Improving Annual Legume Green Manure Management by Optimizing Seeding Rate and Termination Timing

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INTRODUCTION

Legume green manures (LGMs) are beneficial for soil conservation and may provide a positive agronomic and economic alternative to summer fallow in the northern Great Plains (Zentner et al., 2004). It is important to understand management practices that best balance LGM gains, such as fixed nitrogen (N) and weed suppression, with their potential costs, specifically soil water use by the LGM crop and input expenses. Previous LGM research in Montana has supported early termination (first flower stage) as an important management practice to conserve soil water (Miller et al., 2006) and input costs could be decreased with reduced seeding rates. The objective of this study was to understand the effect of legume seeding rate, the resulting crop density, and termination timing on weed biomass and N fixation by LGM.

METHODS

Field plot experiments were conducted at Conrad and Power, MT in 2010. Two LGM crops, pea (*Pisum sativum* cv. Arvika) and lentil (*Lens culinaris* cv. Richlea), were direct seeded with granular rhizobia inoculum at six target seeding rates (14, 28, 42, 56, 84, and 112 lb seed/acre for pea and 7, 15, 22, 29, 43 and 57 lb seed/acre for lentil), with the highest rate for each crop being the full recommended seed rate for legume crop production (Saskatchewan Pulse Growers, 2000). Tame oat (*Avena sativa*) was seeded perpendicular to LGM crops at a rate of 3 lb seed/acre to act as a moderate surrogate weed community. Crops were terminated at two times, first bloom and flat pod. At each termination time, a sample of legume and weed aboveground biomass was collected and samples from select plots were analyzed for plant tissue N concentration to obtain plant N yield. The amount of N fixed was measured with the 'natural abundance' method, using tame oat as the reference plant (Shearer and Kohl, 1986). Plant density (plants/ft^2) was recorded at each harvest and plots exceeding 100% of the full recommended seeding rate (due to occasional overseeding) were excluded in the data analysis.

RESULTS

N Fixed by Legumes

Averaged across the two sites, legume species, termination time, and plant density were all significant factors affecting plant N fixed (Figure 1), which was closely correlated with biomass production for each crop. Pea fixed more N than lentil by each termination time. In both crops, terminating at pod yielded more fixed N than terminating at bloom. However, more soil water was likely used by plants terminated at pod and subsequent wheat yields have been found to decrease with legume water use past the first bloom stage in the region (Zentner et al. 2004, Miller et al. 2006).

The effect of plant density on N fixed was influenced by termination time. For pea, reducing the seed rate to 75% of the full rate increased average N fixed by about 8 lb N/acre at bloom whereas it decreased N fixed by a similar amount at pod. Lentil N fixed data were not available for plant densities greater than approximately 85% of the full seed rate, yet similar trends to N fixed by pea were observed with N fixed by lentil continuing to increase beyond the 75% seed rate at bloom and reaching a maximum near 50% of the full rate at pod.

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Weed Biomass and N Yield

Oat biomass yield decreased with increased legume plant density for all treatments, but not substantially beyond a seed rate of approximately 50% for bloom-terminated crops and 75% for pod-terminated crops (Figure 2). At all but the lowest legume seeding rates, average oat biomass yields were lower in the pea plots than the lentil plots at a given plant density, highlighting pea's ability to better control weed growth than lentil. The N in oat averaged across termination time ranged from 12-15 lb N/acre in both the lentil and pea plots. Oat N accounted for approximately 28% and 24% of the total N yield in the lentil and pea plots, respectively. It is unknown what effect weeds may have on soil N availability for the subsequent crop.

FERTILIZER FACTS

- Pea fixed more N than lentil, and crops terminated at flat pod stage fixed more N than when terminated at bloom. However, more stored soil water was likely used by the pod-terminated crops.
- In this study, seeding at 75% of the recommended rate resulted in similar or more N fixed than seeding at full rates. Seeding at a lower rate could be a major seed cost savings, while leaving more soil nitrate for the next crop.
- Reducing legume seed rates to 50% of the full rate did not substantially increase tame oat (weed) biomass, particularly in bloom-terminated crops.

REFERENCES

Miller, P.R., R.E. Engel and J.A. Holmes, 2006. Cropping sequence effect of pea and pea management on spring wheat in the northern Great Plains. Agronomy Journal 98: 1610-1619.

Saskatchewan Pulse Growers. 2000. Pulse Production Manual. Second edition. http://www.saskpulse.com/media/pdfs/ppm-entire-manual.pdf.

Shearer, G., and D.H. Kohl. 1986. N-2-Fixation in field settings - estimations based on natural N-15 abundance. Australian Journal of Plant Physiology 13 (6): 699-756.

Zentner, R.P., C.A. Campbell, V.O. Biederbeck, F. Selles, R. Lemke, P.G. Jefferson and Y. Gan. 2004. Long-term assessment of management of an annual legume green manure crop for fallow replacement in the Brown soil zone. Can. Journal of Plant Science 84 (1):11-22.

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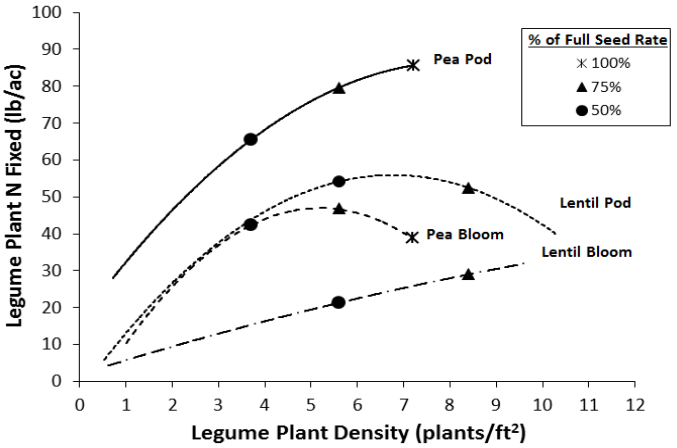

Figure 1. Effect of legume plant density, species, and termination time on N fixed averaged over both sites. Lentil data were only available for plant densities up to approximately 85% of the full recommended seed rate.

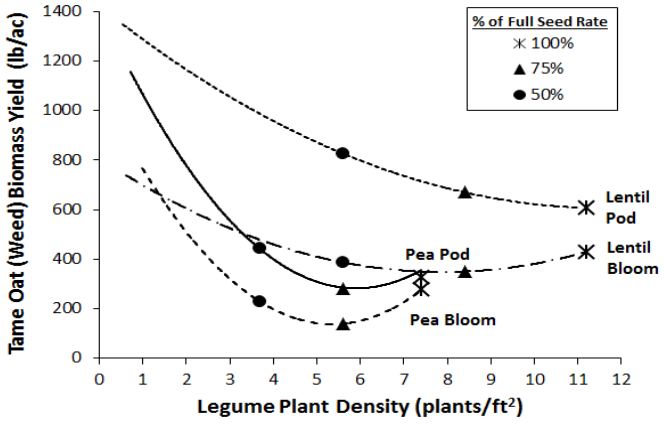

Figure 2. Effect of legume plant density, species, and termination time on aboveground oat (surrogate weed) biomass yield, averaged over both sites.

Edited by Clain Jones, Extension Soil Fertility Specialist, and Kathrin Olson-Rutz, Research Associate