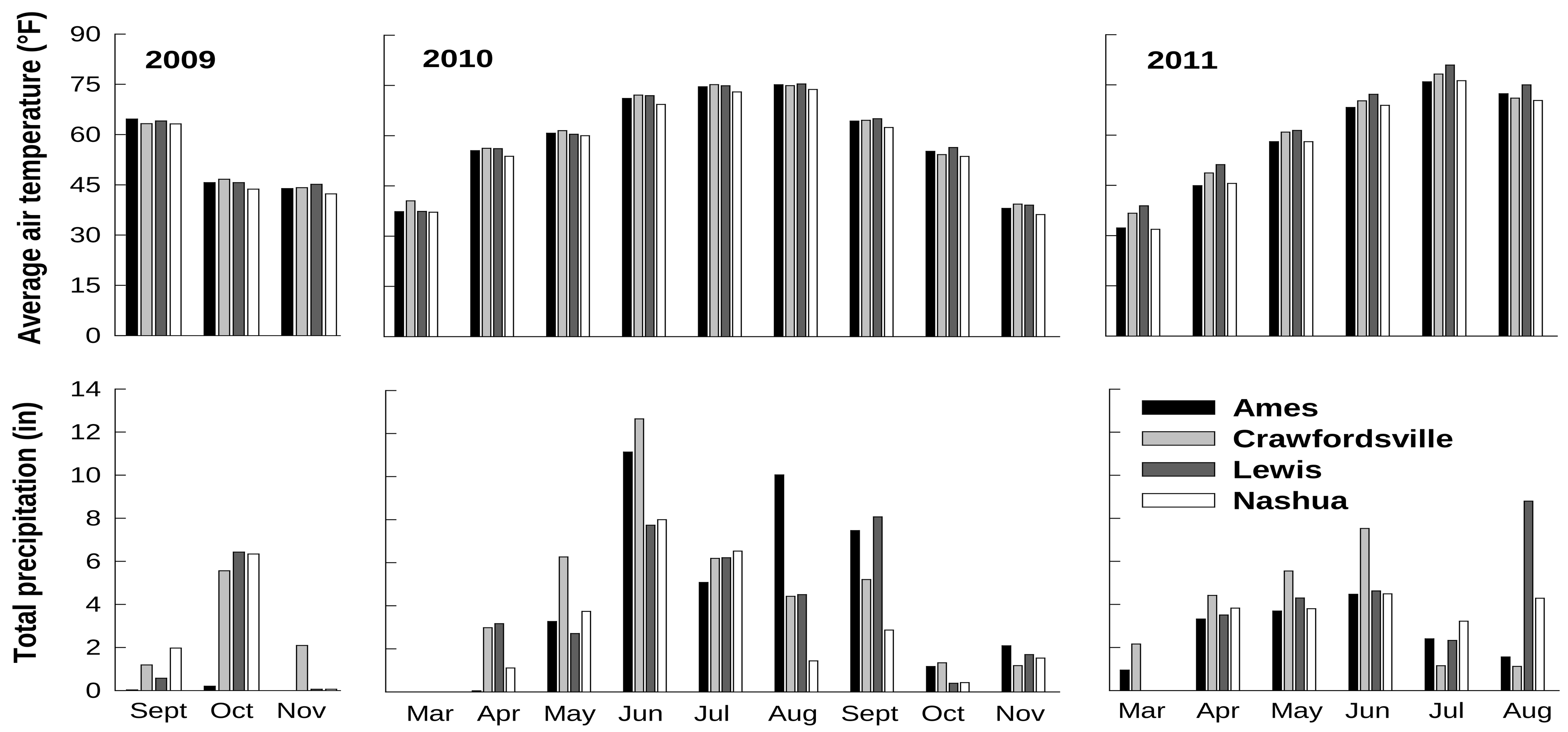

Fig. 1. Monthly average air temperature and total precipitation per site during the study.

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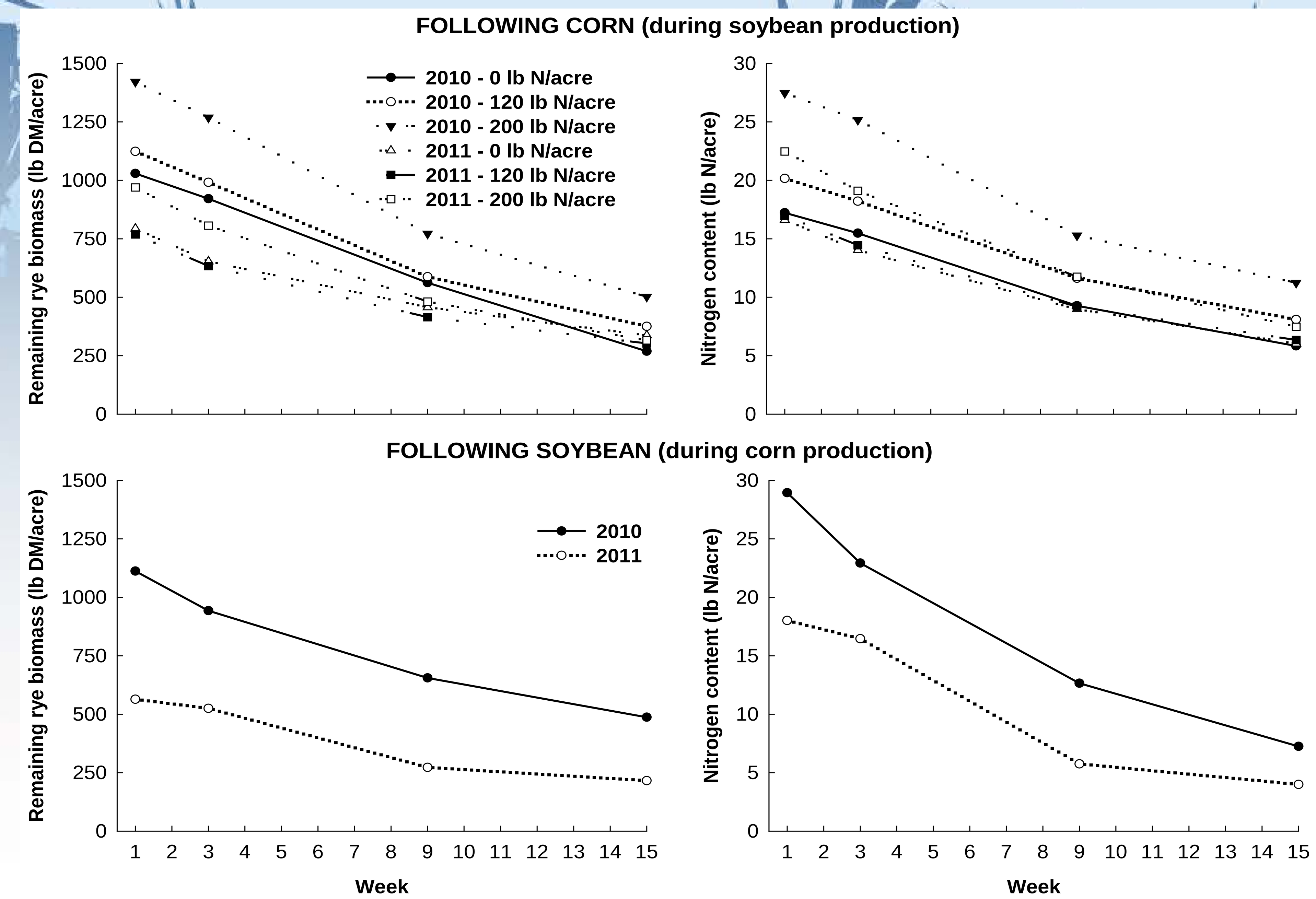

Fig. 2. Remaining rye biomass and N content in the rye residue in 2010 and 2011. The N rates for rye following corn were the rates applied to prior year corn.

RESULTS AND DISCUSSION

Rye fall growth has been low due to late seeding and cold temperatures (Table 1 and Fig. 1), with most rye growth in the spring. Across sites, 2010 rye biomass following corn was 44% greater than in 2011 (Table 2), and 100% greater when following soybean (Table 3). The greater rye biomass production was due to warmer spring temperatures in 2010 compared to 2011 (6 °F greater). The increase in rye biomass production in 2010 resulted in more N uptake (21% greater following corn, and 76% greater following soybean). Applying 120 or 200 lb N/acre to the prior year corn sometimes influenced rye biomass production and N uptake. However, the total N uptake was low in all cases (< 40 lb N/acre, with an average 19 lb N/acre following corn, and 24 lb N/acre following soybean). Rye biomass dry matter loss (degradation) was quite consistent from week 1 to week 15 (Fig. 2). The N remaining in the rye biomass followed a similar trend as rye biomass loss, with approximately 4 lb N/acre released after 3 weeks (following corn or soybean). After 15 weeks, and across sites and years, an estimated 40% of the N remained in the rye biomass when following corn (average 7 lb N/acre), and 23% when following soybean (average 6 lb N/acre).

CONCLUSIONS

Overall, rye biomass production and N uptake has been low, with < 40 lb N/acre across sites and often less than half that amount. Rye biomass degradation and N recycling was quite consistent across the 15 weeks after rye control, with approximately 60% of the N re-cycled from the rye when following corn (during the soybean crop), and 77% when following soybean (during the corn crop). However, the amount of N re-cycled was low. These results help explain the lack of difference in the optimal N fertilization rate for corn with and without a winter rye cover crop found in this study.

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