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# Organic Production Tools for Field Peas: Are Cultivar Mixtures More Competitive with Weeds?

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## Abstract

Within Saskatchewan's organic industry there is a need for improved tools to minimize yield losses due to weeds. Cultivar mixtures may improve the ability of organic pulse crops to suppress weeds and maintain yields in the presence of weeds. While semileafless peas are known for their lodging resistance and high yield potential in the absence of weeds, conventional peas may provide better weed suppression and yield stability in the presence of weeds. A replicated field experiment was conducted at two organic field sites to test the hypothesis that cultivar mixtures of conventional and semileafless field pea would differ in weed suppression and yields. The experiment tested factorial combinations of five ratios of semileafless pea cultivar CDC Dakota and conventional cultivar CDC Sonata (0:100, 25:75, 50:50, 75:25, and 100:0, respectively), and two seeding rates (conventional and organic recommended). Plots were monitored for crop and weed emergence, biomass, and yields. Significant differences were observed among the different ratios of semileafless and conventional field pea. Results indicate that the semileafless cultivar was more competitive with weeds than the conventional. As the canopy composition progressed from a pure conventional canopy towards increasing percentages of semileafless pea in the mixture, total weed biomass decreased, and total crop yields increased. It was concluded that while no additional weed suppression or yield benefits were seen compared with growing the more strongly competitive semileafless cultivar alone, cultivar mixtures reduced the risk associated with growing unfamiliar or less competitive cultivars by stabilizing weed suppression and crop yields at a level between the two components of the mixture.

## Introduction

Certified organic crop production in Saskatchewan covers a significant area of approximately 400,000 ha, or 57% of Canada's total (Macey, 2009). At a given time, approximately 5% of organic land in the province is in annual pulse crops, primarily field peas and lentils. Within the organic industry as a whole there is a need for improved pest management tools, and particularly for methods that reduce yield losses due to weeds (Frick et al., 2008).

Crop yields may be improved in the presence of weeds by enhancing the ability of the crop to capture resources such as sunlight, nutrients, and water. Crop competitiveness refers to resource capture by the crop relative to the weeds, and is indicated by both the ability of the crop to suppress weeds, and the ability of the crop to yield well while growing with weeds. The pulse crops as a group are known to be weak competitors, however differences exist among cultivars in their resource capture abilities. Cultivar vine length (Spies, 2008), and cultivar leaf area index

(Wall and Townley-Smith, 1996) are factors that are correlated with competitive ability for field pea. Cultivars of conventional leaf type, which have leaflets on the tendrils, may be more weed suppressive (Spies, 2008; Harker et al., 2008), and less sensitive to yield loss due to weeds (Harker et al., 2008), than semileafless types, which lack leaflets on the tendrils.

Intercrops and cultivar mixtures refer to growing of multiple crop species, or cultivars of the same species, together in proximity for yield and other benefits. Component crops or cultivars are chosen to complement each other. For field pea, cultivar mixtures may be a tool to combine the high yield potential and lodging resistance of semileafless pea, with the weed suppression and yield stability of conventional leafed pea. Yield and weed suppression of intercrops and cultivar mixtures may be affected by both the mixing ratio of the component crops or cultivars, and by the density at which they are sown.

A field experiment was conducted at two organically managed sites in 2011 near Saskatoon, Saskatchewan, to evaluate mixtures of a conventional and semileafless cultivar, sown in different mixing proportions and densities, as a weed management tool for organic producers. It was hypothesized that the mixtures would differ in competitive abilities, defined both in terms of ability to suppress weeds, and the ability to maintain yields while growing with weeds.

## Materials and Methods

The two sites on which the experiment was conducted were located at Kernen Crop Research Farm, University of Saskatchewan, and in an organic producer's field near Vonda, Saskatchewan. The experiment had a two-way factorial treatment design on a randomized complete block with four replications, with the two factors being ratios of the two cultivars, and target crop density.

All mixtures were established using a semileafless cultivar (CDC Dakota-formerly CDC 2098-20) and a conventional cultivar (CDC Sonata), both bred by the Crop Development Centre, University of Saskatchewan. Both cultivars had similar vine lengths and maturity times, however CDC Dakota is rated to have good lodging resistance, and CDC Sonata has a fair lodging resistance rating (Saskatchewan Pulse Growers, 2011). The seed of the two cultivars was mixed in the desired proportions before seeding, at the conventional and organic recommended densities (Table 1), and the two cultivars were sown into the same rows.

**Table 1:** Ratios of semileafless to conventional peas and target crop densities tested in 2011 field experiments.

| | Ratio of semileafless: conventional cultivars in mixture | | Target crop density |
|---|---|---|---|
| 1 | 0:100 | 1 | Conventional recommended density: 88 plants/m$^2$ (Saskatchewan Pulse Growers, 2000) |
| 2 | 25:75 | 2 | Organic recommended density: 132 plants/m$^2$ (Baird, 2007) |
| 3 | 50:50 | | |
| 4 | 75:25 | | |
| 5 | 100:0 | | |

The two sites were monitored for crop emergence, final stand density, weed density, weed and crop biomass, and crop yields. Crop and weed counts were taken using two $1m^2$ or $0.25m^2$ quadrats per plot, respectively, approximately two weeks after crop emergence. Weeds were identified and counted by species. Crop and weed biomass was sampled prior to harvest by cutting the above-ground plant material from within two $0.25m^2$ quadrats per plot, oven-drying, and weighing. Plots were combined using a small plot harvester. Seed was cleaned of dockage, separated by cultivar, and weighed.

Data were analyzed using the mixed procedure in SAS (version 9.2, SAS Institute Inc., Cary, NC, USA). The ratios of the two cultivars, seeding rate, and the interaction of the two factors were treated as fixed effects in the model, and site and replicate within site were treated as random effects. Only significant treatment effects ($P < 0.05$) or strong trends ($P < 0.10$) are presented.

**Results and Discussion**

Weed community composition differed between the two locations, with predominantly broadleaf weeds present at Kernen, and grassy weeds at Vonda. The total biomass of broadleaf and grassy weeds combined was similar between the two sites. The total weed biomass was analyzed for both sites together, and broadleaf and grassy weed biomasses were analyzed separately for each site.

Canopies comprised of the different ratios of semileafless to conventional pea differed significantly in ability to suppress weeds. The pure stand of the semileafless variety was more weed suppressive than the pure stand of the conventional cultivar. As the canopy composition progressed from a pure conventional canopy towards increasing percentages of semileafless pea in the mixture, total weed biomass decreased ($P = 0.01$, Fig 1). When broadleaf and grassy weeds were analyzed separately for each site, biomass of the dominant broadleaf weed community at the Kernen site followed a similar trend, decreasing as the percentage of semileafless pea in the mixture increased ($P = 0.08$).

The ratio of semileafless to leafy pea significantly interacted with seeding rate on suppression of grassy weeds at the Vonda site ($P = 0.02$). At the low seeding rate, grassy weed biomass was affected in a manner similar to total weed biomass, decreasing with increasing percentage of semileafless pea in the mixture. However at the high seeding rate the monocultures and mixtures of the two cultivars were equally suppressive of grassy weeds (Fig 2). This suggests that a high seeding rate may be more important than cultivar choice for grassy weed suppression; however additional data are needed to confirm this result.

The yields of the two component cultivars individually ($P \leq 0.0003$), as well as the yields of the mixtures as a whole ($P < 0.0001$), were significantly affected by altering the ratio of the two cultivars in the mixture. Yield of each variety individually was favoured by increasing its contribution to the mixture, however the yield of the conventional cultivar grown in monoculture was approximately 60% lower than the yield of the semileafless in monoculture. As a result, total yield of the mixtures closely followed yield of the semileafless cultivar, increasing as the percentage of semileafless pea in the mixture increased (Fig 3). This result confirms that the semileafless cultivar was more competitive than the conventional cultivar, both in terms of ability to suppress weeds, and ability to maintain yields in the presence of weeds.

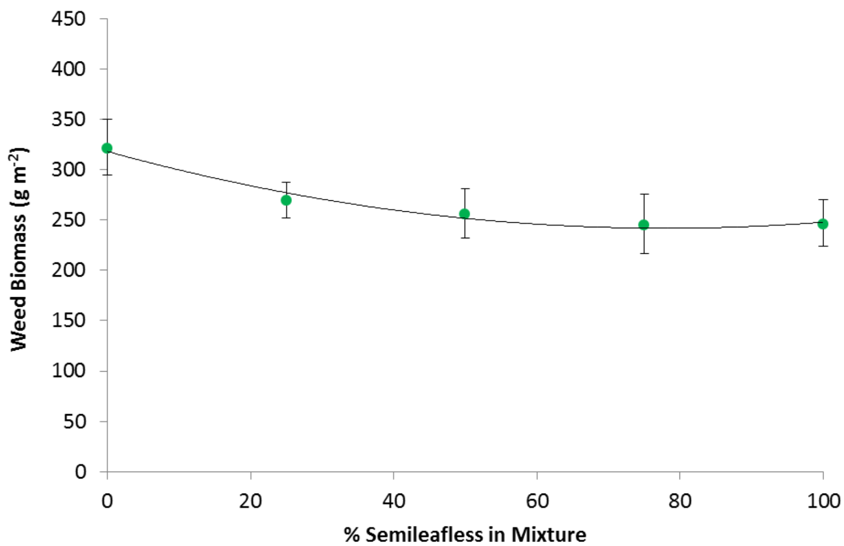


**Figure 1.** Effect of mixing ratio on total weed biomass at Kernen and Vonda organic field sites in 2011. The pure stand of the conventional leafed variety is represented by 0% semileafless. Weed biomasses represent treatment means across both sites. Error bars represent standard error of means.

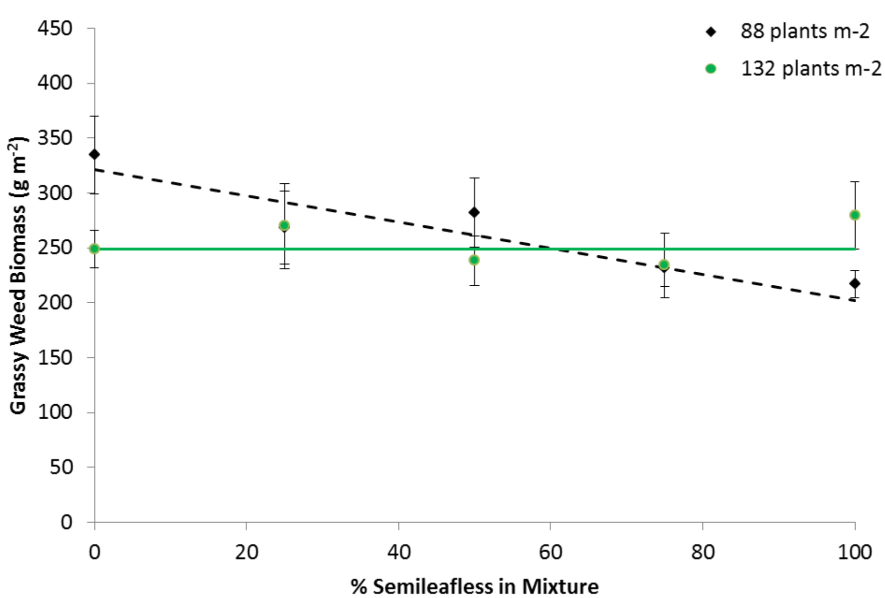


**Figure 2.** Effect of mixing ratio and seeding rate on grassy weed biomass at Vonda organic field site in 2011. The pure stand of the conventional leafed variety is represented by 0% semileafless. Error bars represent standard error of means.

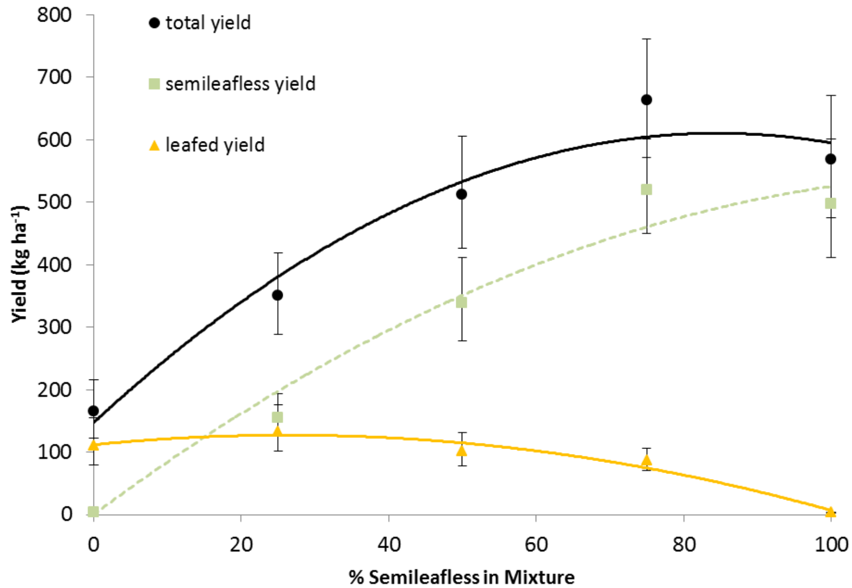


**Figure 3.** Effect of cultivar mixing ratio on yield of each cultivar and total yields at Kernen and Vonda organic field sites in 2011. The pure stand of the conventional leafed variety is represented by 0% semileafless. Yields represent treatment means across both sites. Error bars represent standard error of means.

## Conclusions

Results of this experiment clearly demonstrate that field pea cultivars can differ in their abilities to suppress weeds, and to maintain yields while weeds are present. It is also evident that it is difficult to predict cultivar competitive ability based on single characteristics. In this experiment, a semileafless cultivar was more competitive with weeds than a conventional cultivar. While no additional weed suppression or yield benefits were seen in mixture compared with growing the more strongly competitive semileafless cultivar alone, all mixtures improved weed suppression and yields compared with the weakly competitive conventional cultivar. It is concluded that cultivar mixtures may reduce the risk associated with growing unfamiliar or less competitive cultivars by stabilizing weed suppression and yields at a level between the two components of the mixture.

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