DEEP ROOTED COVER CROP TRIAL - YR 3

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 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 1) soil temperatures before seeding of the main crop, 2) 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:

In the past few years, producers in Alberta have experienced extreme weather events (excess rainfall and/or drought conditions) and are now recognizing that climate variability is going to be a big challenge for them in the years to come. 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).

Species selection is of critical importance in Alberta. The North Peace Applied Research Association (North Star, AB) 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.

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Objectives:

1. 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 soil water infiltration.
2. 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 soil temperatures before spring seeding of the main field crop.
3. 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 soil organic matter.
4. To examine the impact of deep-rooted cover crops 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.
5. To investigate the forage value of deep-rooted cover crops 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).
6. To establish the cost-benefit analysis of introducing rotations with deep-rooted cover crops 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:

Create a cropping system composed of two years:
- Year 1 (2022 & 2024): Deep-rooted cover crops
  - Brassicas
  - Cool seasoned
  - Warm seasoned
  - Fallow
- Year 2 (2023 & 2025)- Field crops, sown perpendicular to the direction of the cover crops planted the year prior
  - Wheat
  - Canola
  - Pea
  - Fallow

Take soil samples and have them tested for
- Soil water holding capacity
- Permanent wilting point
- Field capacity
- Bulk density
- Soil organic matter

Before seeding, both saturated (double ring) and unsaturated (mini disk) infiltration tests were conducted at the site. The same plots from 2022 and 2023 were used.

Agronomics:
Seeding Date: June 10, 2024
Fertilizer:
    Spring side banded: 18.3-2.1-28.5-4.3 @ 200 lbs/ac
        36.6 lbs/ac actual N; 4.2 lbs/ac actual P; 57 lbs/ac actual K; 8.6 lbs/ac actual S
Pesticide:
    Glyphosate + Heat @ 270 g ae/ac + 10.5 g/ac on June 07
    *roguing 3-4 times
Rainfall recorded from June 1 to September 5, 2024: 192.8 mm
Harvest Date: September 9, 2024

Treatments Yr 1 & 3 (2024)

		Seeding rate lbs/ac											
Deep-rooted cover crop species	1	2	3	4	5	6	7	8	9	10	11	12	13
Daikon Radish	Fallow	1.6	3.2	4.8	1.6	3.2	4.8	1.6	3.2	4.8	1.6	3.2	4.8
Forage Brassica		1.6	3.2	4.8	1.6	3.2	4.8	1.6	3.2	4.8	1.6	3.2	4.8
Forage Turnip		1.6	3.2	4.8	1.6	3.2	4.8	1.6	3.2	4.8	1.6	3.2	4.8
Oat					22.4	22.4	22.4						
Japanese millet					2.7	2.7	2.7						
Sweet clover					3.4	3.4	3.4						
Chicory					1.3	1.3	1.3						
Field pea					11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2
Sunflower					1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
Spring triticale								22.4	22.4	22.4			
Red Proso millet								2.7	2.7	2.7			
Berseem clover								3.4	3.4	3.4			
Brown midrib corn											22.4	22.4	22.4
Annual ryegrass											2.7	2.7	2.7
Hairy vetch											3.4	3.4	3.4

Treatments Yr 2 & 4 (2025)
Perpendicular seeding to the direction in which deep-rooted cover crop mixes were sown
Canola, Wheat, Pea, Fallow (no crop)

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Results and Discussion:

Seeding was carried out under slightly wet conditions. The site's high clay content contributed to the formation of a soil crust, caused by the pressure exerted by the seeder's packer wheel, which significantly delayed germination. Even two weeks after seeding, no plant growth was observed. However, rainfall in late June provided enough moisture to break the crust, ultimately triggering germination and allowing the plants to emerge.

Later in the season, the trial was impacted by hail damage, though only the first three to four plots in each row were affected. The remaining plots continued as expected, and the final harvest was completed on September 9th. Following the harvest, samples were sent to the laboratory for feed analysis.

Because the trial faced extreme weather conditions, the data showed a high level of variability (CV), making it less reliable. As a result, we decided not to include this year's data in the final report.

However, 2025 marks the final year of the study, during which we will collect a large number of soil samples. We are eager to see how the soil has changed over the past four years since the trial began in 2022 when we collected the baseline soil samples. By the end of this study, we expect to gain valuable insights into how deep-rooted cover crops influence soil structure and their impact on field crops in the following growing season.

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