APPLICATION OF DEEP-ROOTED COVER CROPS TO IMPROVE SOIL WATER INFILTRATION AND CROP YIELD IN THE PEACE REGION

Deep-rooted cover crops enhance soil physical, hydrological, and nutrient dynamics by developing extensive root systems. These create and stabilize macropores, reduce bulk density, and improve soil aggregation. These structural improvements also increase water infiltration and downward movement, reducing surface runoff, erosion, and nutrient losses, which is particularly beneficial in the Peace Region where soils are prone to compaction and precipitation can be variable. Improved infiltration allows greater water storage in deeper soil layers, supporting crop resilience to short-term moisture stress and improving seedling emergence, root development and establishment.

This project primarily aimed at evaluating the impacts of deep-rooted cover crops on soil water infiltration and the yield of subsequent crops. The crops seeded this year were wheat, canola and pea. The cover crops seeded last year were Brassicas (Daikon radish, forage radish, turnip), Brassicas with DRCC A (Oat, Japanese millet, sweet clover, chicory, field pea, sunflower), Brassicas with DRCC B (Field pea, sunflower, spring triticale, red proso millet, berseem clover) and Brassicas with DRCC C (Field pea, sunflower, brown midrib corn, annual ryegrass, hairy vetch) each seeded at recommended rates as well as at double and triple rates.

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Task	Timeline	Details
Seeding	June 9	Wheat 92.8 lb/ac Pea 140 lb/ac Canola 6 lb/ac
Maintenance	May 10-June 24	Urea 120 lb/ac S15 80 lb/ac Glyphosate (pre-seed) 1 L/ac Coragen 0.71 L/ac
Harvest (Wheat)	Sept. 16	Straight-cut

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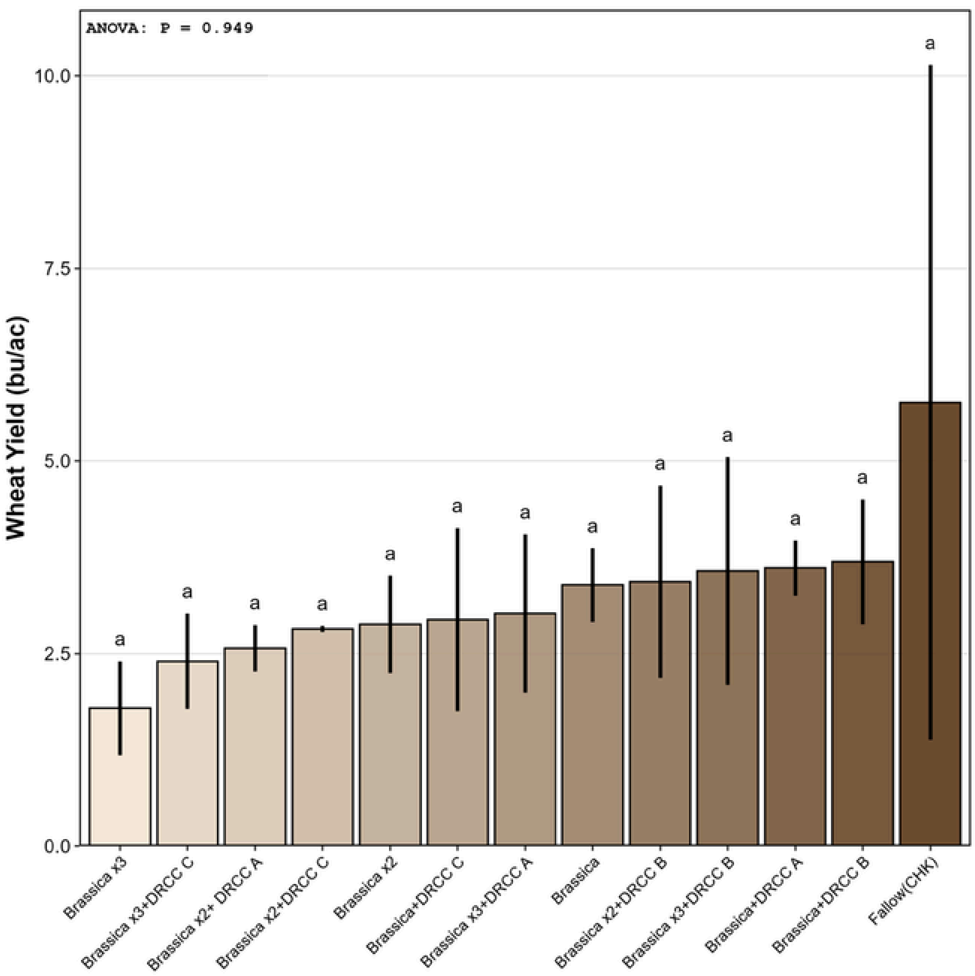
Due to drought and extreme weather conditions during the 2025 growing season, canola and pea yields were not quantifiable. Similarly, although wheat yields were measurable but also severely impacted, no statistically significant results were seen for any of the treatments (ANOVA $P > 0.05$). Similar yield results were reported by Gateway Research Organization (GRO; Westlock, AB) for the year 2025.



Key Points:

Brassica + DRCC B which includes Field pea, sunflower, spring triticale, red proso millet, berseem clover had the best performance in increasing wheat yield

Soils at the research farm fall predominantly under the Nampa series, which is classified as a Solodic Grey Luvisol, with clay loam in the Ap horizon, and heavy clay in the B and C horizons. Drainage is classified as imperfect. Soil samples were taken using a 2cm diameter core, a total of 6 samples per plot and were pooled according to depth. Thus, samples taken at 0-15 and 15-30cm were separated for fertility analysiss.

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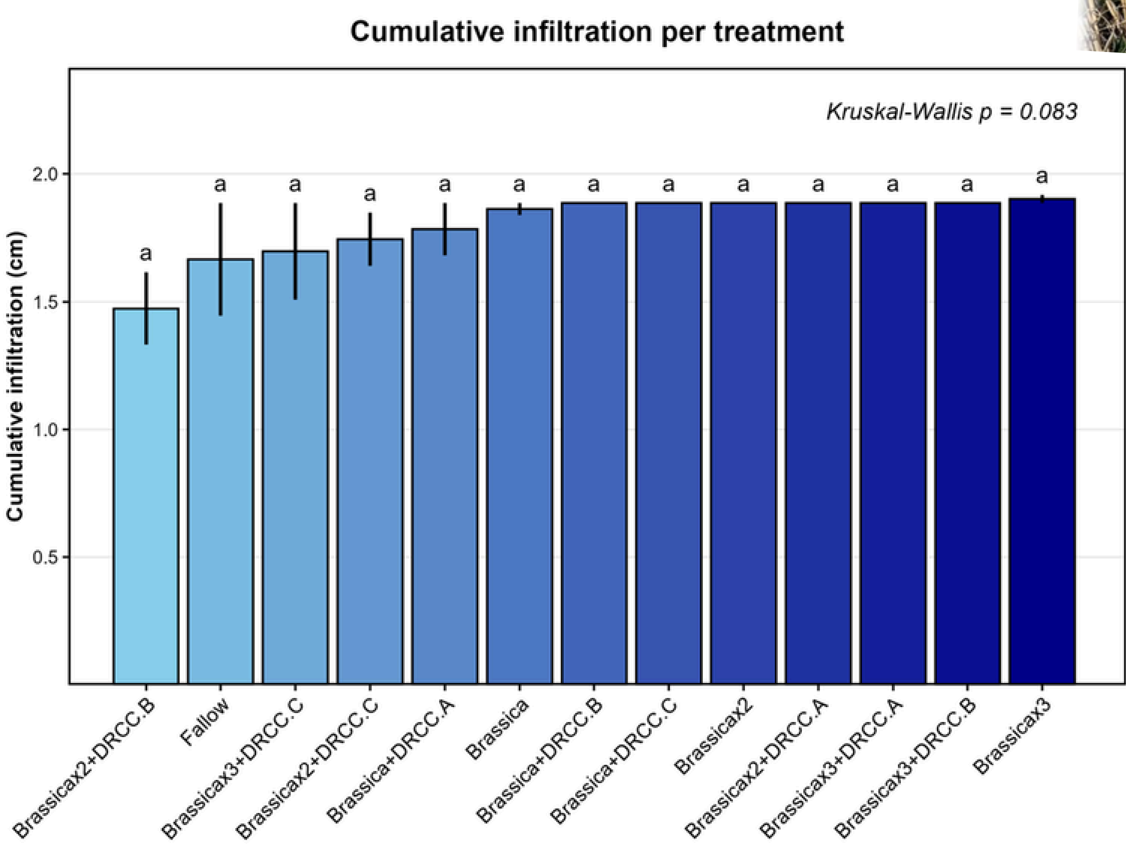
Unsaturated Hydraulic Conductivity

Unsaturated hydraulic conductivity measurements were taken using a mini disk infiltrometer. The mini disk infiltrometer is a glass cylinder with a special permeable base. When set on soil and adjusted properly volume can be read from the cylinder and with a time measurement this gives a rate of volume over time.
The goal with this style of measurement is to measure the time it takes for a specific volume of water to infiltrate unsaturated soil.



Key Points:

No significant difference between the treatments in mini disc water infiltration

The results indicate cumulative water infiltration, as measured by the mini disk infiltrometer. No significant differences were observed between treatments. However, most of the cover crops slightly improved water infiltration compared to the fallow treatment.

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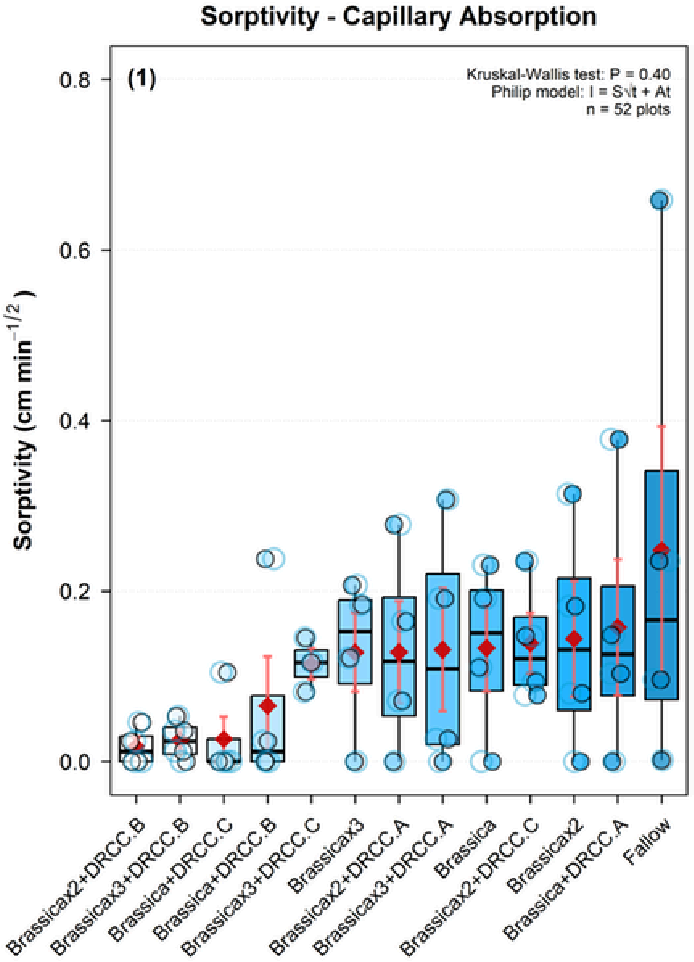
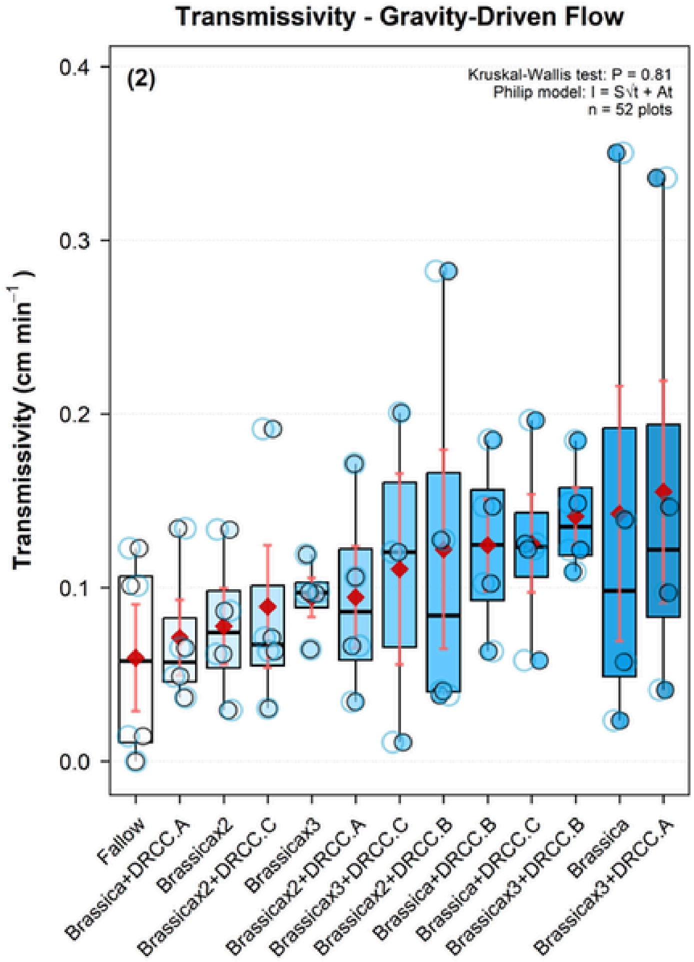
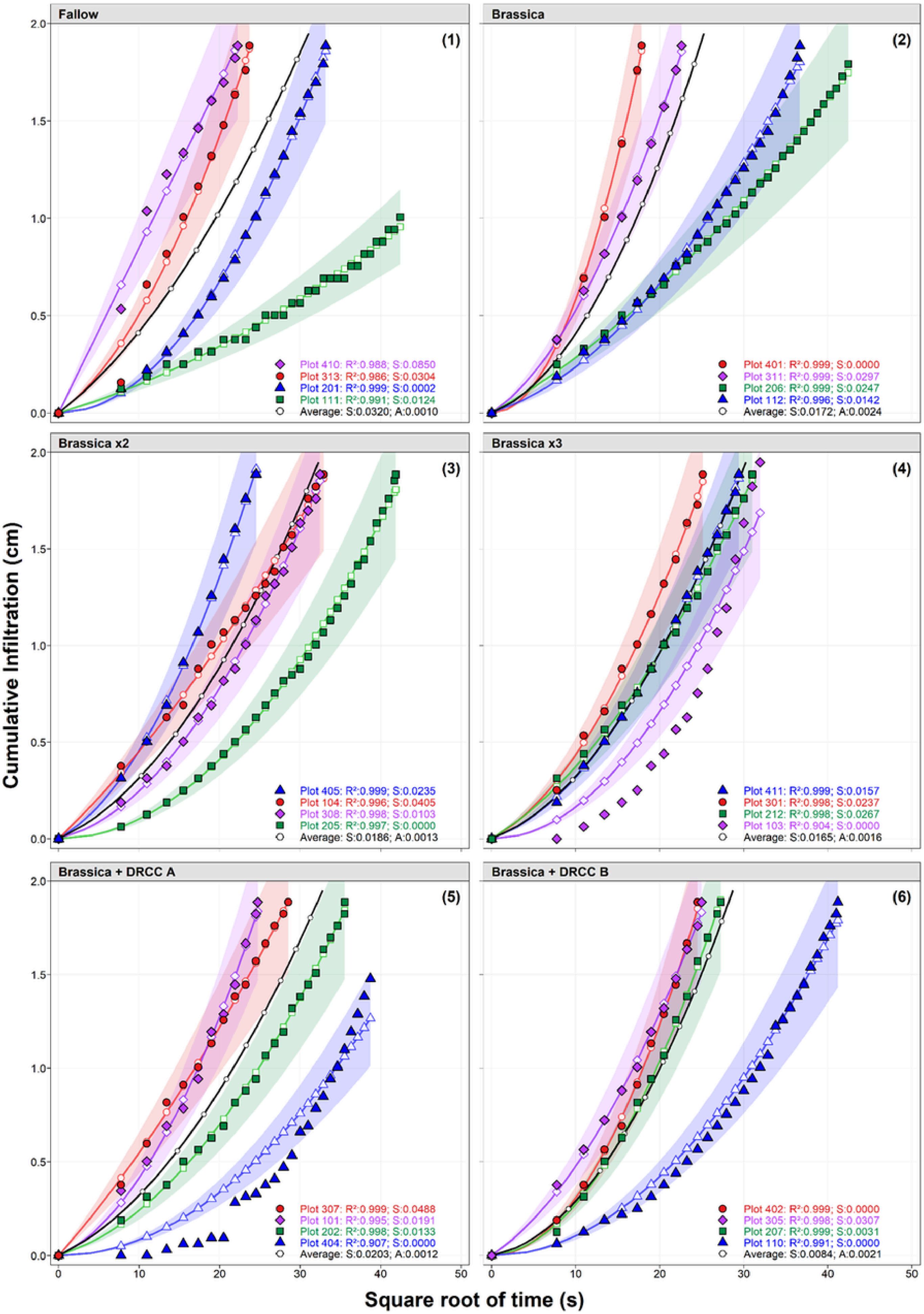


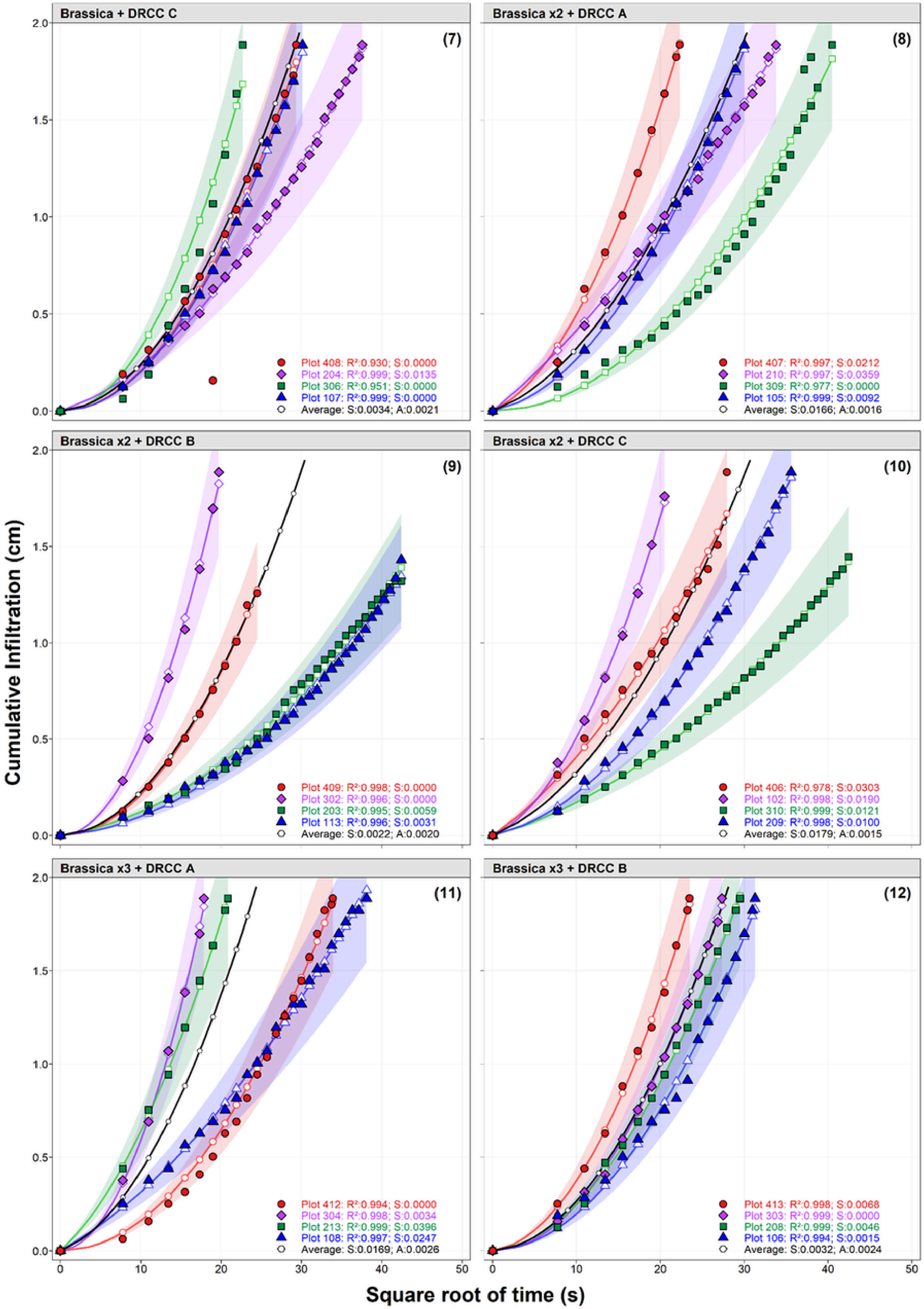


Key Points:

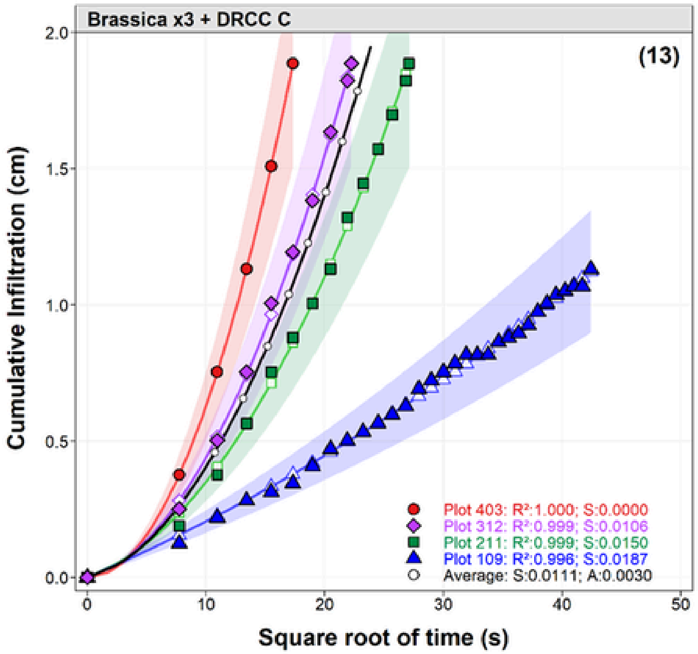
Higher transmissivity by using cover crop treatments than fallow

Cumulative infiltration was modeled using the two-term Philip infiltration equation, $I(t) = S\,t^{1/2}* + At*$, where S represents sorptivity (initial capillary-driven infiltration under dry soil conditions) and A represents transmissivity (gravity-driven infiltration at later times). Parameter estimates for both sorptivity and transmissivity showed considerable overlap among treatments, and no statistically significant differences were detected (Kruskal–Wallis $P = 0.40$ for sorptivity and $P = 0.81$ for transmissivity). These results are consistent with the cumulative water infiltration using minidisc infiltrometer. Despite the lack of statistical significance, a consistent trend emerged when comparing cover crop treatments with the fallow control. The fallow treatment exhibited higher sorptivity, indicating more rapid initial water uptake, but lower transmissivity, suggesting reduced water movement during later stages of infiltration. In contrast, most cover crop treatments tended to exhibit lower initial sorptivity but higher transmissivity relative to the fallow treatment, indicating slower early infiltration followed by enhanced water flow at later times.


Fallow
(1)
Plot 410: R²:0.988; S:0.0850
Plot 313: R²:0.986; S:0.0304
Plot 201: R²:0.999; S:0.0002
Plot 111: R²:0.991; S:0.0124
Average: S:0.0320; A:0.0010
Brassica
(2)
Plot 401: R²:0.999; S:0.0000
Plot 311: R²:0.999; S:0.0297
Plot 206: R²:0.999; S:0.0247
Plot 112: R²:0.996; S:0.0142
Average: S:0.0172; A:0.0024
Brassica x2
(3)
Plot 405: R²:0.999; S:0.0235
Plot 104: R²:0.996; S:0.0405
Plot 308: R²:0.998; S:0.0103
Plot 205: R²:0.997; S:0.0000
Average: S:0.0186; A:0.0013
Brassica x3
(4)
Plot 411: R²:0.999; S:0.0157
Plot 301: R²:0.998; S:0.0237
Plot 212: R²:0.998; S:0.0267
Plot 103: R²:0.904; S:0.0000
Average: S:0.0165; A:0.0016
Brassica + DRCC A
(5)
Plot 307: R²:0.999; S:0.0488
Plot 101: R²:0.995; S:0.0191
Plot 202: R²:0.998; S:0.0133
Plot 404: R²:0.907; S:0.0000
Average: S:0.0203; A:0.0012
Brassica + DRCC B
(6)
Plot 402: R²:0.999; S:0.0000
Plot 305: R²:0.998; S:0.0307
Plot 207: R²:0.999; S:0.0031
Plot 110: R²:0.991; S:0.0000
Average: S:0.0084; A:0.0021
Cumulative Infiltration (cm)
Square root of time (s)



Brassica + DRCC C
(7)
Plot 408: R²:0.930; S:0.0000
Plot 204: R²:0.999; S:0.0135
Plot 306: R²:0.951; S:0.0000
Plot 107: R²:0.999; S:0.0000
Average: S:0.0034; A:0.0021
Brassica x2 + DRCC A
(8)
Plot 407: R²:0.997; S:0.0212
Plot 210: R²:0.997; S:0.0359
Plot 309: R²:0.977; S:0.0000
Plot 105: R²:0.999; S:0.0092
Average: S:0.0166; A:0.0016
Brassica x2 + DRCC B
(9)
Plot 409: R²:0.998; S:0.0000
Plot 302: R²:0.996; S:0.0000
Plot 203: R²:0.995; S:0.0059
Plot 113: R²:0.996; S:0.0031
Average: S:0.0022; A:0.0020
Brassica x2 + DRCC C
(10)
Plot 406: R²:0.978; S:0.0303
Plot 102: R²:0.998; S:0.0190
Plot 310: R²:0.999; S:0.0121
Plot 209: R²:0.998; S:0.0100
Average: S:0.0179; A:0.0015
Brassica x3 + DRCC A
(11)
Plot 412: R²:0.994; S:0.0000
Plot 304: R²:0.998; S:0.0034
Plot 213: R²:0.999; S:0.0396
Plot 108: R²:0.997; S:0.0247
Average: S:0.0169; A:0.0026
Brassica x3 + DRCC B
(12)
Plot 413: R²:0.998; S:0.0068
Plot 303: R²:0.999; S:0.0000
Plot 208: R²:0.999; S:0.0046
Plot 106: R²:0.994; S:0.0015
Average: S:0.0032; A:0.0024
Cumulative Infiltration (cm)
Square root of time (s)



Philip's Infiltration Model fitting for all 13 treatments: Filled shapes represent observed cumulative infiltration, while unfilled shapes represent Philip model-predicted values, both shown as a function of the square root of time for each of the 13 treatments. Plots could not be pooled together due to significant differences among them; therefore, each plot is presented individually for every treatment. The solid black line in each panel represents the average model fit across all plots within that treatment. The treatments include: (1) Fallow; (2) Brassica; (3) Brassica x2; (4) Brassica x2; (5) Brassica + DRCC A; (6) Brassica + DRCC A; (7) Brassica + DRCC B; (8) Brassica + DRCC C; (9) Brassica + DRCC C; (10) Brassica + DRCC C; (11) Brassica + DRCC C; (12) Brassica + DRCC C; (13) Brassica + DRCC C. The Philip model provided an excellent fit across all treatments, with R^2 values consistently near or above 0.99.

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Saturated Hydraulic Conductivity

The double-ring infiltrometer method is a field test used to measure soil water infiltration rate under saturated or near-saturated conditions. It uses two concentric rings (one ring placed inside the other with the same center) driven into the soil. Water is added to both rings, and the drop in water level in the inner ring is recorded over time. The water level in the outer ring of the infiltrometer drops laterally (i.e., sideways), so the inner ring mainly represents vertical infiltration. This method differs from the mini disk infiltrometer, which measures unsaturated infiltration.

Key Points:
Brassica (Daikon radish, forage radish, turnip) and Brassica ×2+ DRCC A (Oat, Japanese millet, sweet clover, chicory, field pea, sunflower) improved saturated hydraulic conductivity more than the other treatments

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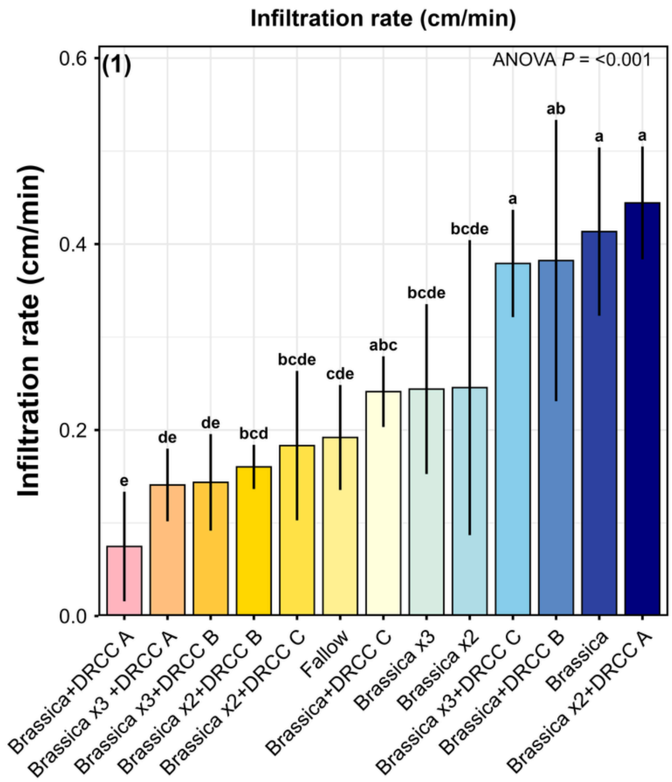
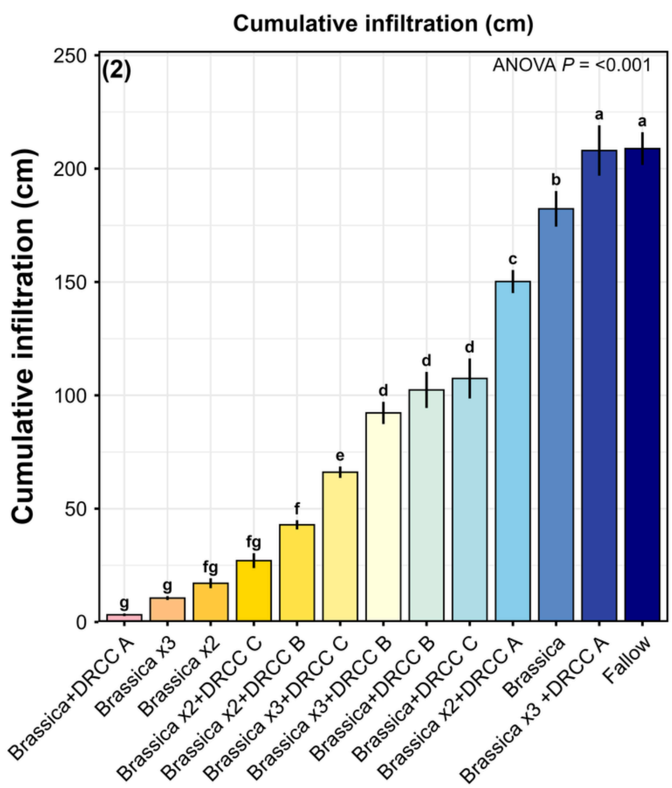
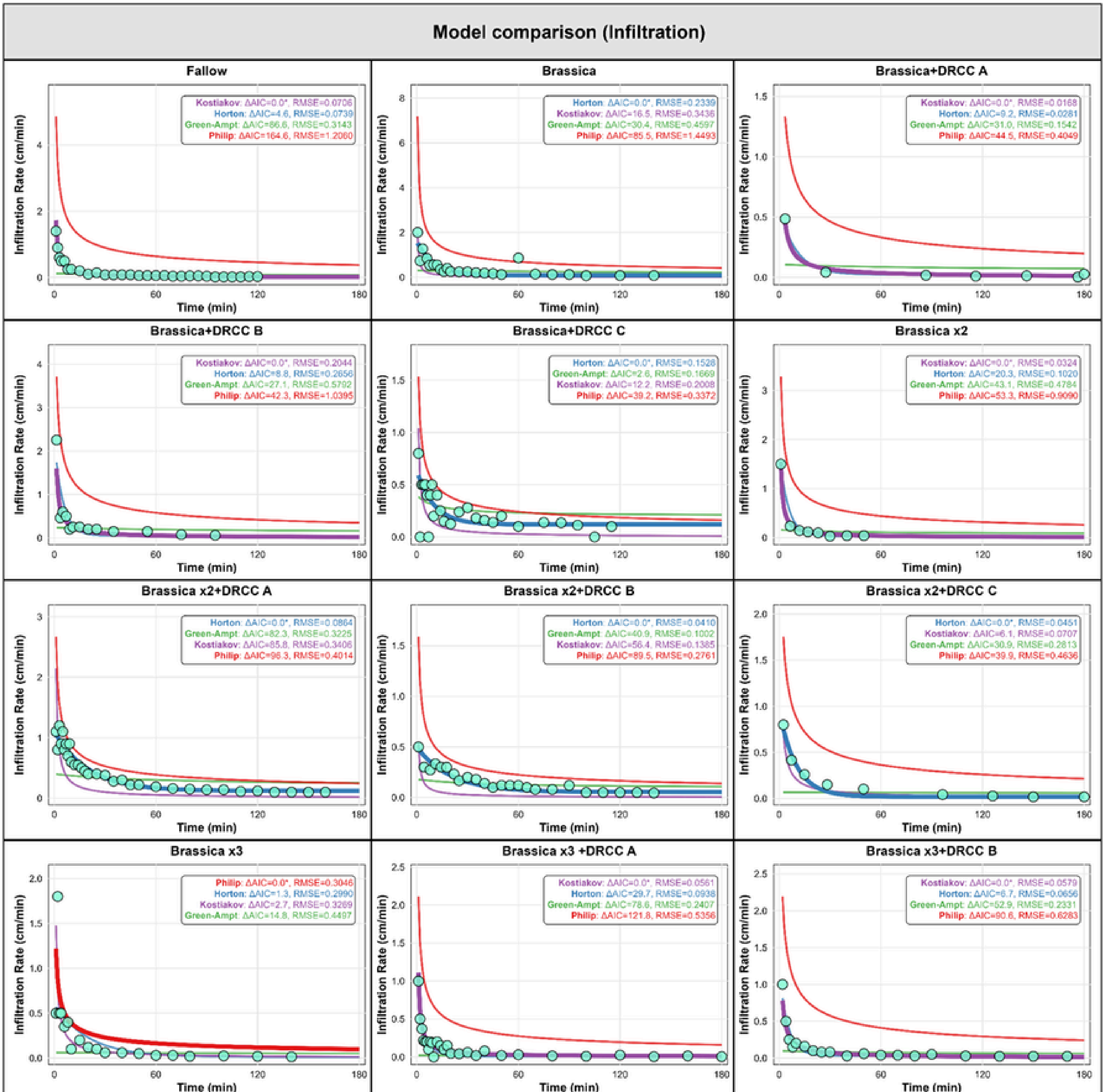
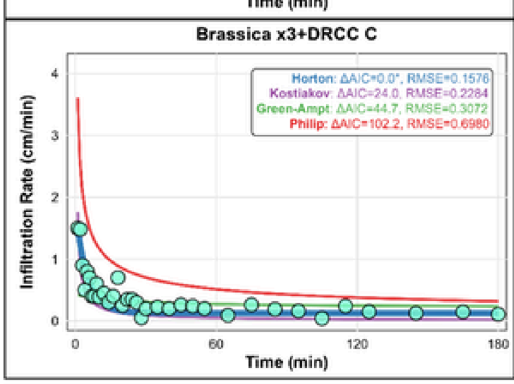
Despite no significant differences in mini disk infiltrometer measurements, significant differences were observed in double-ring infiltration results. In terms of infiltration rate (1), which reflects how rapidly water enters the soil at a given time and is indicative of soil hydraulic conductivity under near-steady conditions, the Brassica, Brassica ×2 + DRCC A, and Brassica ×3 + DRCC C treatments exhibited significantly higher values compared with the other treatments. For cumulative infiltration (2), which represents the total amount of water entering the soil over the duration of the test, the fallow and Brassica ×3 + DRCC A treatments showed significantly higher values than the other treatments. Although cumulative infiltration describes total water intake, infiltration rate provides a more direct indication of soil hydraulic performance as it reflects the soil's capacity to transmit water under steady-state conditions. While the fallow treatment exhibited the highest cumulative infiltration, its infiltration rate was significantly lower than that of several cover crops treatments. This likely reflects rapid filling of transient macropores and surface cracks commonly found in non-vegetated soils, rather than an improvement in soil structure or hydraulic conductivity. Overall, treatments such as Brassica alone and Brassica ×2 + DRCC A, which exhibited both higher infiltration rates and relatively high cumulative infiltration, demonstrated greater estimated saturated hydraulic conductivity compared with the other treatments.

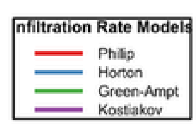


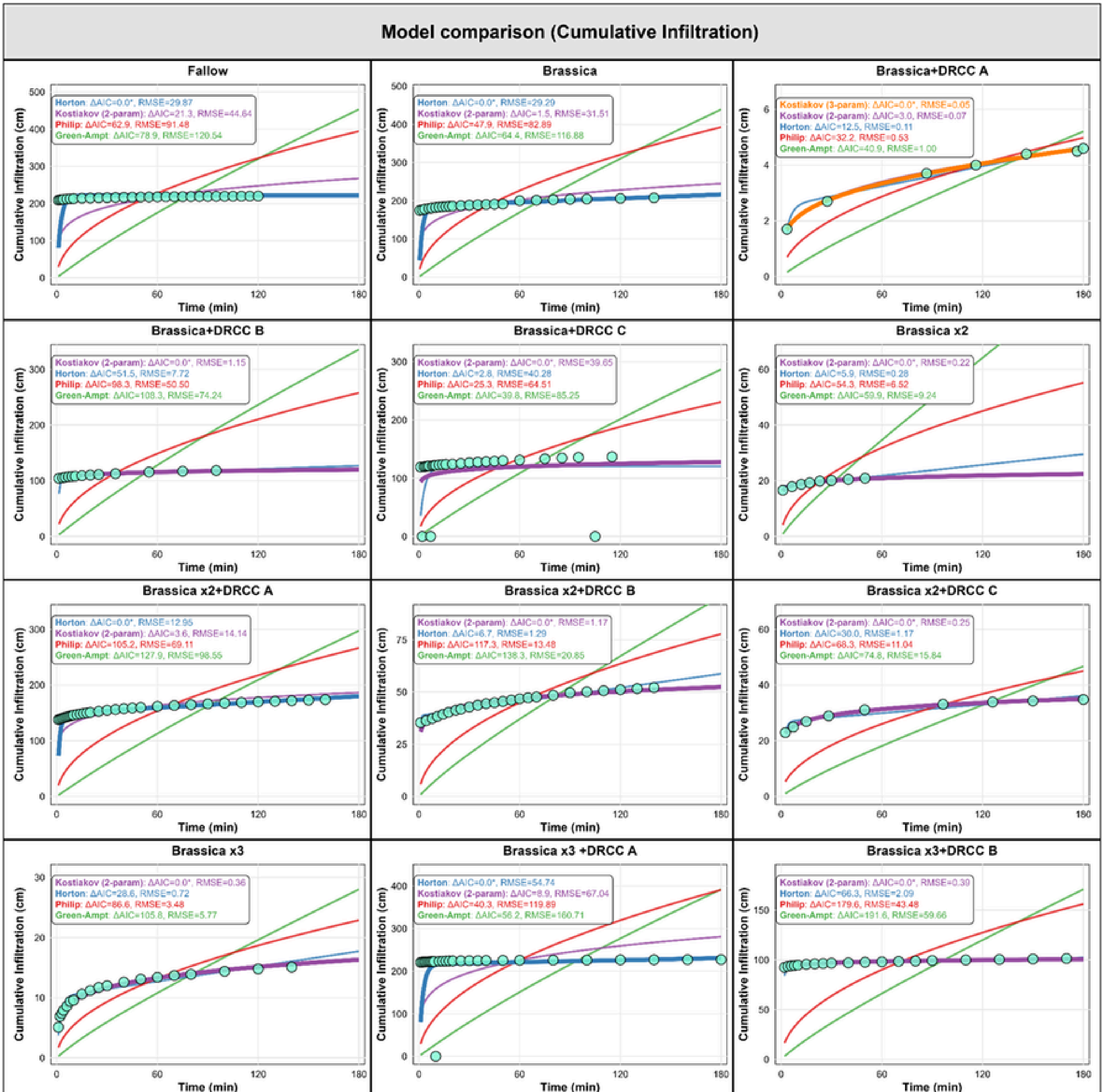


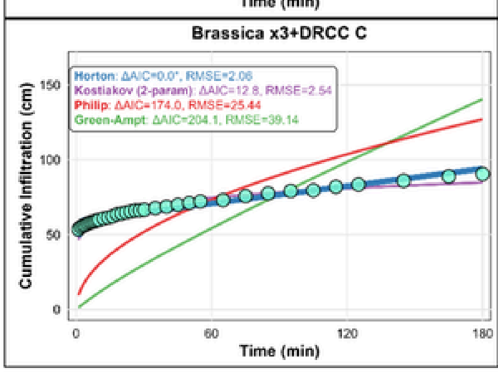




Model comparison for infiltration rate over time across 13 representative treatments. Filled shapes represent observed data and the thicker lines represent the best fitting models. The models compared include Horton, Kostiakov (2- and 3-parameter), Philip, and Green-Ampt.







Model comparison for cumulative infiltration over time across 13 representative treatments. Filled shapes represent observed data and the thicker lines represent the best fitting models. The models compared include Horton, Kostiakov (2- and 3-parameter), Philip, and Green-Ampt.