100371

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 (63 kg ha^{-1} in 19 cm row spacing) following corn (22 Oct. 2014) and soybean (30 Sept. 2014) harvest.
- Two ingrowth tubes per plot, 5.6 cm diameter (0-60 and 0-30 cm 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 DM			Carbon			Nitrogen		
N rate	Shoot	Root	Mean	Shoot	Root	Mean	Shoot	Root	Mean
kg ha^{-1}	kg ha^{-1}								
0	983	544	764	397	229	313	16.8	4.4	10.6
135	1154	519	837	465	219	342	21.1	4.1	12.6
225	1166	491	829	475	206	341	20.9	4.5	12.7
Mean	1101a	518b		446a	218b		19.6a	4.3b	

Only main effect of plant component is 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 DM			Carbon			Nitrogen		
N rate	Shoot	Root	Mean	Shoot	Root	Mean	Shoot	Root	Mean
kg ha^{-1}	kg ha^{-1}								
0	1202	648	925	480	277	379	26.9	5.6	16.3
135	1267	713	990	509	318	414	28.6	6.3	17.5
225	1211	565	888	494	250	372	30.1	6.1	18.1
Mean	1227a	642b		494a	282b		28.6a	6.0b	

Only main effect of plant component is 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
kg ha^{-1}						
0	2.1	2.0	4.6	1.8	1.7	4.7
135	2.3	2.2	5.3	1.8	1.6	4.5
225	2.5	2.4	5.0	2.5	2.4	5.9
Mean	2.3	2.2	5.0	2.0	1.9	5.0

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
kg ha^{-1}				
0	53	23	50	16
135	56	22	49	18
225	48	23	41	15
Mean	52a	23b	47a	16b

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 35% of total plant C and 20% of N in the root biomass. Nitrogen in the roots was only 4 to 6 kg N ha^{-1}, with 20 to 29 kg N ha^{-1} in the shoots.
- The C:N ratio of root material was high (47 to 52 ratio) and more than double the shoot material (16 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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