Seeding ratios and rates that maximize annual forage production in Black soil zones of central Saskatchewan

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McCartney, D., Townley-Smith, L., Stevenson, F. C. and Pearen, J. R. 2005. **Seeding ratios and rates that maximize annual forage production in Black soil zones of central Saskatchewan**. Can. J. Plant Sci. **85**: 615–622. Three different seeding densities and four seeding ratios of spring and fall crop components for annual forage production were evaluated for maximizing silage and fall regrowth yield in a 3-yr study at Melfort, Saskatchewan. Binary mixtures of a spring cereal, barley (*Hordeum vulgare* L.) or oat (*Avena sativa* L.), and a fall crop, fall rye (*Secale cereale* L.) or Italian ryegrass (*Lolium multiflorum* Lam.), were seeded at three total stand seed densities (150, 275 and 400 seeds m^{-2}), which consequently resulted in the following spring:fall seeding crop component ratios: 1:0, 2:1, 1:2 and 0:1. Both spring and fall crops were harvested when the spring cereals were at the soft-dough stage (silage cut) and late in the autumn (fall regrowth cut). Average spring crop component yield was greater for the silage cut (4806 kg ha^{-1}) than for the fall regrowth cut (329 kg ha^{-1}), and total sward yield was greater for the silage cut (5995 kg ha^{-1}) than for the fall regrowth cut (1261 kg ha^{-1}). Productivity of the fall component was 1173 and 929 kg ha^{-1} for the silage and fall regrowth cuts, respectively. Total crop yield was often maximized with seeding ratios of 60% spring:fall crop component or greater for the different combinations. Fall regrowth cut yields were always maximized by seeding 100% fall crop component. The spring crop component yield, especially for the oat mixtures, contributed very little to fall regrowth yields. Stand seeding rate frequently affected spring component and total crop yield, but not fall crop yield. Silage and annual yield for the spring crop and total sward increased with increase in stand seeding rate. Fall crop yield was not affected by stand seeding rate or its effect was of questionable practical importance. Italian ryegrass produced the most fall regrowth yield. Weed management was identified as a possible area for future research with regard to seeding ratios and rates for annual forage stands.

Key words: Monocrop, intercrop, annual forage, seeding rates, seeding ratio

McCartney, D., Townley-Smith, L., Stevenson, F. C. et Pearen, J. R. 2005. **Densité de semis et ratio d'ensemencement maximisant la production annuelle de fourrages sur les sols noirs du centre de la Saskatchewan**. Can. J. Plant Sci. **85**: 615–622. Les auteurs ont évalué trois densités de semis et quatre ratios d'ensemencement de plantes fourragères de printemps et d'automne en vue d'établir comment maximiser la quantité d'ensilage et le rendement de la repousse automnale dans le cadre d'une étude de trois ans poursuivie à Melfort, en Saskatchewan. Des combinaisons binaires de céréale de printemps, à savoir d'orge (*Hordeum vulgare* L.) ou d'avoine (*Avena sativa* L.), et de plante automnale, en l'occurrence du seigle d'automne (*Secale cereale* L.) ou du ray-grass d'Italie (*Lotium multiflorum* Lam.), ont été cultivées à trois densités de semis (150, 275 et 400 graines par m^2), ce qui a donné les ratios entre composantes du printemps suivant et cultures grainières automnales de 1:0, 2:1, 1:2 et 0:1. Les cultures printanières et automnales ont été récoltées au stade pâteux mou des céréales de printemps (ensilage) et à la fin de l'automne (repousse automnale). Le rendement moyen des composantes printanières est plus élevé pour l'ensilage (4 806 kg par hectare) que pour la repousse automnale (329 kg par hectare) et le rendement total du peuplement était plus important pour l'ensilage (5 995 kg par hectare) que pour la repousse automnale (1 261 kg par hectare). La productivité des composantes automnales s'établissait respectivement à 1 173 kg par hectare pour l'ensilage et à 929 kg par hectare pour la repousse automnale. Le rendement total des différentes combinaisons est souvent maximisé par un ratio d'ensemencement de 60 % ou davantage entre composantes printanières et composantes automnales. Le rendement de la repousse automnale est toujours maximisé par l'ensemencement de 100 % de composantes automnales. Le rendement des composantes printanières, surtout pour les combinaisons incluant l'avoine, concourt très peu au rendement de la repousse automnale. La densité de semis affecte souvent les composantes printanières et le rendement total de la culture, mais pas le rendement des composantes automnales. Le rendement de l'ensilage et le rendement annuel des composantes printanières et du peuplement global augmentent avec la densité de semis. Le rendement automnal n'est pas affecté par la densité de semis ou les effets de cette dernière sont douteux sur le plan pratique. Le ray-grass d'Italie donne la meilleure repousse automnale.

Mots clés: Monoculture, culture intercalaire, annuelles fourragères, densité de semis, ratio d'ensemencement

Spring-planted annual cereals including spring-planted winter cereals can be used in mixtures to provide excellent-quality late-fall grazing (Howard et al. 1990; Baron et al. 1992; Aasen and Baron 1993; Baron et al. 1994; McCartney et al. 2004). Baron et al. (1992) demonstrated that spring-planted mixtures of spring and winter cereals could provide a spring silage crop, and the regrowth, primarily of the winter cereal component could provide fall pasture. However, the effect of the proportion of spring and winter cereals at seeding, and the seeding rate of the mixture has not been studied in depth. Walton (1975) showed that higher seeding rates of oat, barley, and wheat seeded alone or in combination with soybean or rape improved forage yields and reduced fibre contents for all crops. The increase was not substantial and except for oat, the higher seed rates were not economical. The presence of a non-cereal in the mixture reduced yield, but pea in the mixture with oat increased crude protein per hectare. Baron et al. (1992) found that total forage yield of spring and winter cereal mixtures seeded in equal proportions was 10% lower than that of the corresponding spring cereal seeded as a monocrop when harvested at the late-milk stage. However, the spring cereal's dominance in the mixture resulted in the spring component contributing more than 50% to the dry matter yield. It was concluded that the lower yield of spring-fall mixtures was offset by a 3% increase in in vitro digestibility due to the higher leaf content of the unvernalized winter cereal. In another study in low-soil-N environments in southwestern North Dakota, Carr et al. (2004) showed that intercropping oat or barley with pea increased forage and N yield. The forage yield was reduced, but the quality was enhanced when oat was replaced with barley in low-soil-N environments. In addition, the forage yield and quality were enhanced by intercropping barley or oat with pea.

In field pea (*Pisum sativum*) and canola (*Brassica napus*) crops, Townley-Smith and Wright (1994) and Harker et al. (2003) found that higher seeding rates increased the ability of the crop to compete with weeds. Our objective was to evaluate the effect of seeding rate and spring:fall seeding ratios on crop yield, crop composition and weed competition in binary mixtures of barley (*Hordeum vulgare* L.) or oats (*Avena sativa* L.) seeded in combination with fall rye (*Secale cereale* L.) or Italian ryegrass (*Lolium multiflorum* Lam.) using a two-cut system.

MATERIALS AND METHODS

Site Description and Experimental Design

The study was conducted in 1994, 1995, and 1996 at the Agriculture and Agri-Food Canada Research Station at Melfort, SK. (52°65′N, 104°45′W). The soil was an Orthic Thick Black Chernozem (Udic Boroll). A new study site was established for each year of the study. Fields were previously dressed with cattle manure and soil tests indicated that fertility levels were high, and no additional fertilizer was required in any year according to provincial soil test recommendations.

A Fabro double-disk plot seeder was used to sow the crops at a 3-cm depth in rows spaced on 0.36-m spacing, except ryegrasss, which was seeded at a 1-cm depth. Forty-eight treatments were evaluated. The treatments included three factors: crop combination, seeding ratio (proportion of stand density sown to spring or fall crop), and seeding rate of the entire sward. The treatments were arranged in a split-plot design with four replicates. The main plots included all possible binary mixtures of a spring cereal crop (AC Lacombe barley or Calibre oats) and fall crop (Prima fall rye or Lemtal Italian ryegrass). The different crop combinations were achieved by seeding spring cereal and fall components perpendicular to each other in 7 × 5 m plots. The subplots included factorial combinations of stand seeding rate by seeding ratio treatments. These combinations of treatments were achieved with three stand seeding rates (150, 275 and 400 seeds m^{-2}) each seeded at four spring:fall seeding ratios (1:0, 2:1, 1:2 and 0:1).

A 1.5 × 7 m section was harvested from the centre of each plot at a 5-cm cutting height using a self-propelled sickle bar cutting type Haldrup plot harvester. Plots were harvested when the spring component reached soft dough stage (silage cut) and in late September (fall regrowth). Total fresh weight of each plot was measured, and then a 500-g subsample was separated into spring cereal, fall crop and weed component and dried (65°C) to constant weight. The total dry weight of these crop subsamples was used to adjust total crop fresh weight to a dry weight basis, and to separately calculate spring and fall crop dry weight. The total dry weight of the weed component was also calculated. Environmental data were recorded at a weather station within 1 km of the experimental sites each year.

Statistical Analysis

Yield responses for the crop components were analyzed using the PROC MIXED procedure of SAS software (SAS Institute, Inc. 1996), with block, year, and the applied treatments (forage combination, seeding ratio, and seeding rate) as fixed effects. Treatment effects were significant at $P < 0.05$.

Since significant year by crop combination by seeding ratio interactions were detected for most of the response variables a second-order regression model was used to investigate crop response to seeding ratio for each year by crop combination. In particular, the optimal seeding ratio associated with maximum yield was calculated for those instances where a significant quadratic effect occurred for crop yield. This parameter was estimated by differentiating a regression model including a linear and quadratic function with respect to seeding ratio with the result equal to zero.

RESULTS AND DISCUSSION

Growing-season rainfall was 96, 83 and 107% of long-term average during 1994, 1995 and 1996, respectively (Table 1). Periods with precipitation substantially lower than the 30-yr average were encountered in all 3 yr, notably in April and September 1994, May, July, and September 1995, and June and August of 1996. July and August mean monthly temperatures throughout the study were close to the 30-yr average.

Significant year by crop combination by seeding ratio interactions were observed for all spring crop, fall crop, and total (spring plus fall) crop yield variables, with the exception of silage yield for the fall crop (Table 2). Stand seeding rate affected the silage cut and annual yield for the spring crop and total sward. This effect was consistent across the levels of the other factors for total yield. However, the stand seeding rate effect for spring crop yield (silage cut and annual) varied among years and different seeding ratios; i.e., year by stand seeding rate by seeding ratio interaction. Seeding rate did not affect fall crop yield, with one exception. A crop combination by stand seeding rate by seeding ratio interaction occurred for fall crop, silage yield.

Table 1. Monthly precipitation, total precipitation for the growing season and monthly mean temperature at Melfort, Saskatchewan, from 1994 to 1996

Variable/year	April	May	June	July	August	September	Total
				Monthly precipitation (mm)			
1994	8.2	54.7	60.1	76.2	45.3	21.6	389.1
1995	20.9	5.4	54.7	28.9	134.8	10.2	335.9
1996	28.2	68.4	23.2	146.7	10.2	36.4	432.9
Long-term avg.[z]	18.9	41.4	61.9	66.6	53.1	40.8	404.9
				Mean temperature (°C)			
1994	3.7	10.8	15.7	16.8	15.8	13.5	
1995	–2.2	10.3	18.1	16.7	16.2	12.2	
1996	1.0	7.8	16.5	17.4	17.8	9.7	
Long-term avg.[z]	2.4	10.3	15.7	17.0	17.0	11.2	

[z] Nine-year mean precipitation and temperatures assessed from 1990 to 1998.

Harvest Times

The crop combinations were seeded on 1994 Jun. 03, 1995 May 25, and 1996 Jun. 05 and harvesting of the barley intercrop combinations occurred 1994 Aug. 06, 1995 Jul. 27, and 1996 Aug. 09, and of the oat intercrop combinations 1994 Aug. 16, 1995 Aug. 03, and 1996 Aug. 20. Average spring crop yield was much greater for the silage cut (4806 kg ha^{-1}) than for the fall regrowth cut (329 kg ha^{-1}) as was the total sward yield (5995 kg ha^{-1} vs. 1261 kg ha^{-1}) (Figs. 1 and 2). Fall crop yields were 1173 and 929 kg ha^{-1} for the silage and fall regrowth cuts, respectively (Fig. 3). Therefore, the effect of seeding ratio contrasted more between cut times for spring crop yield than for fall crop yield.

Silage cut yield was closely related ($r > 0.928$; $P < 0.001$) to annual yield for spring component and total sward (Figs. 1 and 2). The silage and fall regrowth cuts of the fall crop yield were also highly correlated ($r > 0.827$; $P < 0.001$) to annual fall crop yield. Therefore, spring crop and total sward annual yields were mostly a function of the silage cut responses. Annual fall crop yield was closely related to yields at either cut time (Fig. 3).

Seeding Ratio

Over the years the total crop yield was often maximized with seeding ratios of 60% spring crop or greater for the combinations tested (Table 3, Figs. 1 and 2). However, there were some notable deviations from this overall optimal seeding ratio of 60% or greater.

Annual yields in 1994 were maximized when the sward included 100% Italian ryegrass (Figs. 1 and 2). Silage and annual yields for the oat plus fall rye combination often were maximized when the sward included 100% oat. There was also notable variation by year for the linear effect of increasing ratios of spring crop silage and annual yields varied among years (Figs. 1 and 2). The spring crop silage and annual yield responses to seeding ratio for 1995 and 1996 were different from those for 1994, particularly for the Italian ryegrass treatments. The contrasting seeding ratio effects among years could in part be attributed to greater weed pressure in the later 2 yr of the study. The more positive response of fall regrowth to decreasing proportions of spring crop, especially for Italian ryegrass (Fig. 1), occurred in 1994 when weed pressure was least. Also, spring crop yield was less responsive to increasing proportions of spring crop in 1995 (Fig. 2), a year when weed pressure was greatest. In addition, the lower than average precipitation in May, June and July contributed to the fluctuations in yields over the years. As part of this year by crop combination by seeding ratio interaction, increasing proportions of spring crop increased silage cut and annual yields to a greater extent in 1996 compared with 1995 and especially 1994 (Figs. 1 and 2), especially for the Italian ryegrass combinations.

Generally, the spring component made up about 80% or more of the total annual yield among the crop combinations in all years (Fig. 2). This is in agreement with Spitters and Vanden Burgh (1982) and Baron et al. (1996), who indicated that the competitive ability of a species is determined by the space it occupies in the sward at the beginning of the season. For example, the plant height of fall rye was the same as barley from early spring until the jointing stage of the barley, after which the barley canopy rose above that of the winter cereals. McCartney et al. (2004) reported that the spring crop yields in spring-fall intercrop mixtures of barley and oat were 87 and 85% of the corresponding monocrop yields.

Fall regrowth cut yields were always maximized by seeding 100% fall crop (Figs. 1 and 2). This was especially true for the Italian ryegrass combinations in 1994 where the linear effect of increasing ratios of spring crop was more negative than for other year by crop combinations (Fig. 1). In this study, and in an accompanying study (McCartney et al. 2004), fall regrowth was best with Italian ryegrass. Otherwise, the impact of spring:fall seeding ratio for fall regrowth dry matter yield was considerably less than for the spring silage yield, especially in 1994 and 1996 (Fig. 2). Maximum fall regrowth yield occurring with 100% fall crop also occurred in an accompanying study (McCartney et al. 2004), which showed winter cereal fall regrowth yields were greatest when sown as a monoculture rather than in a mixture. Baron et al. (1995) also recommended the use of a winter cereal monocrop for maximizing fall regrowth. Therefore, if fall pasture yield is the primary management goal, a producer should consider either fall monocrops or binary mixtures with barley rather than oats due to the earlier silage harvesting date of barley.

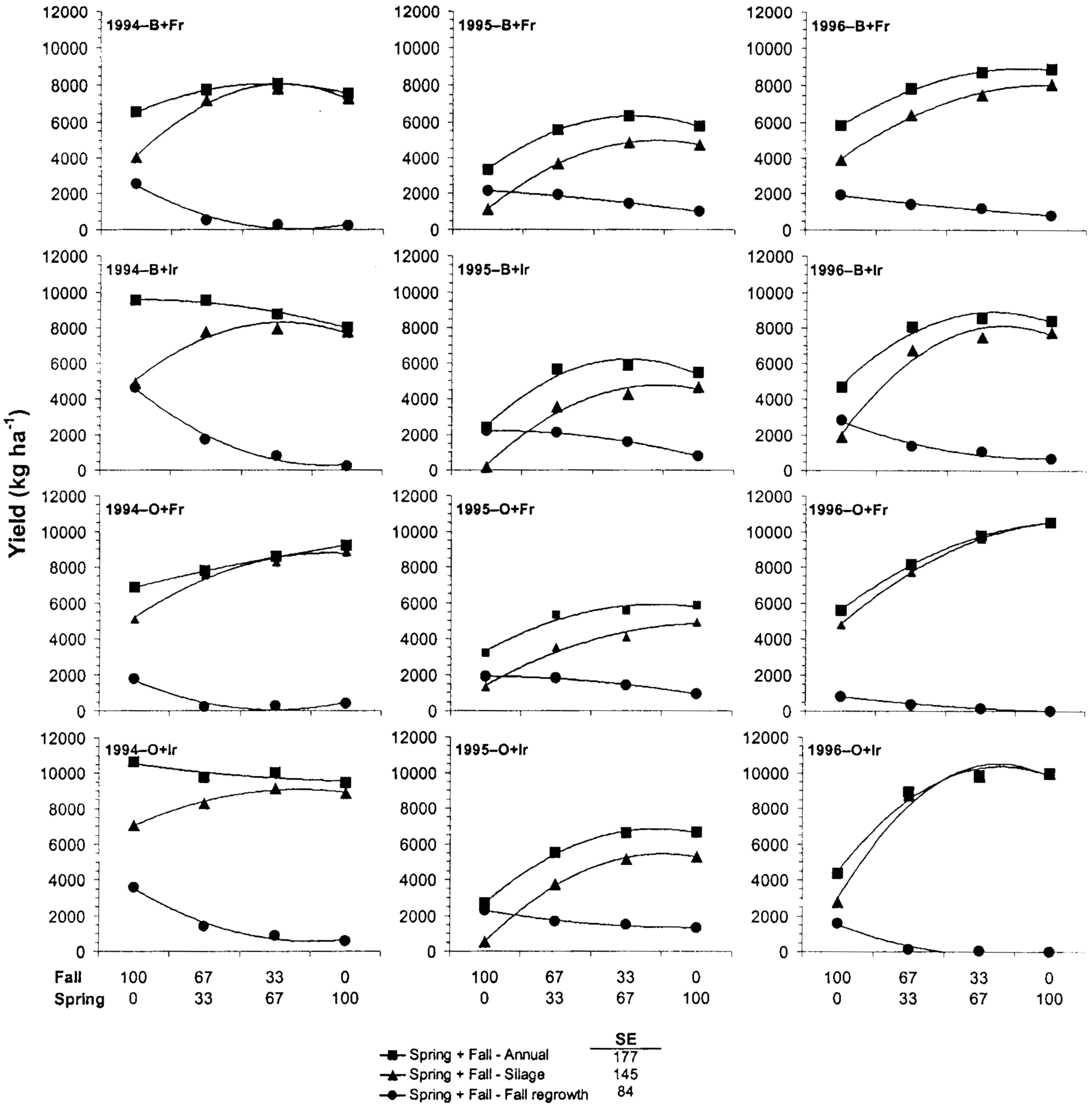

Fig. 1. Mean total (spring + fall) sward yield responses to seeding ratio (% of spring:fall crop) for different crop combination during 3 yr at Melfort, Saskatchewan. Abbreviations for crop combination are as follows: B = barley, O = oat, Fr = fall rye, and Ir = Italian ryegrass.

Spring crop, especially the oat combinations, contributed minimally to fall regrowth yields (Fig. 2). This was likely due to the short growth period (1 wk) between the silage and fall regrowth cut for oat vs. barley. Baron et al. (1995) found that the initial harvest of the mixture should occur no later than 2 wk after heading of the barley component in order to allow sufficient time for recovery of the winter cereal component after harvest. In some years at Melfort, hot dry weather followed the silage cut and this severely limited the amount of regrowth of the fall cereal and Italian ryegrass. For example, hot, dry weather in August 1996 resulted in total annual yield that was considerably lower when spring:fall ratio was less than 67% (Figs. 1 and 2).

Treatment effects were less frequently detected and more consistent, and optimal responses were less variable among years for the fall regrowth yield compared with the silage yield. Therefore, the management of the silage cut is more important and has a greater effect than the fall regrowth cut. Thus, spring:fall seeding ratios should be selected (60% or greater) to minimize the unpredictable effects of climatic conditions, especially if the silage cut is of primary importance.

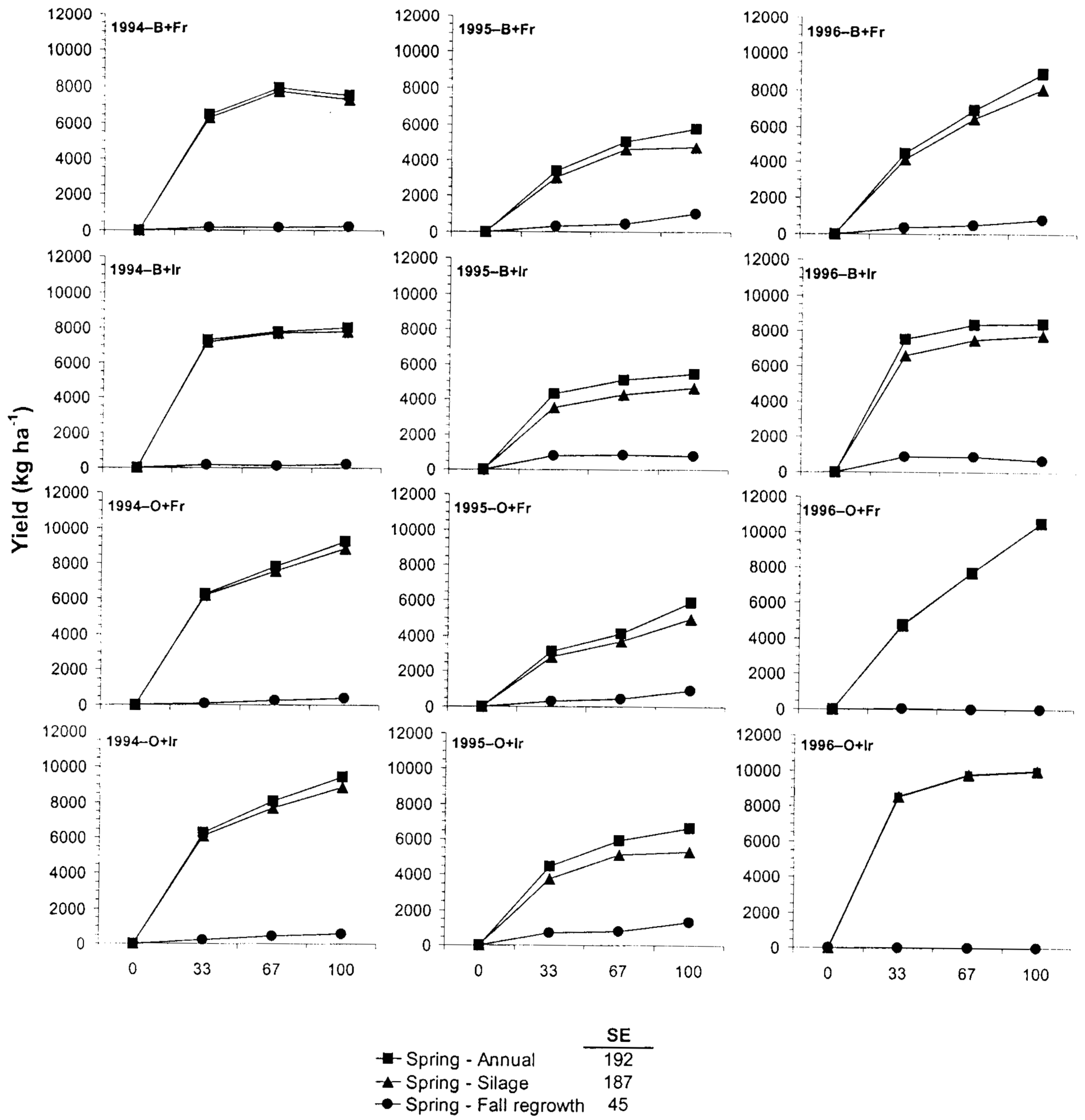

Fig. 2. Mean spring crop yield responses to seeding ratio (% of spring:fall crop) for different crop combination during 3 yr at Melfort, Saskatchewan. Abbreviations for crop combination are as follows: B = barley, O = oat, Fr = fall rye, and Ir = Italian ryegrass.

Seeding Rate

The seeding rate often affected spring component and total crop yield, but generally did not affect fall crop yield (Table 2 and 5). The oat and barley grew quickly in the spring and contributed to the majority of the silage cut and annual spring and total crop yield. On average, silage yield increased with each additional increase in seeding rate (Tables 2 and 5). Interactions between seeding rate and the other factors often were not important, with a couple of notable exceptions (Table 2). A year by seeding ratio by seeding rate interaction was detected for silage and annual spring crop yields. Yield responses to seeding rate were similar to that for the overall average (Table 4) for most year by crop combinations, with one exception. In 1994, yield did not respond to seeding rate at the 100 and 67% spring:fall ratios (results not shown). A significant crop combination by seeding ratio by seeding rate interaction was detected for the silage yield of the fall crop (Table 2); the 275 or 400 seeds m^{-2} seeding rates only improved silage cut yield for the fall crop component yield relative to the other seeding rates for 3 of 12 crop by seeding ratio combinations. However, responses associated with this interaction were of

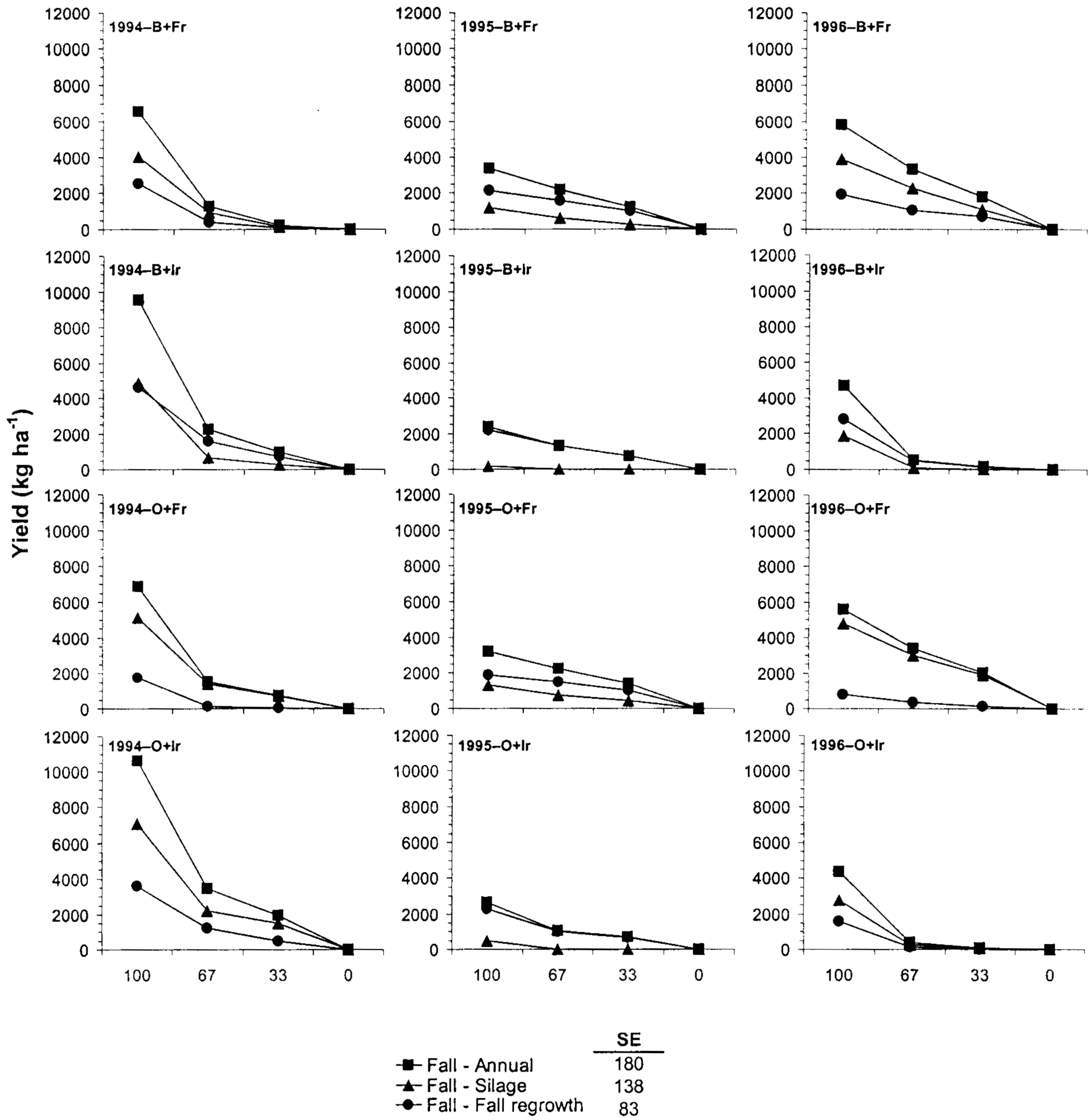

Fig. 3. Mean fall crop yield responses to seeding ratio (% of spring:fall crop) for different crop combination during 3 yr at Melfort, Saskatchewan. Abbreviations for crop combination are as follows: B = barley, O = oat, Fr = fall rye, and Ir = Italian ryegrass.

questionable agronomic importance. Therefore, producers can choose stand seeding rates in accordance with other management issues (e.g., weed management) without needing to alter the seeding ratio or crop combination. For example, producers might consider a greater than normal seeding rate as an alternative weed management strategy when significant weed infestations are anticipated, especially with a low spring:fall seeding ratio.

Weed Management

Weed infestations capable of causing agronomically significant yield reductions occurred, especially in plots with Italian ryegrass in 1995 and 1996 (Table 4). At the time of the study, there were few label-approved herbicide options and limited information on herbicide tolerance for Italian ryegrass was available. Furthermore, high winds and wet weather often delayed spray applications. Recurrent broadleaf weed infestations were particularly problematic for these treatments (Table 4), and consequently necessitated hand weeding. Additionally, the later silage cut time for oats (soft dough stage) compared with barley sometimes allowed for the development of weed infestations capable of reducing yields of oat mixtures (Table 4). Others have shown the early weed removal is a key management practice

Table 2. Probability of *F* value as determined by ANOVA for crop yield responses to crop combination, seeding rate, and seeding ratio at Melfort, Saskatchewan, from 1994 to 1996

Effect	Spring crop component			Fall crop component			Spring + fall crop components		
	Silage cut	Regrowth cut	Total annual	Silage cut	Regrowth cut (*P* value)	Total annual	Silage cut	Regrowth cut	Total annual
Crop combination (C)	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.005	< 0.001	< 0.001	< 0.001
Seeding rate (R)	< 0.001	0.132	< 0.001	0.114	0.784	0.343	< 0.001	0.391	< 0.001
Seeding Ratio (P)	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
R × P	0.429	0.379	0.254	0.215	0.798	0.413	0.125	0.855	0.487
C × R	0.732	0.102	0.402	0.933	0.543	0.792	0.370	0.114	0.079
C × P	< 0.001	< 0.001	< 0.001	0.013	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
C × R × P	0.624	0.314	0.464	0.022	0.949	0.071	0.252	0.932	0.390
Year (Y)	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Y × C	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Y × R	0.199	0.021	0.508	0.964	0.006	0.611	0.232	0.079	0.070
Y × P	< 0.001	< 0.001	0.005	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Y × C × R	0.606	0.212	0.427	0.969	0.612	0.913	0.583	0.368	0.185
Y × C × P	< 0.001	0.011	< 0.001	0.134	< 0.001	0.042	< 0.001	< 0.001	< 0.001
Y × R × P	0.046	0.597	0.050	0.103	0.349	0.208	0.392	0.104	0.479
Y × C × R × P	0.548	0.891	0.631	0.065	0.975	0.238	0.725	0.981	0.770

Table 3. Regression analysis results and optimal seeding ratios for different year by crop combinations at Melfort, Saskatchewan

Cut/Crop^x	1994			1995			1996		
	Linear	Quadratic	Optimum^z	Linear	Quadratic	Optimum	Linear	Quadratic	Optimum
	(kg ha^{-1} per unit change)^y		(%)	(kg ha^{-1} per unit change)		(%)	(kg ha^{-1} per unit change)		(%)
Silage									
B + Fr	118**	–0.864**	68	93**	–0.582**	80	86**	–0.449**	95
B + Ir	95**	–0.692**	69	113**	–0.709**	80	159**	–1.036**	77
O + Fr	78**	–0.418**	93	66**	–0.313**	100	102**	–0.447**	100
O + Ir	53**	–0.342**	77	115**	–0.683**	84	199**	–1.317**	76
Fall regrowth									
B + Fr	–65**	0.436**	0	–8**	–0.039	0	–14**	0.030	0
B + Ir	–95**	0.528**	0	1**	–0.152*	0	–44**	0.242**	0
O + Fr	–49**	0.363**	0	–1**	–0.086	0	–13**	0.051	0
O + Ir	–70**	0.418**	0	–20**	0.104	0	–46**	0.319**	0
Annual									
B + Fr	52*	–0.421*	62	84**	–0.615**	69	72**	–0.419**	86
B + Ir	0**	–0.164	0	115**	–0.873**	66	114**	–0.795**	72
O + Fr	28**	–0.037	100	64**	–0.400**	80	89**	–0.396**	100
O + Ir	–17*	0.076	0	99**	–0.606**	81	153**	–0.998**	77

[z] The optimal seeding ratio (% of spring crop) corresponding with the maximum yield was calculated for those instances where a significant quadratic effect occurred. These parameters were estimated by differentiating the second-order regression model with respect to seeding rate, setting the result equal to zero. The optimal seeding ratio was considered to be 100% or 0% for those instances where only a significant linear effect occurred, the estimated optimum was less than 0% or greater than 100%, or there was an obvious optimal seeding ratio (e.g., 0% for fall regrowth).

[y] The statistical significance of the regression coefficients was represented as follows: * = 0.05 ≥ *P* value ≥ 0.01 and * = *P* value < 0.01.

[x] Abbreviations for crop combination are defined as follows: B = barley, O = oat, Fr = fall rye, and Ir = Italian ryegrass.

to reduce the negative effects of weeds on crop yield (Harker et al. 2003).

The proportion of spring component, rather than total stand seeding rate, was the major factor affecting the silage and fall regrowth yields. However, observations made in this study confirm the conclusion of others (Berkowitz 1988; Kirkland 1993; Mohler 1996) that the higher stand seeding rates may improve crop competitive ability and consequently reduce the risk of problematic future weed infestations. Furthermore, the more rapid growth for the spring crop relative to the fall crop was also observed to suppress weed growth. Therefore, forage swards with greater than 60% of the spring crop component along with higher than normal total stand seeding rates of 400 seeds m^{-2} represents a possible integrated weed management strategy in a mixed farming system.

Table 4. Mean weed biomass for different crop combinations at Melfort, Saskatchewan, from 1994 to 1996

Crop^z	1994	1995	1996
		(kg ha^{-1})	
Barley and fall rye	91	1960	252
Barley and Italian ryegrass	77	2546	633
Oat and fall rye	285	1798	89
Oat and Italian ryegrass	357	2042	806
LSD$_{0.05}$	298	257	254

Table 5. Mean responses to seeding rate (seeds m^{-2}) at Melfort, Saskatchewan, from 1994 to 1996

	150	275	400	LSD$_{0.05}$
Crop/cut		(kg ha^{-1})		
Spring + fall				
Silage	5589	6025	6343	174
Fall regrowth	1299	1238	1237	102
Annual	6877	7263	7587	213
Spring crop				
Silage	6015	6438	6822	260
Fall regrowth	476	435	412	63
Annual	6491	6873	7234	268
Fall crop				
Silage	1442	1596	1636	193
Fall regrowth	1256	1215	1236	116
Annual	2690	2811	2875	252

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