Nitrogen Contributions from Winter Annual Cover Crops in the Upper Midwest

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INTRODUCTION

Nitrogen management is a study of prime concern for farmers and land managers. Current nitrogen delivery through synthetic fertilizer can be inefficient and deleterious to the environment. Legumes, with the ability to fix atmospheric nitrogen into plant matter via rhizobial root colonization and symbiosis, present an alternate source and mechanism of nitrogen fertility, especially for orgranic or marginalized growers with limited fertility options. While legume cover crops may play a valuable role in maintaining and increasing soil quality and nitrogen availability for cash crops, they face unique challenges in the Upper Midwest, such as short growing seasons; cold, wet springs; and harsh winters. **This study was performed to assess the quantity and source of nitrogen credits from winter annual legume species in two Minnesota plant hardiness zones that may address these challenges.**

CURRENT NITROGEN ESTIMATES

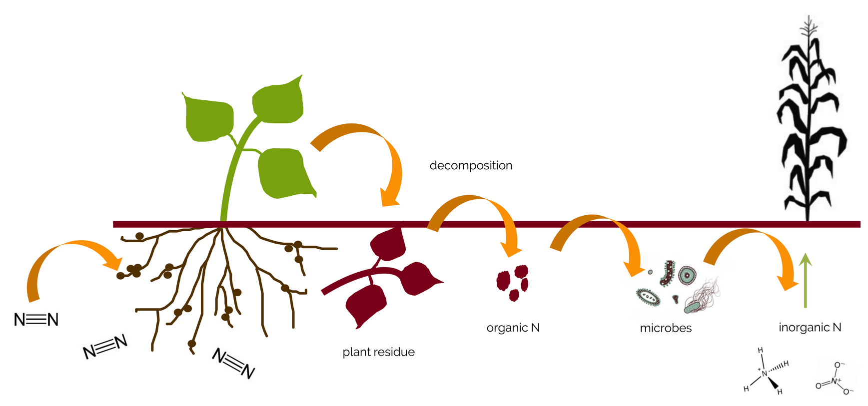
$28 billion spent on fertilizers annually (NASS 2014)

70% of applied nitrogen may not reach the cash crop (ISAAA n.d.)

$210 billion est. costs/year of nitrogen pollution damages to the environment and human health (Sobota *et al.* 2015)

108 million acres in need of improved nitrogen management (Ribaudo *et al.* 2011)

DECOMPOSITION MODEL



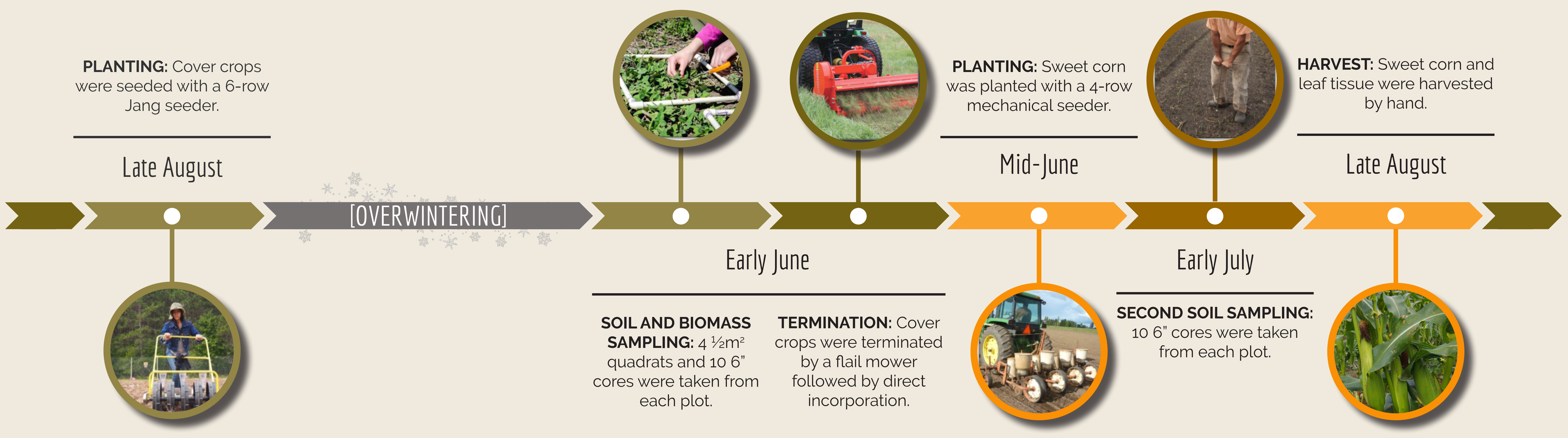
EXPERIMENTAL DESIGN

Species of cold-hardy legumes were planted with a non-legume control in a randomized complete block design in Fall 2014 and Fall 2015 at Grand Rapids, MN (sandy, zone 3b) and Lamberton, MN (loam, zone 4b). Legumes were subdivided into rhizobia inoculated (WIN) and non-inoculated (NIN) treatments. Sweet corn was planted as a cash crop.

Treatment	ID	Source & Cultivar	Rate (#/acre)	Y1	Y2
Hairy Vetch 1	V1	Albert Lea MN 2014 #23	25	✓	✓
Hairy Vetch 2	V2	Buckwheat growers 2014 #25	25	✓	✓
Hairy Vetch 3	V3	Welter Seeds IA GMO Free 2014	25	✓	
Red Clover	clo	Red Clover Albert Lea 2014	12	✓	✓
Hairy Vetch + Rye	mix	V2 + rye	3:1		✓
Winter Rye	rye	rye	105	✓	✓
No Cover Crop	noCC	-	-		✓

HYPOTHESES:

1. Inoculated legumes will outperform non-inoculated legumes in biomass accumulation and total N.
2. The vetch-rye biculture will derive the largest percentage of nitrogen from the atmosphere vs the soil.



DATA COLLECTED

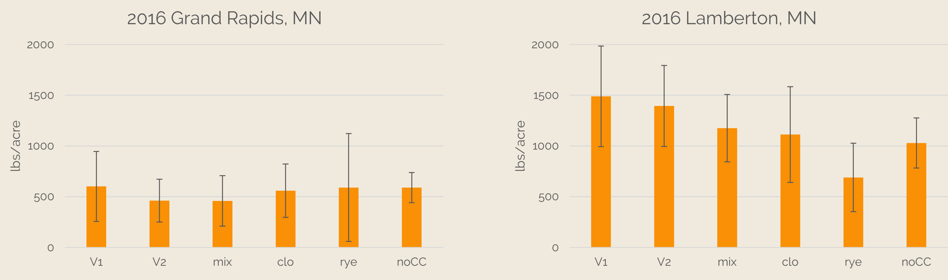
1. Total Plant Biomass
2. Total Plant Nitrogen
3. Nodulation per Plant
4. Nitrogen Derived from the Atmosphere (NDfA)
5. Sweet Corn Yield

*2 & 4 achieved through isotopic elemental analysis with Elementar's vario PYRO cube.

SWEET CORN YIELD

Marketable ears were 17cm in length with < 8% damage or immaturity.

Minnesota 2014 average sweet corn yield was 13,480 lbs/acre.



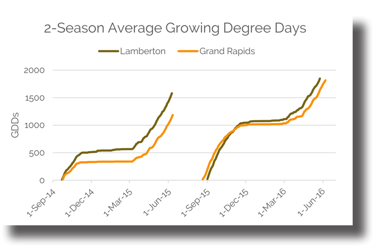
*Corn yield data was not collected in 2015.

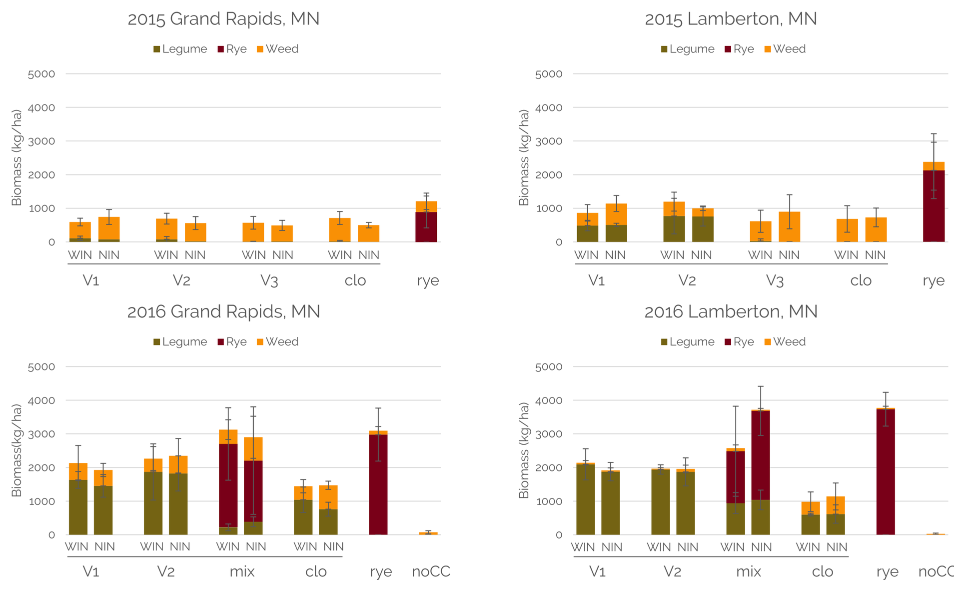
RESULTS

TOTAL BIOMASS

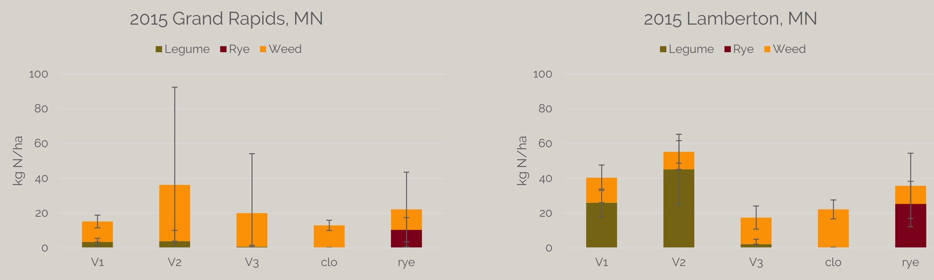
Inoculation did not have a significant effect on biomass growth.

More growth was observed in 2016 due to a mild winter and earlier planting.





TOTAL PLANT N



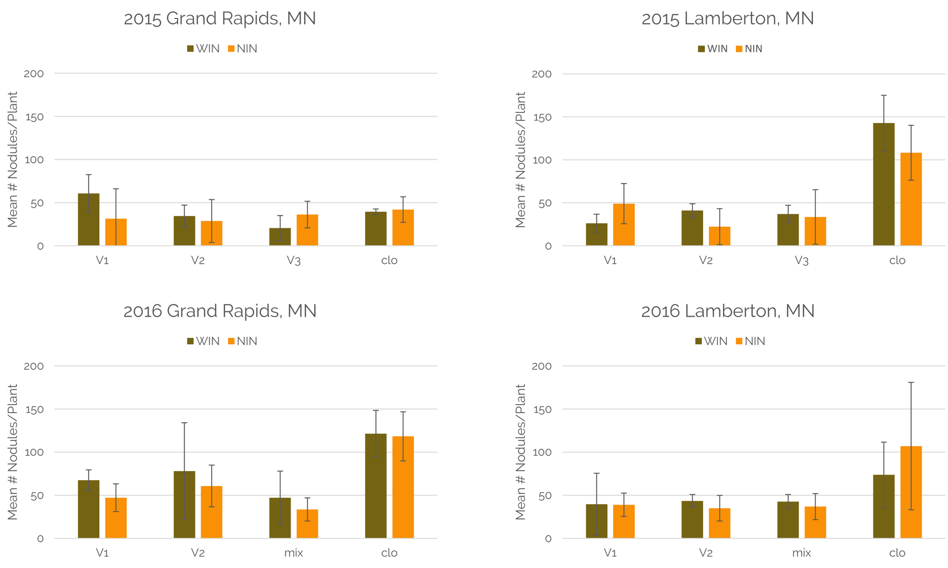
Legumes provided up to 40 kg N/ha.

Legumes contributed more nitrogen than rye or weeds per unit biomass.

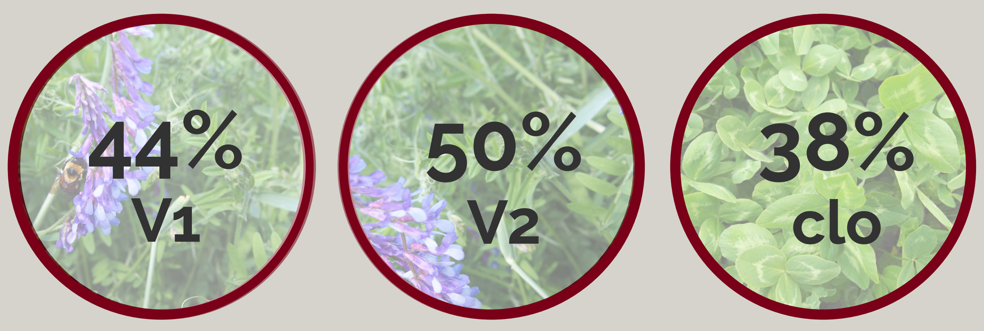
MEAN NODULATION

Inoculation did not have a significant effect on mean nodule number.

Nodulation was not correlated to total plant N.



NITROGEN DERIVED FROM THE ATMOSPHERE (NDfA)



Preliminary 2015 data demonstrate up to half of plant nitrogen is derived from the atmosphere.

SUMMARY

» Legumes may accumulate relevant biomass and plant N to offset standard nitrogen inputs.

» Inoculation does not affect biomass, total plant N, nodulation, NDfA, or sweet corn yield.

» Legumes contribute proportionally more N than rye or weeds.

» Legumes derive between 40-50% of their plant-assimilated nitrogen from the atmosphere in these environments, bringing "free N" to the soil system.

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