

# YIELD AND QUALITY OF CEREAL AND CEREAL-PEA COMPANION CROPS AND THEIR EFFECT ON ALFALFA ESTABLISHMENT

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## ABSTRACT

This study was carried out to determine the effect of management practices (harvest maturity, cereal species, mixtures with field peas (*Pisum sativum*)) on the yield and quality of cereal companion crops harvested for forage and the impact of those practices on subsequent alfalfa (*Medicago sativa*) yields. Replicated factorial experiments were conducted at three locations in northern Ontario from 1993 to 1995. Companion crop forage yields were increased and quality decreased by harvesting as the heads emerged as compared to the late boot stage. Triticale (*X Triticosecale*) was lower yielding than either oats (*Avena sativa*) or barley (*Hordeum vulgare*). Triticale quality was higher primarily due to a higher content of underseeded alfalfa in the harvested forage. Adding peas to cereal companion crops increased crude protein by 2 to 5 percentage units and decreased NDF by 3 to 7 percentage units. Companion crop management usually had no effect on following-year alfalfa yields, except when cereal regrowth was unusually vigorous. Recommendations for companion crop management specific to the intended end-use can now be formulated.

## INTRODUCTION

In Ontario, perennial forage crops such as alfalfa (*Medicago sativa*) are often established with a cereal companion crop (Upfold and Wright, 1991). Current recommendations indicate that removing the cereal companion crop as silage instead of grain will improve the establishment of perennial forages. If companion crops are to be harvested for silage, management recommendations are needed to obtain the best compromise between forage yield and quality for a given farm situation. Research in other areas has shown little difference in forage yield among oats (*Avena sativa*), barley (*Hordeum vulgare*), and triticale (*X Triticosecale*) when harvested for silage (Cherney and Martin, 1982a; McCartney and Vaage, 1994). Barley was shown to have better forage quality as compared to oats due to its greater proportion of highly-digestible inflorescence during development (Cherney and Martin, 1982b). Brink and Martin (1986) also found higher digestibility in barley as compared to oats, but this did not translate to higher yields of digestible dry matter. The addition of field peas (*Pisum sativum*) to the cereal companion crop has been shown to increase crude protein content and decrease the neutral detergent fibre content of the harvested forage without affecting companion crop yield or subsequent alfalfa establishment (Chapko *et al.*, 1991). The current study was undertaken to evaluate several companion crop management systems for yield and quality potential and alfalfa establishment.

## MATERIAL AND METHODS

Replicated small-plot field experiments were carried out in Thunder Bay in 1993, and in New Liskeard and Verner in 1994 and 1995. The New Liskeard and Thunder Bay sites were replicated small plot trials utilizing a 2x3x2 factorial design in a split-split plot laid out in randomized complete blocks with four replicates. Whole plots were stage of maturity when the companion crop was harvested (early=late boot stage, Zadok's 47 or late=heads emerged stage, Zadok's 59), sub-plots were companion crop species (oats var. AC Rigodon, barley var. OAC Kippen, or triticale var. Frank), and sub-sub plots were the presence or absence of field peas (var. Trapper) with the companion crop. At Verner, only cereal species and presence or absence of peas were included (3 x 2 factorial). All plots were underseeded to a mixture of alfalfa-timothy (var. Sure and Climax). Cereal companion crops were seeded at 200 seeds/m<sup>2</sup>, peas at 90 kg/ha, alfalfa at 13 kg/ha and timothy at 4 kg/ha. At the appropriate stage of maturity, cereal companion crops were harvested with a flail-type plot harvester (Carter Manufacturing, Brookston, Indiana, USA). Sub-samples of the harvested material were used for moisture and quality determination. Standard wet-chemistry procedures were used to determine crude protein (CP), acid detergent fibre (ADF), and neutral

detergent fibre (NDF) (Goering and Van Soest, 1970). The unharvested portion of each plot was hand clipped and the material hand-separated into cereal, pea (if present), and alfalfa. In the year following establishment, first cut alfalfa yields were measured using the same harvesting technique.

## RESULTS AND DISCUSSION

**Companion Crop Yield.** As expected, harvesting cereal companion crops at the late (heads emerged) stage resulted in significantly higher yields than harvesting at the early (late boot) stage (Table 1). The interval between the early and late harvests ranged from five to 12 days. Plots at Verner were harvested at the heads emerged stage only. The yields shown below are much lower than those recorded for cereal silage harvested at the soft dough stage at the same sites. Triticale was consistently lower yielding than either barley or oats. Triticale tended to have relatively poor emergence and lacked vigour in our tests. Other management trials in northern Ontario have tended to have similar results with regard to triticale (NLARS, unpublished data). Cereal-pea mixtures yielded less than pure cereals at New Liskeard and Verner, although this effect was more pronounced at the late harvest stage. Northern Ontario typically provides ideal growing conditions for cereals, hence adding peas caused competition and lowered the yield potential of the cereal. At Thunder Bay yields were increased by the addition of peas. Absolute yields at Thunder Bay were very low, reflecting stressful growing conditions which apparently favoured the mixtures over the pure cereals.

**Companion Crop Quality.** Early harvesting consistently increased crude protein and decreased fibre levels in the harvested forage (Table 1). Triticale usually had higher crude protein and lower NDF as compared to barley or oats. Hand separations revealed that triticale companion crops had more seedling alfalfa in the harvested forage than barley or oats and triticale-pea mixtures had more peas in the harvested forage than the other mixtures (data not shown). This data supports earlier observations that triticale had low seedling vigour and poor competitive ability and also explains why the triticale companion crop had better forage quality. Adding field peas to cereal companion crops consistently increased crude protein and reduced NDF in the harvested forage. In situations where intake is limiting, companion crop silage from cereal-pea mixtures would be preferred over pure cereals. (See Table 1.)

**Subsequent Alfalfa-Timothy Yield.** At New Liskeard in 1994, conditions following companion crop harvest were ideal for cereal regrowth. This regrowth was more severe on the early cut companion crops and was clearly heavier from oats than barley or triticale. The competition that the regrowth imposed on the alfalfa-timothy is evident from the yield data in Table 2. Alfalfa established under an oat (or oat-pea) companion crop yielded less the following year than alfalfa established under barley or triticale companion crops. Also, alfalfa yields were lower where the companion crops were cut early as compared to late. The 1994 establishment at Verner and the 1995 establishment at New Liskeard had no cereal regrowth and there were no significant differences in alfalfa yield the following year among the companion crop treatments. At Thunder Bay, alfalfa yields were lower following oats, again due to oat regrowth. In longer season areas, cereal regrowth following companion crop harvest is controlled by taking a second cut of cereal regrowth and new seeding, but in northern Ontario only the initial harvest is recommended to ensure good alfalfa establishment. In cases where regrowth is severe, a second harvest by August 15 would likely be the best course of action. Cereal-pea mixtures did not have any detrimental effect on the new seeding relative to pure cereals at New Liskeard or Verner, but did suppress alfalfa yields at Thunder Bay. Under high stress conditions at Thunder Bay, the higher yielding mixtures apparently had a detrimental effect on the underseeded forages.

This research should allow producers to select the most appropriate management system for their own situation. Using the harvest maturities described here, forage yields from cereal companion crops will be moderate at best, but quality can vary widely. Where high nutrient concentration is required, early harvesting and cereal-pea mixtures would be desired and should not have a detrimental effect on alfalfa establishment. Much higher yields can be obtained by harvesting later than described here, but this may suppress the new seeding. If cereal regrowth threatens the new seeding, a second harvest by mid-August would be necessary. (See Table 2.)

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**Table 1**

Yield (kg/ha) and quality of companion crops harvested as forage at New Liskeard (NL), Verner (VN), and Thunder Bay (TB).

	Dry Matter Yield			Crude Protein			Acid Detergent Fibre			Neutral Detergent Fibre		
	NL <sup>z</sup>	VN	TB	NL	VN	TB	NL	VN	TB	NL	VN	TB
A) Stage												
Early	2807	-	692	20.3	-	16.5	34.2	-	28.0	50.2	-	43.0
Late	4527	-	1122	16.3	-	15.1	39.4	-	32.0	58.8	-	48.0
Sig. <sup>y</sup>	***		**	***		*	***		*	***		*
B) Cereal												
Oats	4188	4782	1045	16.3	14.3	15.0	38.3	40.5	31.0	57.3	57.3	47.0
Barley	3933	4381	1032	17.8	14.8	15.6	36.7	38.7	30.0	56.3	57.5	46.0
Triticale	2880	3565	645	20.8	16.3	16.9	35.4	39.7	29.0	49.9	54.3	44.0
	***	***	**	***	**	*	***	NS	*	***	**	NS
C) Peas?												
Yes	3317	3704	1065	19.4	17.3	16.8	36.7	39.0	30.0	53.0	52.9	43.0
No	4016	4781	749	17.2	12.9	14.8	36.9	40.3	30.0	56.0	59.8	49.0
	***	***	**	***	***	*	NS	NS	NS	***	***	*
Interaction												
AxB	NS	-	***	NS	-	NS	NS	-	*	NS	-	NS
AxC	***	-	NS	NS	-	NS	NS	-	NS	NS	-	NS
BxC	NS	NS	*	NS	NS	**	NS	NS	NS	NS	NS	NS
AxBxC	NS	-	NS	NS	-	NS	NS	-	NS	NS	-	NS
Mean	3667	4243	908	18.3	15.1	15.8	36.8	39.6	30.0	54.5	56.4	46.0
CV <sup>x</sup> (%)	12.9	16.4	12.8	8.0	12.3	6.4	5.5	7.1	7.3	5.5	5.8	10.7

<sup>z</sup> New Liskeard and Verner data is the mean of 1994 and 1995, Thunder Bay data is 1993 only.

<sup>y</sup> \*, \*\*, \*\*\* significant at the 0.05, 0.01, and 0.001 level, respectively; NS, not significant

<sup>x</sup> Coefficient of variation

**Table 2**

First-cut yield (kg/ha) of alfalfa-timothy mixtures in the year following establishment under various companion crops at New Liskeard (NL), Verner (VN), and Thunder Bay (TB).

	NL 1994 <sup>z</sup>	NL 1995	VN 1994	TB 1993
A) Stage				
Early	5035	4407	-	1248
Late	5601	4315	-	1228
Sig. <sup>y</sup>	*	NS		NS
B) Cereal				
Oats	4700	4240	4879	950
Barley	5509	4275	5314	1386
Triticale	5745	4569	5318	1378
Sig.	*	NS	NS	*
C) Peas?				
Yes	5375	4455	5026	1043
No	5262	4267	5314	1433
Sig.	NS	NS	NS	*
Interaction				
AxB	NS	NS	-	NS
AxC	NS	NS	-	NS
BxC	NS	NS	NS	NS
AxBxC	NS	NS	-	NS
Mean	5318	4361	5170	1238
CV <sup>x</sup> (%)	13.7	14.1	10.7	

<sup>z</sup> Year of establishment

<sup>y</sup> \*, \*\*, \*\*\* significant at 0.05, 0.01, and 0.001 levels, respectively, NS=not significant

<sup>x</sup> Coefficient of variation