DEEP ROOTED COVER CROP TRIAL - YR 4

ABSTRACT:

In recent years, producers in Alberta have experienced extreme weather events (excess rainfall and/or drought conditions) and are now recognizing that climate variability will continue to be a challenge to their farming operations. Producers have thus expressed a need to build more resilient soils. Cover crops have been suggested as a solution to improve soil water holding and drainage capacity. Most studies have shown that the extent to which cover crops improve soil properties depends on their ability to produce high below--ground biomass. Spring-seeded cover crops offer the advantage of a full growing season, and species selection is imperative for optimizing below-ground biomass production. Deep-rooted cover crops (DRCC) can also improve soil permeability and infiltration.

The objectives of this study are to determine the impact of two 2-year crop rotations (4 years total) of deep-rooted cover crop mixtures (first and third year, respectively) and field crops (second and fourth years, respectively) on two outcomes; soil temperatures before seeding of the main crop, and soil water holding and drainage capacity. The impact of deep-rooted cover crops mixtures composed solely of brassicas versus mixtures composed of brassicas along with cool-season and warm-season crops on such properties will also be measured. Cover crop mixes have been selected based on rooting depth, and ability to produce high below--ground biomass under climatic conditions in Alberta.

BACKGROUND:

Agricultural production in Alberta is increasingly affected by changing climate conditions, including more frequent heavy rainfall events and periods of drought. In the Peace region, soils developed primarily from lacustrine or glaciolacustrine deposits and are characterized by finer textures (clay and silt loams). Under excess rainfall, these soils are particularly susceptible to ponding. Cover crops (CC) have been suggested to improve both soil water holding and drainage capacity (Basche et al. 2016) and may offer a solution for producers that have finer texture soils.

Blanco-Canqui et al. (2020) conducted a review of the literature on the impacts of CCs on soil physical properties and concluded that CCs increased wet aggregate stability by an average of 16% across 27 studies, macro-porosity by an average of 1.5% across 8 studies, and water infiltration by 62% across 17 studies. The scale of the benefits from CCs is often related to the total amount of below-ground biomass produced (Bowman et al. 2000). However, measuring below-ground biomass is difficult in the field, and most authors have relied on above-ground biomass for determining the impact on soil water movement. For example, Martinez-Feria et al. (2016) found that rye CCs had 21 mm of transpiration per 1000 kg/ha of biomass production.

In Alberta, as with most of the Canadian Prairies, the climate is characterized by a short growing season, which often leads to insufficient biomass production for fall-seeded cover crops (<1000 kg/ha) (NPARA 2019). Thus, there is a need to establish strong research on the benefits of spring-seeded cover crops, which regularly yield >2000 kg/ha (NPARA 2019), on soil properties. Cover crop mixtures of cool (C3) and warm (C4) season crops have been suggested to maximize biomass production under both cool and warm conditions (Chu et al. 2017; Snapp et al. 2005). Mixes containing fibrous root systems from grasses and legumes also have a higher surface area than tap roots and further promote soil aggregation and water infiltration (Blanco-Canqui et al. 2020).

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Species selection is of critical importance in Alberta. The North Peace Applied Research Association (NPARA), located at North Star, Alberta has been growing a variety of cool and warm season CCs since 2012 and has listed corn, proso millet, German millet, and Japanese millet as excellent warm season choices for grasses in mixtures (NPARA 2019). Deep-rooted CCs, such as oilseed radish, chicory, sunflower, and sweet clover have also done well in the Peace region (NPARA 2019) and have been suggested to improve soil water infiltration in finer textured soils (Bowman et al. 2000; Chen and Weil 2009; Chen and Weil 2011). Most of the research on deep-rooted CCs has been conducted on brassicas, where seeding rates vary considerably across studies (1 to 5 kg/ha) (Chen and Weil 2009; Chen and Weil 2011; Halde and Entz 2016; Marshall et al. 2016; Murrell et al. 2017). Thus, there is also a need to assess which brassica seeding rates are best suited for mixtures.

OBJECTIVES:

- To determine the impact of two 2-year crop rotations (4 years total) consisting of deep-rooted cover crop mixtures (years 1 and 3) and field crops (years 2 and 4) on soil water infiltration, soil temperature before spring seeding of the main field crops, and soil organic matter.
- To examine the impact of deep-rooted cover crops (DRCC) mixtures composed solely of brassicas, as well as mixtures of brassicas with cool and warm season crops on soil properties. Brassica seeding rates will be evaluated in all cover crop mixes.
- To investigate the forage value of deep-rooted cover crops DRCC mixtures composed solely of brassicas, as well as mixtures of brassicas with cool and warm season crops on main crop yield (years 2 and 4, respectively).
- To establish the cost-benefit analysis of introducing rotations with deep-rooted cover crops DRCC mixtures composed solely of brassicas, as well as mixtures of brassicas with cool and warm season crops on main crop yield (years 2 and 4, respectively).

STRATEGY:

The study implemented a two-year rotational cropping system. In the first and third years (2022 and 2024), DRCCs were established. These included the baseline Brassica cover crop mix, composed of daikon radish, forage radish, and turnip, applied at the standard seeding rate as well as at two and three times the standard rate. In addition, three diverse multi-species cover crop blends were evaluated. DRCC A consisted of oat, Japanese millet, sweet clover, chicory, field pea, and sunflower. DRCC B included field pea, sunflower, spring triticale, red proso millet, and berseem clover. DRCC C comprised field pea, sunflower, brown midrib corn, annual ryegrass, and hairy vetch. A fallow treatment was included as a control.

In the second and fourth years (2023 and 2025), field crops were sown perpendicular to the orientation of the cover crops planted the previous year. These included wheat, canola, and peas, with a fallow treatment serving as a control.

In 2025, before seeding, a composite soil sample was collected to determine the recommended fertility requirements for the canola, wheat, and pea crops. Both saturated infiltration tests (double-ring infiltrometer) and unsaturated infiltration tests (mini-disk infiltrometer) were conducted at the site. Unfortunately, the data were misplaced at the GRO office during the busy summer season, and we sincerely regret that we are unable to provide these results.

AGRONOMICS:

Seeded: June 9, 2025
Seed Depth: ½ inch - Canola & 1 inch – Wheat and Peas
Soil Temp: 20 °C
Rainfall recorded from June 1, 2025 to September 30, 2025: 162.3 mm
Fertilizer:
- Wheat - Side Banded (at seeding): 28.29-5.78-15.42-1.93 @ 311.28 lbs/ac
- Canola - Deep Banded (before seeding): 28.29-5.78-15.42-1.93 @ 415.04 lbs/ac
  - Side Banded (at seeding): 28.29-5.78-15.42-1.93 @ 104 lbs/ac
- Peas – Seed Placed (at seeding) – 11-52-0 @ 23 lbs/ac

Herbicides:
- Pre-emergence - Glyphosate @ 280 g ae/ac on June 10, 2025
- In-Crop Application
  - Wheat – Curtail M + Axial @ 700 ml/ac + 500 ml/ac on July 07, 2025
  - Peas – Viper + UAN @ 404 ml/ac + 810 ml/ac on July 07, 2025
  - Canola and Fallow – Glyphosate @ 270 g ae/ac on July 07, 2025

Harvested On:
- Peas – September 12, 2025
- Wheat and Canola – October 09, 2025

RESULTS AND DISCUSSION:

The 2025 growing season trials examined the yields of wheat, peas, and canola in plots that had previously received different cover crop treatments in 2024.

Peas (AAC Carver): The pea yield did not differ significantly across the various Brassica and cover crop treatments ($p = 0.227$), suggesting that under these experimental conditions, treatment choice had no clear effect on yield. However, the high variability and relatively low mean yield (27.08 bu/ac) likely reflect the challenging growing environment.

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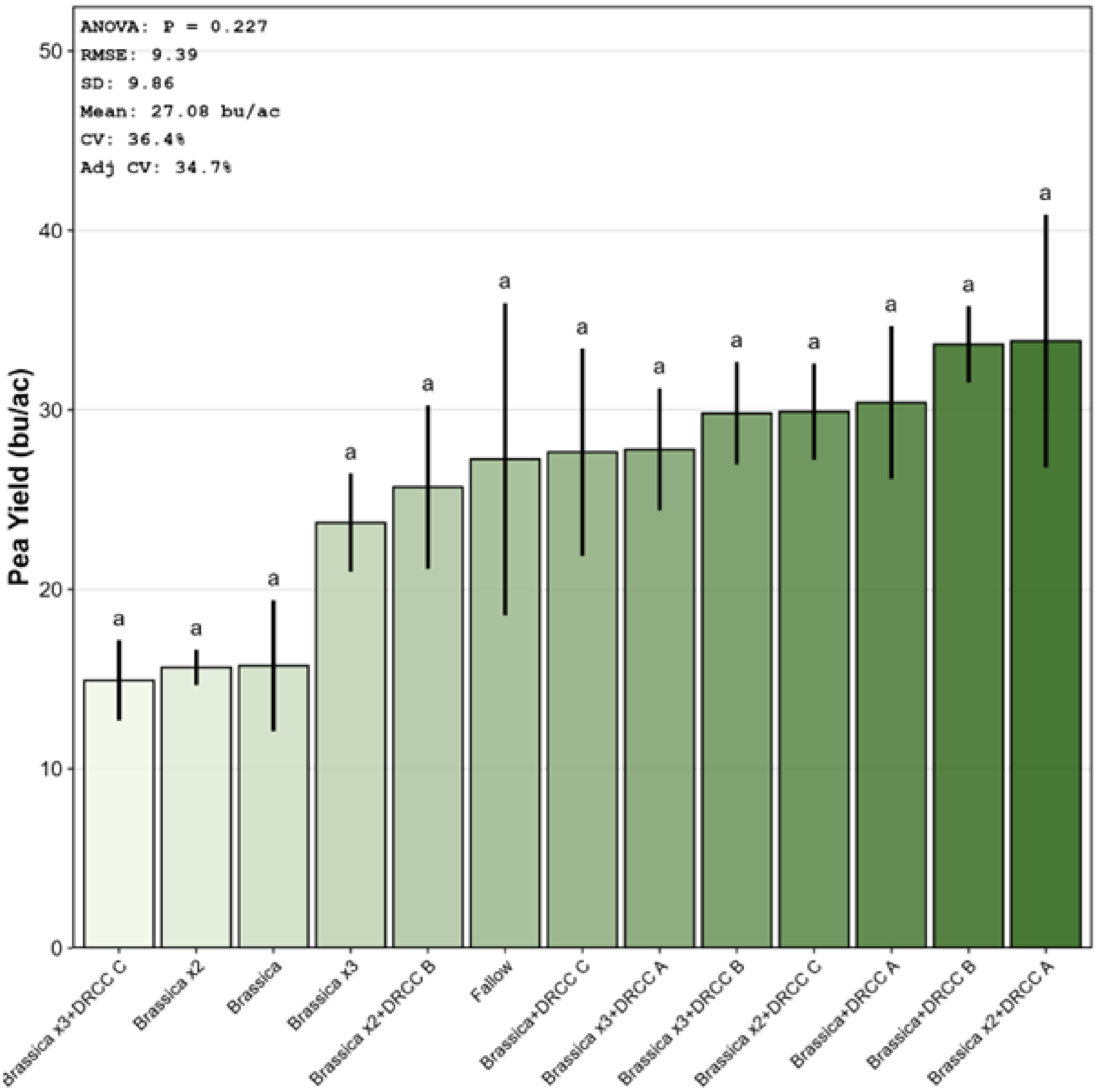
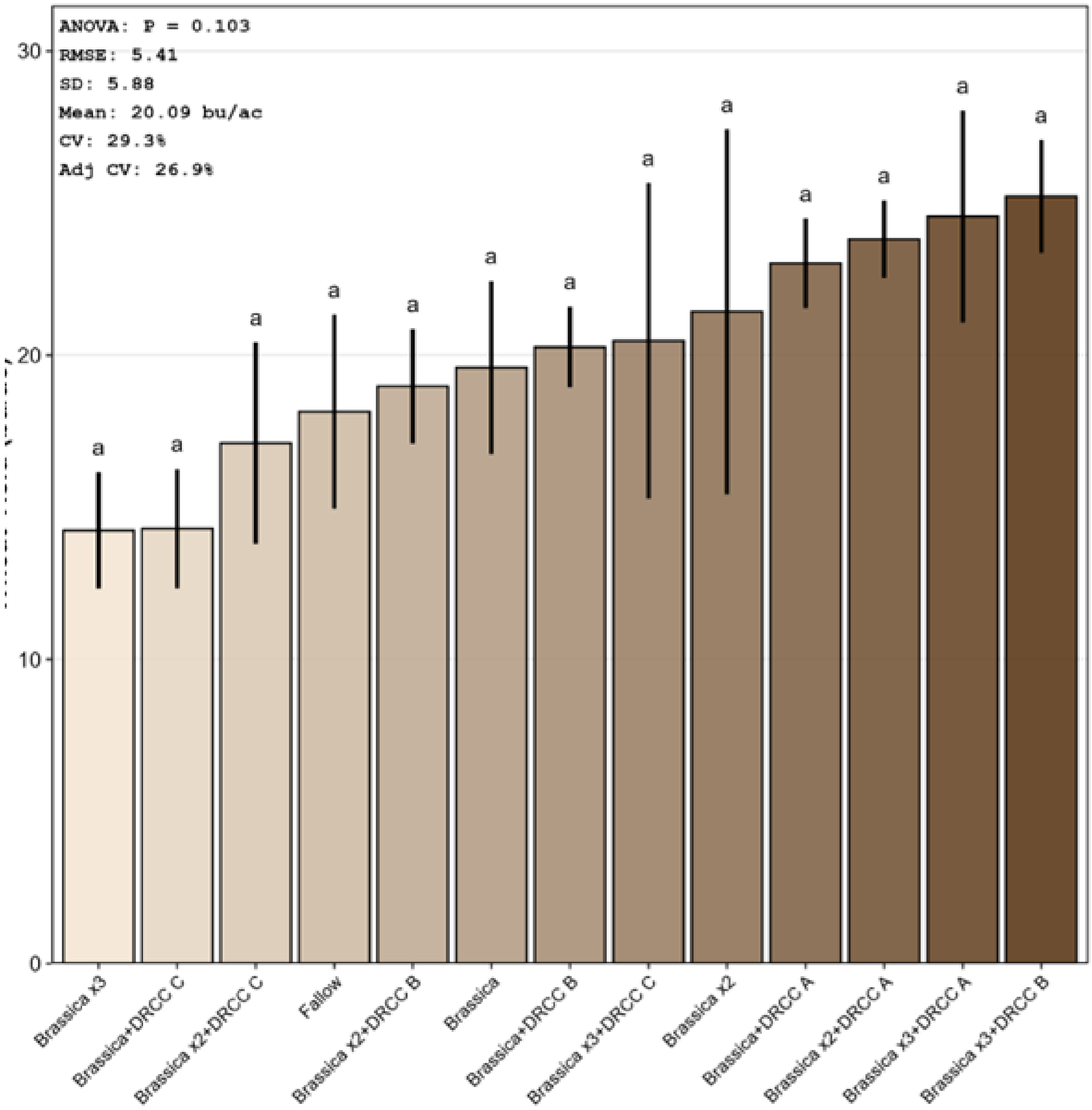


Wheat (AAC Wheatland VB): The wheat yield across the different Brassica and cover crop treatments showed no statistically significant differences (ANOVA p = 0.103), although there was a trend toward higher yields in some treatments. The mean yield was 20.09 bu/ac with variability (CV = 29.3%).



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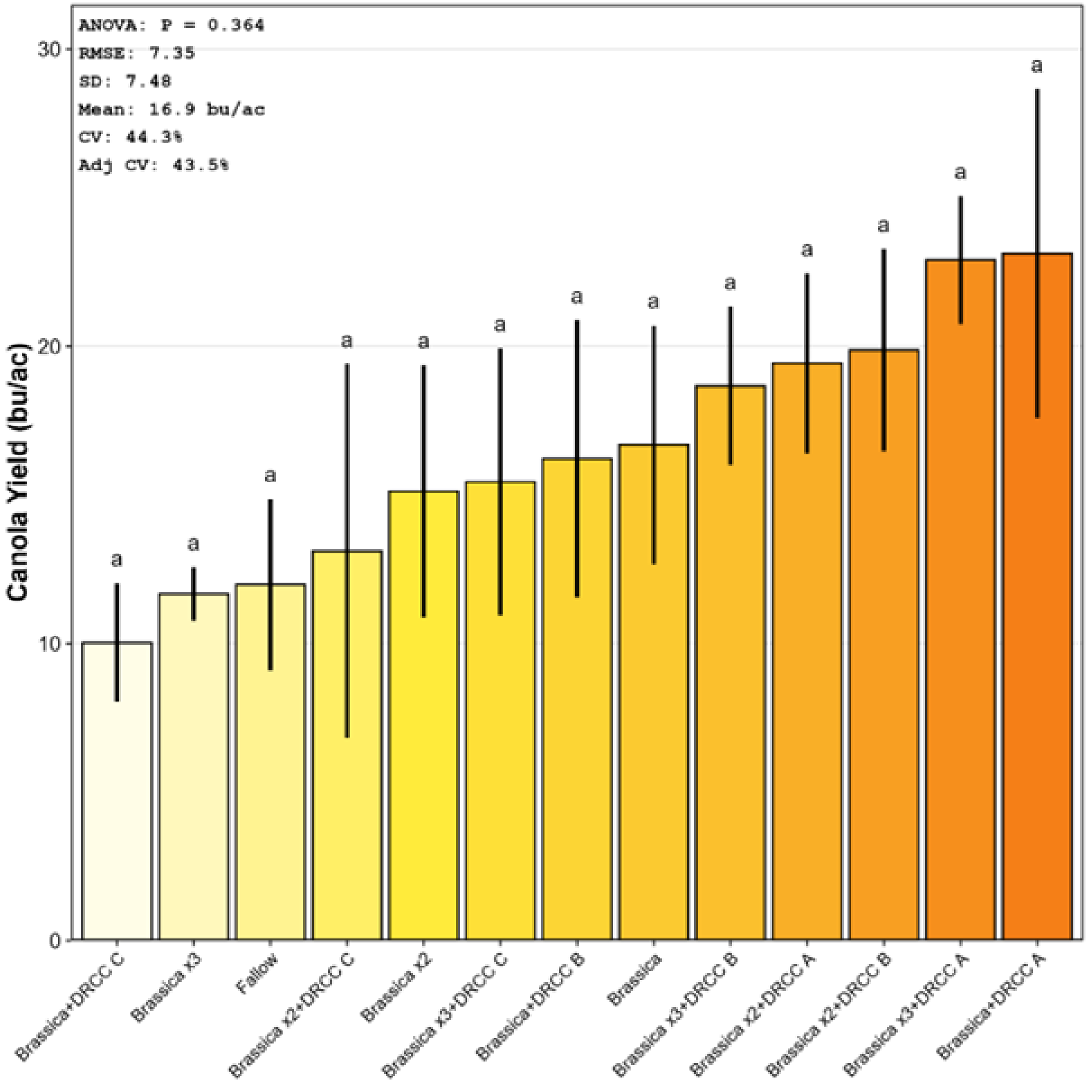
Canola (DEKALB 74-44 BL): Canola yield did not differ significantly across the Brassica and cover crop treatments (ANOVA p = 0.364), even though there was noticeable variation in average yields. The mean yield was 16.9 bu/ac, accompanied by high variability (CV = 44.3%), which is evident from the large error bars and the uniform significance grouping marked by the letter "a."



In conclusion, statistical analysis indicated that none of the treatments had a significant effect on the yield of any of the three crops (ANOVA, $P > 0.05$ at $\alpha = 0.05$). However, numerical differences in yield (bushels per acre) were observed. The highest numerical yields for wheat, peas, and canola were recorded on the Brassica + DRCC A or Brassica + DRCC B plots, whereas Brassica + DRCC C and Fallow plots consistently exhibited lower numerical yields.

Several factors likely contributed to the observed variability and suppressed yield differences. The study experienced significant challenges each year including below-average precipitation, and hail damage in 2024. Additionally, in the 2025 season, seeding was delayed due to a number of factors, and the site received minimal precipitation in month of June, which likely contributed to yields being well below the regional average. Future trials conducted under more optimal or controlled conditions may be necessary to more clearly detect treatment effects.

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RDAR Results Driven Agriculture Research

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