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MANAGEMENT OF SWEETCLOVER FOR NITROGEN SUPPLY, SOIL CONSERVATION AND WEED CONTROL

Interim Research Report W2008-43

INTRODUCTION

There is increased interest by conventional and organic producers in decreasing inputs of fertilizer and herbicides while maintaining sufficient crop residue to prevent soil erosion. This interest is caused by a dramatic increase in the cost of energy for the production of nitrogen fertilizer and a growing market for organic crops. Biennial sweetclover or annual legumes used as a summerfallow replacement can add nitrogen into wheat rotations. Sweetclover is one of the most effective crops for nitrogen fixation and weed suppression. In addition, mycorrhizae are associated with sweetclover roots which may improve soil structure and increase phosphorus absorption from the soil. Sweetclover is widely grown by organic producers who are increasingly interested in reducing tillage. Incorporation of sweetclover has traditionally been tillage intensive, often involving several passes with disc type implements. However, sweetclover can be killed by mowing at full bloom and leaving it on the soil surface. This method leaves plant residue that prevents soil erosion, conserves soil moisture and has been shown to be effective in suppressing weed growth (Blackshaw et al. 2001). Producers need additional information to fit this legume into farming practices that produce N while also assisting in soil and water conservation.

Questions that need to be answered include: Does sweetclover need to be incorporated into the soil to obtain sufficient N for crop production? Does N become available over time when residues are left on the soil surface? Do incorporated or surface sweetclover residues achieve the same weed suppression? In addition, information is needed regarding N supplied when sweetclover is removed for hay and only the stubble and roots are left in the field.

OBJECTIVE

The objective of this trial was to develop best management practices for using sweetclover as an alternative to summerfallow to obtain N supply for the following crop, maintain enough crop residue to prevent erosion, suppress weeds, conserve soil moisture and possibly increase P absorption from soil.

Field plots at Lethbridge Research Station in year 2 (2006)

WHAT WAS DONE?

A factorial experiment was established at Agriculture and Agri-Food Canada's Lethbridge Research Station to compare different sweetclover termination methods. A three-year trial was begun that would be repeated in time, beginning in 2005 and 2006. The experiment had 8 treatments with 4 replicates; only 5 treatments from the trial beginning in 2005 will be discussed in this report.

In year 1 (2005), all plots were seeded with AC Barrie wheat at 90 kg ha^{-1}, with sweetclover (cv. Norgold) underseeded at 9 kg ha^{-1}in the first four treatments.

Prior to harvest, biomass of wheat, sweetclover and weeds was assessed by collecting above-ground plant material from 4 – 0.25 m^2 quadrats. Wheat yield was determined by harvesting the subplots with a small plot combine.

In year 2 (2006), sweetclover originally underseeded in year 1 was terminated using various methods:

1) SC Hay: Sweetclover is mowed and the residue is removed as hay
2) SC Mow: Sweetclover is mowed and the residue is left on the soil surface
3) SC Plow: Sweetclover is fully incorporated using a moldboard plow
4) SC Disc: Sweetclover is partially incorporated with a heavy duty disc
5) Tilled wheat check plot: Wheat grown in year 1 is not underseeded to sweetclover. In year 2, this plot is left fallow and cultivated with sweeps and harrow tines for weed control

All sweetclover treatments were applied (plowed or mowed) at 80% bloom and samples of clover and weeds were collected for biomass and nutrient analysis. In September, weed density was determined and soil samples were taken (0-120 cm) and analysed for available N, P and soil moisture.

In the spring of year 3 (2007), soil N and moisture samples and pre-seed and post-emergence weed density measurements were collected. After the application of a glyphosate herbicide, spring wheat (cv. AC Lillian) was seeded across all treatments at 115 kg ha^{-1}, with seed-placed phosphorus fertiliser (0-46-0) applied at a rate of 43 kg ha^{-1}. At maturity, total wheat and weed biomass was determined, and grain yield and protein content was assessed at harvest.

Table 1. 2007 Wheat crop establishment and wheat crop biomass at harvest

	Crop Density plants m^{-2}		Crop Biomass g m^{-2} dry wt.	
	Mean	**SE**	**Mean**	**SE**
SC Hay	183	14	538	49
SC Mow	124	13	435	41
SC Plow	136	24	573	61
SC Disc	133	11	409	31
Tilled check	125	15	474	76

Sweetclover plow down (cr. Manitoba Agriculture Food and Rural Initiatives)

Soil nitrogen, soil moisture and plant nutrient content data is not presented here. All analyses of soil and crop samples will be completed by March 2009.

PRELIMINARY RESULTS

While detailed statistical analysis has not been completed on these data, means and standard errors have been calculated and those are presented here for discussion.

Establishment of the wheat crop, as assessed in spring 2007, was high in plots where the SC was removed as Hay and lower in the Mowed SC and the tilled wheat treatments (Table 1). The highest and lowest crop counts are in plots that differ only in the removal of sweetclover residue. This suggests that surface residues may have interfered with wheat emergence. The SC Hay plot may have retained more soil moisture than the tilled treatments, which could have helped germination and establishment.

In the untilled treatments, wheat had greater biomass at harvest when residues were removed. This may be a reflection of emergence numbers. In tilled treatments plowing sweetclover residues resulted in greater wheat biomass than discing did. Plowing puts most residues below the germination layer, whereas discing incorporates more residues at the surface.

Weed biomass was assessed at two points: in the fall of 2006 after a season of sweetclover growth and incorporation/mowing or of fallow, and at wheat harvest in 2007 (Figure 2). In the fall of 2006, weed biomass was highest in the treatment that did not have sweetclover,

suggesting that the sweetclover did suppress weed growth. The plowed and the mowed treatments had similar, low levels of weeds. The SC treatment where hay was removed did not have either the weed suppression ability of the surface residue or any tillage, so weed pressure was high immediately after incorporation. Weed levels in that treatment declined by 2007, perhaps due to the more competitive wheat crop that year (higher density, greater biomass).

The plowed area had previously not been plowed for decades. It is likely that there were few viable weed seeds turned up during the incorporation of 2006. The disced treatment had more weeds after the harvest of 2007. Discing would have stirred up the surface layers, perhaps stimulating germination. In addition, the discing process only partially incorporated the clover (about 50% of biomass was incorporated) and this may have allowed some weeds to continue growing.

Weed pressures vary considerably from year to year. In previous studies, in dry years, residues on the surface have sometimes increased weed growth by conserving limited moisture near the surface. It is difficult or risky to draw conclusions from preliminary data from one year.

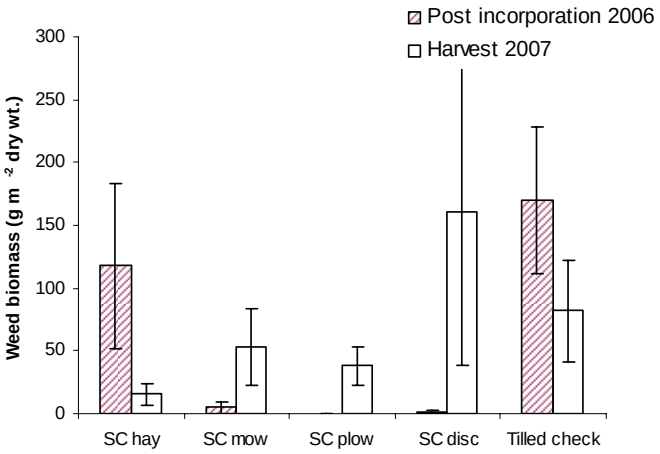

Figure 2. Weed biomass measured after sweetclover incorporation (fall 06) and just before wheat harvest in 2007 (error bars represent ± 1 standard error)

Field plots at Lethbridge Research Station in year 3 (2007)

Wheat yield ranged between 2.27 – 2.84 t ha^{-1}; yield was highest in the SC Plow and SC Hay treatments. Lowest yield was observed in SC Disc and SC Mow. The low yield from plots with sweetclover residues on the surface is not in agreement with a previous study. In that study, wheat yield was similar whether residues were left on the surface, or removed. We need more data before we can determine the relative benefits of mowing and plowing.

Protein content was high, ranging between 15% and 17.24%, which may be related to the dry weather experienced in 2007. Best protein levels were observed for the SC Plow, SC Disc, and SC Hay treatments. The Wheat Till treatments were lower than the others, indicating that the sweetclover was providing soil nitrogen for the wheat to increase protein content. The SC Hay treatment had lower protein levels than the other SC treatments, which may be due to the removal of N in biomass as hay.

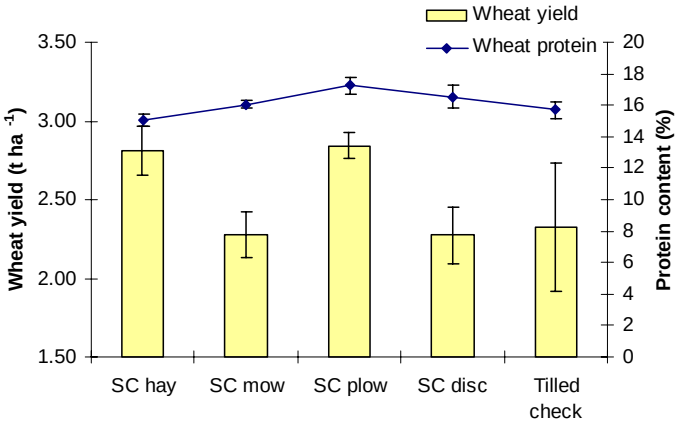

Figure 3. Wheat yield (bars) and protein content (lines) from wheat harvest in 2007 (error bars represent ± 1 standard error)

Jen Parnell collecting data from field plots at Lethbridge Research Station

SUMMARY

These early data suggest that sweetclover may not always need to be incorporated into the soil to obtain sufficient N for crop production; however, the highest protein levels were found following incorporation of sweetclover residues.

Incorporated or surface sweetclover residues had similar levels of weed suppression both in the fall of incorporation and in the wheat year (with the possible exception of the disced treatment).

When sweetclover residues are removed as hay and only the stubble and roots are left, plots were weedier after termination and following crop has lower protein.

Further assessment of soil nutrient levels will determine if the soil fertility is negatively affected when sweetclover residues are removed as hay and if more N becomes available over time when residues are left on the soil surface.

The second cycle of this three-year trial is currently underway and will provide additional results to support the study objectives.

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THE BOTTOM LINE...

Sweetclover reduced weeds relative to tilled fallow. Protein levels following sweetclover were highest when residues were incorporated into the soil.

REFERENCES

Blackshaw, R. E., Moyer, J. R., Doram, R. C., and Boswall, A. L. 2001. Yellow sweetclover, green manure, and its residues effectively suppress weeds during fallow. Weed Science **49**: 406-413.

CREDITS

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