Establishment Methods for Forages

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Background: On improved land, most forages mixtures include alfalfa. Alfalfa is usually established by seeding the forage mixture under a cereal companion crop. In the year of seeding, a crop of grain is harvested along with the straw. In the following year (first production year), the forage mixture is harvested for hay or silage. This establishment method can be problematic since the small grain crop competes with the underseeded forages for light, water, and nutrients. It has become more common in recent years to remove the small grain crop in the vegetative stage as whole plant silage. This allows the underseeded forage most of the summer (from July onwards) to grow without competition from the small grain crop.

Another option for establishing alfalfa-based mixtures is direct seeding. Direct seeding means that no companion crop is used. Some concerns with direct seeding include increased risk of erosion in spring since there is less ground cover during forage establishment and weed control can be more critical since there is no companion crop to compete with the weeds.

In cash-crop rotations, it is desirable to include a legume ploughdown crop to return nitrogen and organic matter to the soil. Red clover is most commonly considered as a ploughdown crop in Ontario. Ploughdown crops such as red clover are often sown with spring cereals, but some producers in have reported success establishing red clover under a canola crop. If this method was reliable, it would provide another option in the crop rotation for short-season areas where cropping choices are limited to small grains, canola, and pulse crops like field peas. This trial was designed to evaluate the effectiveness of establishing either alfalfa-timothy or red clover-timothy mixtures via direct seeding or by a range of companion crops including spring grains and canola.

Methods: The forage mixtures to be established were alfalfa-timothy and red clover-timothy (Table 1). The establishment options were: direct seeding, barley silage, Polish canola in 7" rows, Polish canola in 14" rows, Argentine canola in 7" rows, Argentine canola in 14" rows, and barley grain (Table 1). These treatments were established at New Liskeard in 1999 and in 2000. In the seeding year, the grain crops were all direct combined (no swathing). Forage harvests were taken from the 1999 establishment in 2000, and from the 2000 establishment in 2001.

The trial utilized a randomized complete block design laid out as a split plot. Main plots were establishment method and subplots were legume mixture. Data collected included forage yields and mixture composition. Data was analyzed using analysis of variance. When significance was indicated, mean separations were done using the protected LSD method.

Table 1. Companion crop and forage underseeding treatments

Companion Crop	Variety	Row Spacing	Seeding Rate
Direct Seeding (No companion crop)	Centurion alfalfa *or* Walter red clover *with* Climax timothy	17.5 cm	alfalfa 12 kg/ha red clover 11 kg/ha timothy 4 kg/ha
Barley Silage	AC Stephen	17.5 cm	90 kg/ha
Barley Grain	AC Stephen	17.5 cm	120 kg/ha
Argentine Canola	Hyola 401	17.5 and 35 cm	17.5 cm = 5 kg/ha 35 cm = 4 kg/ha
Polish Canola	HySin	17.5 and 35 cm	

Results: Tests were established in 1999 and 2000. Each test had forage harvested in the first production year only (ie: 2000 forage harvest from the 1999 seeding, and 2001 forage harvest from the 2000 seeding). Each test will be referred to by the year in which it was harvested (2000 and 2001). Results for the 2000 and 2001 harvests are presented separately.

In the first cut of the 2000 harvest, forage mixtures that were established in 1999 by direct seeded or with a barley silage companion crop were the highest yielding (Table 2). Forage yield following establishment with Polish canola were intermediate in yield, while those established with Argentine canola or a barley grain crop were lowest in yield. In the second cut, no differences occurred in response to establishment method. Total seasonal yield showed similar results to the first cut, where the highest forage yields were from direct seeded forage and barley companion crops, Polish canola companion crops gave intermediate forage yields, and Argentine canola and barley grain companion crops gave the lowest forage yields.

In all of the 2000 harvests (1st, 2nd, and total yield), red clover-timothy mixtures outyielded alfalfa-timothy mixtures (Table 2). Results from the second cut and from total seasonal yield showed a significant interaction between establishment method and forage mixture (Table 2). In both cases, the cause of this interaction was that the barley silage companion crop had either a higher yield from the alfalfa mixture as compared to red clover mixture or else had no difference between the mixtures. In all other cases, the red clover mixture outyielded the alfalfa mixture by a wide margin. The grass content of the alfalfa mixtures was significantly higher than the red clover mixtures. This indicates that conditions for establishment of red clover were more favourable than for alfalfa. Field notes also indicated more weeds in the alfalfa plots, but sufficient records for statistical analysis of this point are not available.

Table 2. Forage yield and grass content of mixtures in 2000 following various establishment methods in 1999.

Factor	Cut 1	Cut 2	Total Yield	% Grass (Cut 1)
A) Establishment Method				
Direct	6191a[c]	2752	8944a	9.4
Barley silage	5434ab	2998	8431a	0.0
Arg. Canola 7"	2371 d	2556	4927 c	12.5
Arg. Canola 14"	2598 d	2501	5099 c	19.4
Polish Canola 7"	4071 c	2824	6894 b	7.5
Polish Canola 14"	4491 bc	2724	7215 b	8.8
Barley Grain	2662 d	3112	5733 c	0.6
Significance[a]	***	ns	***	ns
LSD[b]	1342	-	1100	-
B) Legume Mix				
Alfalfa-Timothy	3192	2661	5853	14.2
Red Clover- Timothy	4756	2900	7656	2.3
Significance	***	**	***	**
C) Interaction	ns	*	*	ns
Mean	3974	2781	6755	8.3
CV (%)	17.2	11.2	12.3	156

a: *, **, ***=significant at the 0.05, 0.01, and 0.001 level of probability, respectively, ns: not significant
b: least significant difference using the protected LSD procedure
c: Within a column, averages followed by different letters differ at the 0.05 level of significance.

Only one cut was taken from the 2001 harvest (2000 seeding). Forage yields from the 2001 harvest were surprising; the top forage yields resulted from a Polish canola companion crop seeded in 35 cm rows (Table 3). Other establishment methods with statistically equal forage yields were Polish canola in 17 cm rows, direct seeded forage, and Argentine canola in 35 cm rows. Intermediate forage yields resulted from the barley silage companion crop, while the lowest forage yields resulted from the Argentine canola in 18 cm rows and the barley grain companion crops. Legume content was highest in the barley silage, barley grain and direct seeded treatments. Grass content was highest in the canola treatments as well as the direct seeded forage. Weed content was highly variable and not significantly different among treatments.

While there was a tendency for red clover mixtures to outyield alfalfa-mixtures in the 2001 harvest, the difference was not significant (Table 3). Red clover mixtures had higher legume content and lower grass and weed content than alfalfa mixtures in the 2001 harvest (Table 3). Interactions between establishment method and legume type were all non-significant in the 2001 harvest.

Table 3.Forage yield and mixture composition in 2001 following various establishment methods in 2000.

Factor	Cut 1	% Legume	% Grass	% Weed
A) Establishment Method				
Direct Seeding	6615ab[c]	61ab	37ab	2
Barley silage	5871 bc	72a	17 c	10
Arg. Canola 7"	4915 cd	56 bc	35 b	9
Arg. Canola 14"	6469ab	53 bc	44ab	3
Polish Canola 7"	6769ab	50 bc	33 b	17
Polish Canola 14"	7033a	45 c	50a	5
Barley Grain	4724 d	73a	12 c	15
Significance[a]	***	**	***	ns
LSD[b]	1050	15	14	
B) Legume Mix				
Alfalfa-Timothy	5837	32	51	17
Red Clover- Timothy	6276	85	15	0.4
Significance	ns	***	***	***
C) Interaction	ns	ns	ns	ns
Mean	6057	59	33	9
CV (%)	15.2	37	64	154

a: *, **, ***=significant at the 0.05, 0.01, and 0.001 level of probability, respectively, ns: not significant
b: least significant difference using the protected LSD procedure
c: Within a column, averages followed by different letters differ at the 0.05 level of significance.

Discussion: Results of the 2000 harvest were as expected: namely that the highest forage yields resulted from establishment methods that maximize the amount of sunlight getting to the forage plants and minimize the competition for water and nutrients. Direct seeded forage fits this description best since no companion crop is present to compete with the forage plants. Barley silage also fits this description since the crop is removed in July, leaving half of the growing season for the forage plants to establish. Canola and barley grain fall at the other end of the spectrum, since they are longer season crops that leave little time after maturity for the forage crop to grow unimpeded.

In the 2001 harvest, direct seeded forage was still among the best treatments and barley grain was the poorest; however, 3 of the 4 canola companion crop treatments were much better than expected. Given the 4 canola treatments tested, we might expect 35 cm rows to show an advantage (to the underseeded forage) since more light would penetrate the canopy. Similarly, we would expect Polish canola to show an advantage since it matures much earlier, leaving more time for the forages grow without competition. Given these considerations, it is reasonable that we found Argentine canola in 17.5 cm rows to be poorer in terms of forage establishment than

the other three canola treatments combinations. What is surprising is that the other canola treatments were equivalent in subsequent forage yield to the direct seeded forages. Also surprising is that the barley silage treatment had forage yields that were slightly lower than the Polish-35 cm treatment. The barley silage treatment did however, have subsequent forage yields statistically equal to the direct seeded forage and the other two canola treatments. These results indicate that canola may be more successful as a companion crop than previously thought. It should be noted that two factors could affect these results when tested on a field scale. The first is that the small plots were kept weed free or with low weed pressure without herbicides. In the field, herbicides used on canola will damage forage seedlings. It is likely that with early spraying onto a thick canopy of canola and weeds, little damage to the forage legumes would occur, but this could not be assessed from the present trial. The other factor is that in the field, canola often lies in the swath curing for several weeks. This could lead to smothering of the underseeded forages. In our plot trials, canola was direct combined, thus we have no estimate of the damage that may occur to underseeded forages from canola swaths.

In the 2000 harvest, red clover mixtures outyielded alfalfa mixtures, and this trend was evident in 2001 as well. In addition, red clover mixtures had less grass in both years, indicating a stronger stand of the legume component for red clover. This was expected, since red clover is known to be quite vigorous in the seeding year. Given the good stands of red clover obtained from canola companion crops, it seems probable that a red clover ploughdown could be established in the canola year of a cash crop rotation.

Conclusions:

i) Based on subsequent forage yields, direct seeded forages are generally the most reliable way to establish legumes, provided that seedbed preparation and weed control are good.

ii) Barley for silage is also a reliable method of establishing forage legumes.

iii) Canola gave a variable response as a companion crop, with better results from Polish types and from wider (35 cm) row spacings. Canola underseeded to red clover appears to be viable as a ploughdown option, assuming the legume is not severely damaged by the canola herbicide.

iv) Barley for grain was consistently the poorest option for establishing forages. Under normal barley management (full seeding rate and fertility), this should not be considered as a means of establishing a vigorous, high yielding forage crop.