Root and shoot biomass and nutrient composition in a winter rye cover crop

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INTRODUCTION

Nitrogen loss from applied fertilizer can be significant economic and environmental quality issues in corn (*Zea mays* L.) production systems. The Iowa Nutrient Reduction Strategy science assessment identified winter cereal rye (*Secale cereal* L.) as a cover crop that can significantly reduce nitrate-N loss (31% nitrate-N concentration reduction) from the corn-soybean [*Glycine max.* (L.) Merr.] system. Cereal rye, through its fibrous root system, can explore the soil and take up inorganic-N. In order to further understand N uptake and effectiveness as a cover crop for scavenging and recycling N, there is a need to study the amount of root/shoot biomass production and N and C partitioning at time of rye control.

MATERIALS AND METHODS

This study was conducted at the Ames, IA CSCAP cover crop site. Corn was grown in rotation with soybean and winter cereal rye was drilled (1bu/acre in 7.5 inch row spacing) following corn (22 Oct. 2014) and soybean (30 Sept. 2014) harvest. Two ingrowth tubes per plot, 2.2 inch diameter (0-24 and 0-12 inch depth following corn and soybean, respectively), were installed between rye rows shortly after seeding. The tubes were collected the next spring at rye control (following soybean 29 Apr. 2015 and following corn 8 May 2015). Root and shoot biomass was analyzed for total C and N.




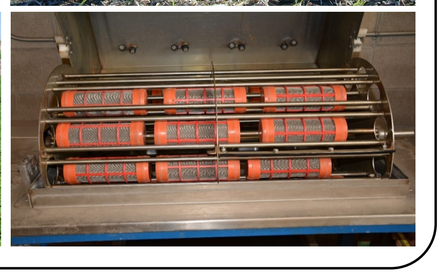

Table 1. Rye cover crop plant components at time of in-growth tube removal, following corn.

	Biomass			Carbon			Nitrogen		
N rate	Shoot	Root	Mean	Shoot	Root	Mean	Shoot	Root	Mean
lb/acre	lb/acre								
0	1095	485	790	443	204	324	19	4	12
120	1287	464	875	518	195	357	23	4	13
200	1301	438	869	529	184	357	23	4	13
Mean	1227a	462b		497a	194b		22a	4b	

Only main effect of plant component significant. Component mean with different letter is significantly different, $P \leq 0.05$.

Table 2 . Rye cover crop plant components at time of in-growth tube removal, following soybean.

	Biomass			Carbon			Nitrogen		
N rate	Shoot	Root	Mean	Shoot	Root	Mean	Shoot	Root	Mean
lb/acre	lb/acre								
0	1349	575	962	538	246	392	30	5	18
120	1413	636	1024	567	284	425	32	5	19
200	1359	501	930	553	222	387	34	5	20
Mean	1374a	571b		552a	251b		32a	5b	

Only main effect of plant component significant. Component mean with different letter is significantly different, $P \leq 0.05$.

Table 3. Rye cover crop plant shoot:root ratio.

	Following corn			Following soybean		
N rate	Biomass	Carbon	Nitrogen	Biomass	Carbon	Nitrogen
lb/acre						
0	2.6	2.5	5.6	2.3	2.2	5.9
120	2.8	2.7	6.6	2.2	2.0	5.6
200	3.1	3.0	6.2	2.7	2.6	6.3
Mean	2.8	2.7	6.1	2.4	2.2	6.0

No statistical difference due to N rate, $P \leq 0.05$.

Table 4. Rye cover crop plant components C:N ratio.

	Following corn		Following soybean	
N rate	Root	Shoot	Root	Shoot
lb/acre				
0	52	23	49	17
120	53	22	50	18
200	47	23	41	15
Mean	51a	23b	46a	17b

Only main effect of plant component significant. Component mean within a crop with different letter is significantly different, $P \leq 0.05$.

RESULTS AND DISCUSSION

- There was no effect of prior N fertilizer rate on root and shoot biomass, C, and N ($P \leq 0.05$) (Tables 1 and 2). This was likely due to low residual profile soil nitrate-N concentration at the time of rye seeding and in the spring (data not shown).
- The rye biomass, C, and N (mean across N rates applied to corn) were significantly different between the root and shoot following both corn and soybean (Tables 1 and 2), with more biomass, C, and N in rye shoots than roots.
- The shoot:root ratio of rye biomass and C was lower than for N (Table 3), with about 30% of total plant C and 14% of N in the root biomass. Nitrogen in the roots was only 4 to 5 lb N/acre, with 22 to 32 lb N/acre in the shoots.
- The C:N ratio of root material was high (46 to 51 ratio) and more than double the shoot material (17 to 23 ratio) (Table 4).

CONCLUSIONS

- The shoot biomass of the rye was more than twice the amount of root biomass.
- The largest fraction of total N uptake and C assimilation by the rye cover crop was contained in the aboveground shoot biomass.
- Measurement of the aboveground rye biomass provided a reasonable estimate of rye cover crop N uptake and also the main N amount available for recycling.
- The C:N ratio of root material was high enough to likely cause N immobilization.

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