

1. **Project Title:** Evaluating the use of Direct Seeding and Pre-Seedling Cultivation in Forage Seed Crop Establishment
2. **Producer Group Sponsoring the Project:** Saskatchewan Forage Seed Development Commission (SFSDC)
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3. **Funder:** The project was supported by the Agricultural Demonstration of Practices and Technologies (ADOPT) initiative under the Canada-Saskatchewan Growing Forward bi-lateral agreement.
4. **Researchers:** Stewart Brandt, Jessica Pratchler, and Stephanie Ginter. Northeast Agriculture Research Foundation (NARF), Melfort, SK
5. **Objectives:**

This project evaluates and demonstrates the use of direct seeding with the use of pre-seeding herbicide applications or pre-seeding cultivation when establishing forage seed crops. It demonstrates the agronomic advantages of early weed control and various methods of plant establishment to new and existing forage seed growers.

With the adoption of advanced direct seeding equipment throughout Saskatchewan, forage seed producers are looking to find the most effective method for planting forage seed crops while controlling early emerging weeds.

Early weed control and good crop establishment are two of the most important requirements in successful forage seed production. This project compares direct seeding with various registered herbicide applications to pre-seeding cultivation and demonstrates the best combination to growers.

6. **Methodology:**

An area of wheat stubble in black clay soil was selected for this project at the Agriculture and Agri-Food Canada (AAFC) Research Farm near Melfort, SK. Red clover (Variety Altaswede) and Faba bean (Variety Snowdrop) were planted in alternate rows using a Conserva-Pak airseeder with double-shoot technology with 9 inch row spacing on May 26, 2016. The red clover seed was placed with the seed opener and faba bean through the fertilizer opener to achieve optimum seeding depths for both crops. The ports to alternate rows on the seeder were diverted at the meters, so that when seeded at 18" spacing, the seed from 2 rows was combined into 1 row to target correct seeding rates. The target plant density for the faba bean was 45 plants per M² and the target seeding rate for red clover was 4.2 kg per ha. Fertilizer (11-52-0) was applied at a rate of 67 kg per ha at the time of seeding in the sideband. A randomized complete block design field trial was used and each treatment was replicated four times.

Treatments included pre-seed tillage (**Figure 3**) verses no pre-seed tillage (**Figure 6**). Pre-seed tillage was done on May 24, 2016 using a rotor tiller at a depth of 7cm.

Herbicide treatments (**Table 1**) included pre-seed herbicide burn-off with either Express SG + Roundup (**Figure 5**) or Roundup alone (**Figure 4**) verses no pre-seed herbicide burn-off. Pre-seed herbicide treatments were applied on May 25, 2016 with a hand-held sprayer. Express SG was applied at 6 g per acre and Roundup was applied at 180 g active ingredient per acre in 40 L per acre of spray solution.

Table 1: Treatments. 2016 Pre-seed activities in Red Clover and Faba Bean planted in Alternate Rows near Melfort, SK.

Treatment	Tillage	Herbicide
1	No pre-seed tillage	-
2	Pre-seed tillage	-
3	No pre-seed tillage	Roundup
4	No pre-seed tillage	Express SG + Roundup

Pre-seed weed counts on the entire trial were carried out on May 26, 2016 and post emergent weed counts and crop plant counts were completed on June 21, 2016. The trial was oversprayed with Odyssey herbicide at 17.3 g per acre plus Merge at 0.5L per 100L of spray solution in 40 L per acre of spray solution on July 6, 2016 using a tractor-mount sprayer.

Weed and crop plant biomass was measured on August 10, 2016 (five weeks after the Odyssey application) to determine the fresh weight of broadleaf and grassy weed species. The faba bean was allowed to dry naturally. Following a delay due to poor harvest weather in October, the faba bean was harvested with a Wintersteiger plot combine on November 9, 2016. The faba bean grain samples were dried to 10 per cent moisture and cleaned to assess yield.

During 2017, no herbicide was applied for in-crop weed control. All plots were desiccated using Reglone Ion, when the majority of seed heads of individual plants were ripe, but before shattering.

The red clover seed crop was harvested September 25, 2017 with a Wintersteiger plot combine. Red clover seed samples were dried to 0 per cent moisture content followed by cleaning and weighing to determine yield. Seed samples were collected and submitted to the Ag Seed Laboratory in Carrot River, SK for seed purity analysis.

Statistical analysis was done by NARF.

7. Results:

May 2016 was 2.9 degrees C warmer than normal, June and July were only slightly warmer than normal and August was a bit cooler than normal (**Table 2**). Precipitation during April and May 2016 was much below normal. Precipitation during June was near normal, while July and August 2016 were much wetter than normal. These conditions allowed for a productive and responsive faba bean crop to develop (**Figure 1**). The red clover crop also established well. In addition, 2016 had a long frost free period with the first fall frost recorded on October 4 when it normally occurs near September 10. Snow fell on October 5, 2016 before the faba bean was harvested and caused some crop damage and made it difficult to avoid harvest losses. This may have reduced accuracy of faba bean yield measurements.

Table 2: Mean temperatures and precipitation at Melfort, SK from May to October 2015, 2016 and 2017.

	--- Temperature ---						
	May	Jun.	Jul.	Aug.	Sept.	Oct.	Average
2015	9.9	16.4	17.9	17.0	11.9	6.6	13.3
2016	13.6	17.1	18.1	16.3	12.0	1.7	13.1
2017	10.8	15.2	18.7	17.2	12.5	4.3	13.1

Long-Term Average^a 10.7 15.9 17.5 16.8 10.8 3.3 12.5

--- Precipitation ---

	May	Jun.	Jul.	Aug.	Sept.	Oct.	Total
2015	7.1	54.8	149.8	57.4	70.0	33.0	372.1
2016	16.8	53.2	128.7	80.8	41.3	57.7	378.5
2017	46.4	44.1	33.3	3.1	13.2	43.5	183.6
Long-Term Average ^a	42.9	54.3	76.7	52.4	38.7	27.9	292.9

^a Long-Term Climate totals and averages calculated between 1981 to 2010 from Melfort, SK weather station (52°49'00 N, 104°36'00 W).

Very dry conditions in spring 2016 resulted in the pre-seed tillage treatment reducing crop plant counts as well as faba bean yield (**Table 3**). Treatments with the herbicide applications appeared to have no impact on red clover or faba bean emergence or faba bean yield. Plant densities of the faba bean crop were largely unaffected by treatments although they did appear lower for the tillage treatments and where the combined application of Express SG + Roundup were applied. Where tillage was done (Treatment 2), red clover density declined sharply compared with where red clover was direct seeded (Treatments 1, 3 and 4). This was likely due to drying of the seedbed during the tillage operation. May 2016 rainfall was much below normal, so conserving moisture in the seedbed was important to ensure adequate moisture for successful establishment of the shallow-seeded red clover crop.

Table 3: Influence of Direct Seeding and Pre-Seeding Cultivation on Red Clover and Faba Bean Establishment and Yield at Melfort in 2016 and 2017.

Treatment	Red Clover Counts (m ²)	Faba Bean Counts (m ²)	Faba Bean Yield ¹ (kg/ha)	Red Clover seed yield (kg/ha)
1. No Tillage No Burn off	164a	33a	2,087	288
2. Tillage No Burn off	68b	29a	2,063	237
3. No Tillage Roundup	136a	31a	2,483	262
4. No Tillage Express SG + Roundup	144a	27a	2,321	290

Values in a vertical column followed by the same letter do not differ significantly at P=0.05

¹ Faba bean yield differences were not significant at P=0.05 but were at P=0.10

Grassy weed biomass (**Table 4**) was very low for treatments where no pre-seed tillage was utilized, even where no pre-seed herbicide was applied. Very dry conditions in the spring of 2016 may have limited germination of grassy weeds. However, where tillage was done, grassy weed emergence was much higher. Tillage may have increased grassy weed seed to soil moisture contact, thereby promoting weed emergence.

Broadleaf weeds showed a similar trend to grassy weeds. Broadleaf weed biomass (**Table 4**) was lowest where Express SG + Roundup were applied. Broadleaf weed biomass was somewhat higher where Roundup alone was used and higher still where no

pre-seed herbicide or no pre-seed tillage was applied. However, broadleaf weed biomass was much higher where pre-seed tillage was carried out (Treatment 2). Faba bean yield (**Table 3**) was lowest where no pre-seed tillage or pre-seed herbicide was applied or where tillage only (Treatments 1 and 2) was used. Faba bean yields were highest where Roundup alone or Express SG + Roundup (Treatments 3 and 4) were applied before seeding.

Table 4: Influence of Direct Seeding and Pre-Seeding Cultivation on Weed numbers and Weed biomass in Red Clover and Faba Bean during establishment at Melfort in 2016.

Treatment	Weed Counts at Seeding (#/m ²)	Weed Counts 5 Weeks After Seeding (#/m ²)	Grassy Weed Biomass (kg/ha)	Broadleaf Weed Biomass (kg/ha)
1. No Tillage No Burn off	78a	16a	6b	227b
2. Tillage No Burn off	0b	24a	178a	666a
3. No Tillage Roundup	0b	9b	13b	85c
4. No Tillage Express SG + Roundup	0b	9b	18b	37c

Values in a vertical column followed by the same letter do not differ significantly at P=0.05

In 2017, temperatures and precipitation in May and June were close to long-term averages (**Table 2**). This led to the red clover crop developing very well (**Figure 7**). Temperatures in July through October were warmer than the long-term average. Precipitation was lower in July through September, but higher than the long-term average in October. Good harvest conditions allowed for the crop to be combined in a timely manner. Red clover seed yields (**Table 3**) were not significantly different for all treatments, indicating the resilience of red clover to overcome the previous year’s treatment effects. However, red clover seed yields did tend to be lower in the tilled treatment. Seed purity analysis (**Table 5**) showed an increase in weed seeds in red clover seed production with pre-seed tillage.

Table 5: Seed purity analysis showing weed seed numbers in Direct Seeding and Pre-Seeding Cultivation in Red Clover seed production at Melfort in 2017.

Treatment	Primary Noxious		Secondary Noxious		Other Weed Seeds	Total Weed Seeds
	Canada Thistle	Perennial Sowthistle	Cleavers	Stinkweed		
1. No Tillage No Burn off	4	1	3	1	28	37
2. Tillage No Burn off	1	3	9	21	365	399
3. No Tillage Roundup	1	3	2	0	37	43
4. No Tillage Express SG + Roundup	1	2	2	0	22	27

8. Conclusions:

Direct seeding combined with pre-seeding herbicide treatment with glyphosate alone or in combination with Express SG improved red clover establishment and reduced weed competition and tended to enhance yield of faba bean in year one and red clover seed in year two. Tillage promoted weed germination and drying of the seed bed that in turn resulted in reduced red clover establishment and a trend toward reduced grain yield of the companion faba bean crop. Pre-seed Roundup alone reduced broadleaf weed biomass compared with tillage or no pre-seed tillage or no pre-seed herbicide, but combining Express SG + Roundup as a pre-seed treatment provided the best weed control. Eliminating pre-seed tillage was the most beneficial treatment for increasing red clover establishment, while using Express SG + Roundup in combination without pre-seed tillage was the most beneficial for reducing weed competition.

Red clover seed yields in year two were not significantly different in any treatment. This indicates the ability of red clover to overcome treatment effects in the year of establishment. Faba bean and red clover appear to be quite compatible and faba bean could be considered as a suitable companion crop for red clover seed production.

9. Acknowledgements:

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Figure 1.Faba bean and red clover seedlings emerging in alternate rows. Melfort SK. June 9, 2016. Source: SFSDC



Figure 2. Field Tour signs. Melfort SK. July 20, 2016. Source: SFSDC



Figure 3. Tillage No pre-burn Melfort SK. July 20, 2016. Source: SFSDC



Figure 4. No Tillage. Roundup. Melfort SK. July 20, 2016. Source: SFSDC



Figure 5. No Tillage. Express SG+Roundup. Melfort, SK. July 20, 2016. Source: SFSDC



Figure 6. No Tillage No Pre-Burn. Melfort SK. July 20, 2016. Source: SFSDC



Figure 7. Red clover in alternate rows with faba bean stubble. Melfort, SK. June 1, 2017 Source: SFSDC



Figure 8. Stu Brandt describing project at field tour. Melfort, SK. July 27, 2017. Source: SFSDC