NATURAL NITROGEN IN YOUR CROPPING SYSTEM

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INTRODUCTION

One of the major costs of crop production is nitrogen (N) fertilizer; however, there are other means of supplying N to our cropping systems. Nitrogen fixed by annual and perennial legumes represents a renewable source of N for our cropping systems. Including legumes in our crop rotations can reduce: input costs, energy requirements, and the potentially harmful environmental effects of improper N fertilizer applications. Furthermore, legumes can increase profitability by eliminating the need for N fertilizer in the legume crop and reducing N fertilizer requirements in subsequent crops. The four main sources of legume N in our cropping systems are: perennial alfalfa, annual grain legumes, legume green manures, and legume cover crops. In this section, N release from decomposing annual grain legume (pea, faba bean, and lupin) crop residues will be discussed. We will also look at the amount and timing of N release in no-till and conventional-till systems. This section will conclude with the potential for these residues to supply "natural" N to your cropping system.

NITROGEN RELEASE IN NO-TILL AND CONVENTIONAL-TILL SYSTEMS

In monitoring the rate and extent of grain legume crop residue decomposition and N loss over a 22-month period, we observed rapid decomposition and N loss of buried residues (simulating conventional tillage systems) but slower decomposition and N loss of surface placed residues (simulating zero tillage systems) (Figure 1).

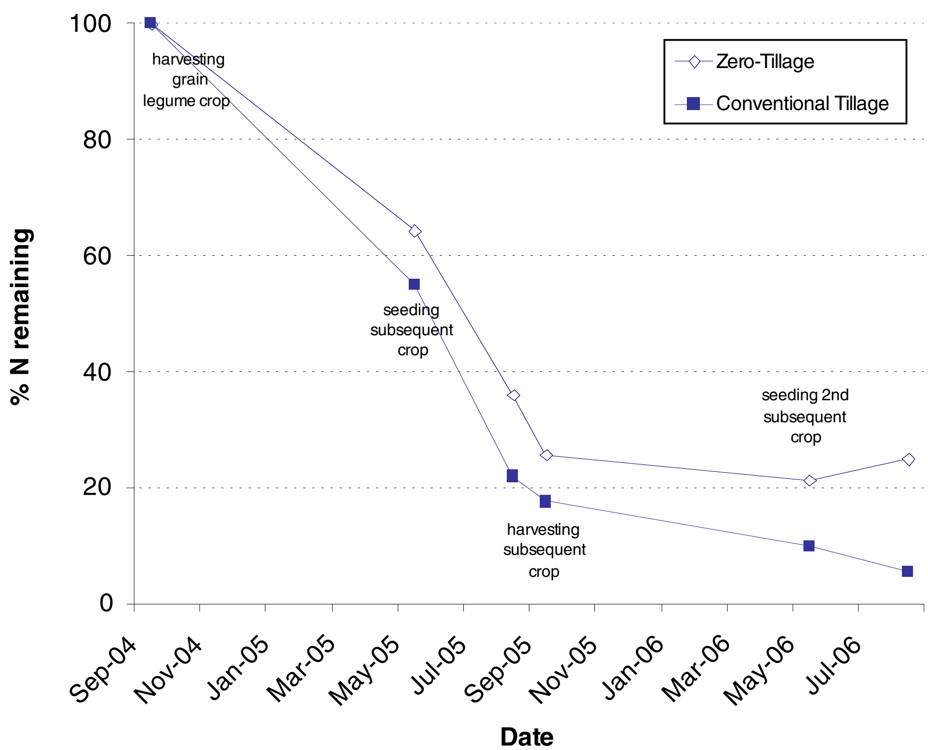

Figure 1. % N remaining in crop residues decomposing under a simulated zero-tillage system and a simulated conventional tillage system, over a 22 month period.

Although overall N loss is slower in zero tillage systems, during the initial stages of decomposition, surface placed and buried residues had similar rates of N release. Initial N loss was likely due to release of soluble and readily decomposable N compounds (Paul and Clark 1996). At later stages of decomposition, faster N release from buried residues may be attributed to more stable temperature and moisture conditions (Summerell and Burgess 1989) which favors microbial activity. However, slower N release from surface placed residues may be desirable as there may be fewer opportunities for N loss during the non-growing season (September 2004 to May 2005).

NITROGEN SUPPLYING POTENTIAL OF ANNUAL GRAIN LEGUME RESIDUES

Given that spring wheat removes 85 lb N/acre/yr in typical Alberta cropping systems (Alberta Agriculture and Food 2000), decomposing grain legume crop residues could theoretically supply a significant portion of a subsequent wheat crop's N requirements. If all of the N released from decomposing residues, by the August 2005 sampling time, was available for crop uptake, pea residues could supply 45% of a subsequent wheat crop's N needs (Figure 2), faba bean residues could supply 71% of a subsequent wheat crop's N needs (Figure 3), while lupin residues could supply 125% of a subsequent wheat crop's N needs (Figure 4). However, much of the N released from decomposing crop residues has not been traced to the subsequent crop (Bremer and van Kessel 1992; Jensen 1994a). Rather it has been found primarily in soil organic matter (Jensen 1994b; Mayer et al. 2004). In this form, the N can be gradually mineralized for use by future crops and can increase long-term soil fertility (Kumar and Goh 2002).

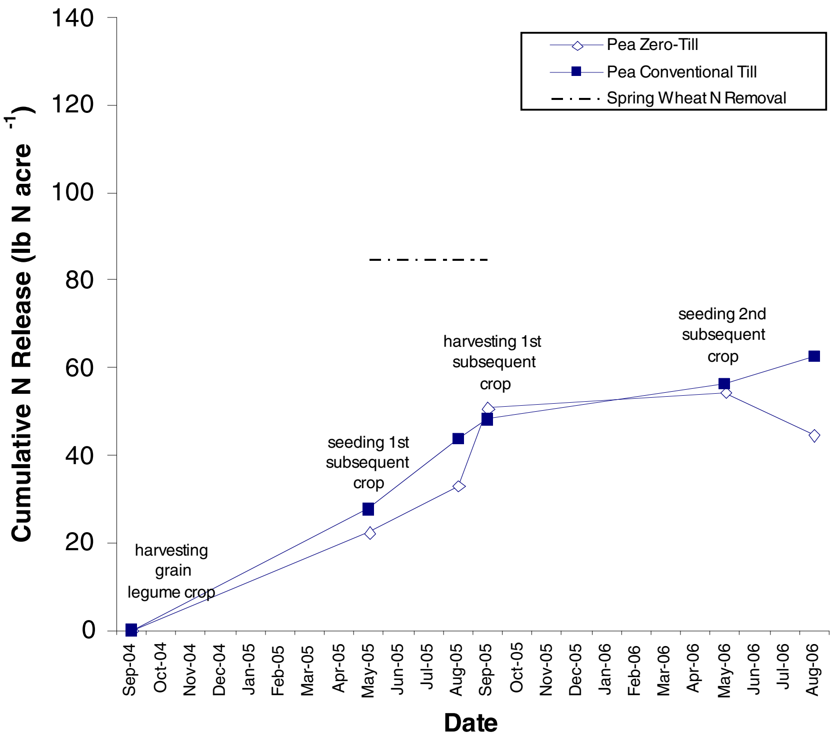

Figure 2. Cumulative N release from pea crop residues decomposing under a simulated zero-tillage system and a simulated conventional tillage system, over a 22 month period.

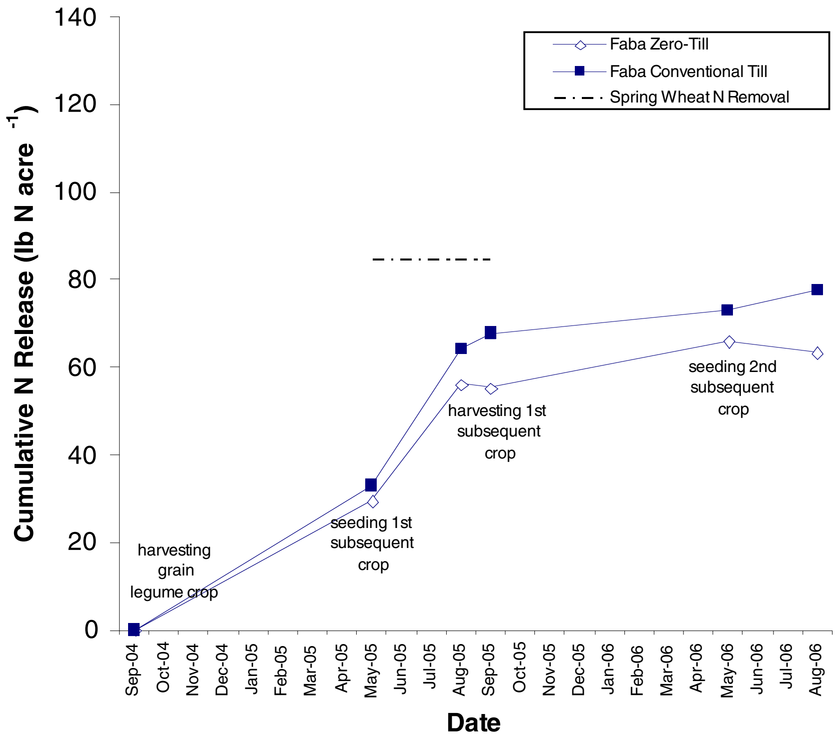

Figure 3. Cumulative N release from faba bean crop residues decomposing under a simulated zero-tillage system and a simulated conventional tillage system, over a 22 month period.

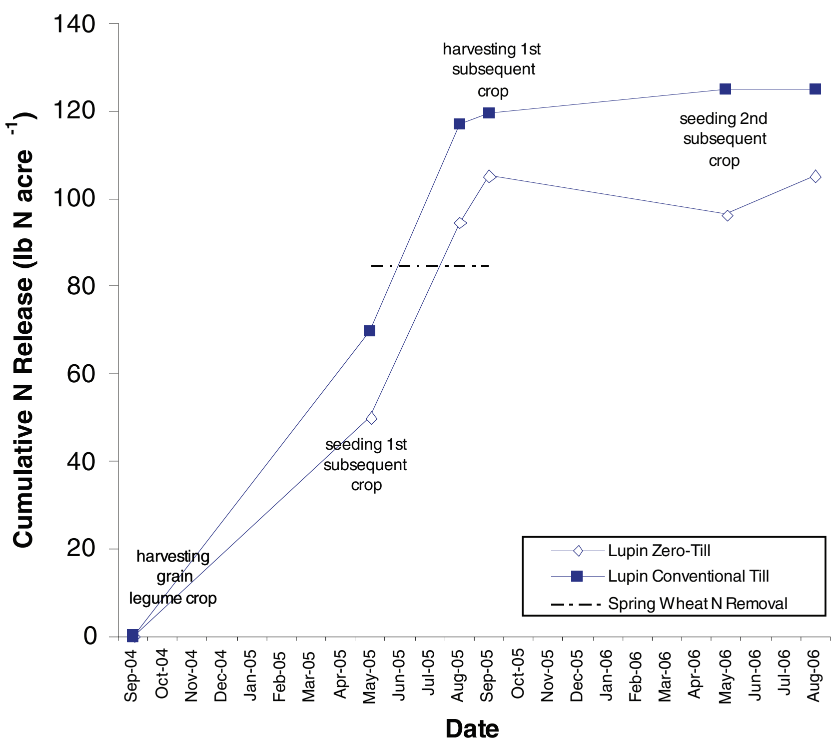

Figure 4. Cumulative N release from lupin crop residues decomposing under a simulated zero-tillage system and a simulated conventional tillage system, over a 22 month period.

THE REALITY: QUANTIFYING THE POTENTIAL

Tannin-free faba bean and narrow-leafed lupin crop residues have the potential to supply more N to subsequent crops compared to pea crop residues. However, the timing of N release from decomposing lupin and faba bean crop residues does not coincide well with the timing of subsequent crop N uptake.

As a result, wheat grown on pea stubble had the highest N accumulation, wheat grown on lupin stubble had moderate N accumulation while wheat grown on faba bean stubble had lower N accumulation (Table 1). The N credit ranged from 11 to 28 lbs N/acre, depending on the grain legume species. Despite the low N supplying potential of pea residues, as indicated by the decomposing crop residues, there may be less N loss resulting in more N being available for the subsequent crop.

Table 1. Subsequent wheat crop yield, N accumulation, and N advantage as affected by previous crop type.

	Cereal and grain legume seed yield†	Subsequent wheat crop yield†	Subsequent wheat crop N accumulation	N advantage over wheat grown on barley stubble
	(Bushels per acre)	(Bushels per acre)	(Pounds N per acre)	(Pounds N per acre)
Barley	83	65	105	-
Faba	106	75	116	11
Lupin	54	80	125	20
Pea	79	80	133	28

† Yields were calculated based on 48 lb/bu barley; 60 lb/bu grain legumes; and 60 lb/bu wheat

OTHER CONSIDERATIONS

Although faba bean and lupin fix more N than field pea, they also produce seed that has a higher protein content (protein content = N content x 6.25). Field pea seed is 22% protein, faba bean seed is 27% protein, and lupin seed is 34% protein. The N that is stored in the seed, in the form of protein, is exported off the field in the harvested grain. For example, a faba bean seed yield of 74 bushels per acre (5000kg/ha) with a protein content of 27%, represents an export of 193 lbs N/acre off the field. Since much of the fixed N is exported off the field in the harvested grain, the rotational benefits of grain legume crops must be partially attributed to things other than N. Non-N rotational factors such as: reduced root and leaf diseases, reduced weed pressure, increased P,K,S availability, improved soil structure, and growth substances released from the grain legume residue, can account for part of the rotational benefit. Grain legumes do provide some N for subsequent crops but that is only part of the picture.

CONCLUSION

In Alberta, grain legume crop residues have the potential to supply 45 to 125% of a subsequent wheat crop's N needs. However, N accumulation by the subsequent crop depends on synchronizing N release with N uptake. When considering the N credit of grain legumes to your cropping system, one must consider the potential N supplying power, the timing of N release from the crop residues, the tillage practice used in the cropping system, and N export in the harvested grain. Although lupin has tremendous potential to supply N to subsequent crops, agronomic practices must be changed to improve synchrony with subsequent crop N demands to capture this potential. In this study, wheat always followed the grain legume crop. Other crop types (i.e. barley, triticale, oats, rye, canola, flax, perennial grass) may have different/more efficient N uptake patterns. Further research could optimize the “natural” N advantage of grain legume crops in our cropping systems.

References

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