Dynamic Duo: Using Pea-Canola Intercrops to Bolster Inland Pacific Northwest Soil Health

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Introduction

- Historically, cropping systems in the inland Pacific Northwest (iPNW) have been dominated by winter wheat *(Triticum aestivum* L.*)*-fallow (WW-F) rotations
- Continuous use of WW-F in the iPNW has led to issues such as herbicide resistance, erosion, declining soil organic matter, soil acidification, and lack of microbial diversity
- Previous studies have shown that pea *(Pisum sativum* L.*)*-canola *(Brassica napus* L.*)* ("peaola") intercropping has the potential to fix significant quantities of nitrogen (N) and can improve soil health
- Little is known about producing peaola in the iPNW, the quantity of fixed N resulting from pea-canola intercropping, and the impact of peaola on soil microbial community status

Objective

- To evaluate the effect of varied pea-canola seeding rates and N fertility regimes on:
  - Soil microbial diversity and interactions
  - N derived from the atmosphere (%Ndfa)

Materials and Methods

- **Study duration:** April 2024 – Present
- **Study location:** WSU Wilke Research & Extension Farm, Davenport, WA
- **Study site precipitation:** 11.2 in. from 1 Sept. 2023 to 31 Aug. 2024
- **Soil type:** Broadax silt loam (fine-silty, mixed, superactive, mesic Calcic Argixerolls)
- **Study design:** Randomized complete block design with four replicates (Table 1)

Table 1: Experimental treatments listed numerically by treatment ID, ratio of pea-to-canola seeded, and N fertilizer input as a percent of the recommended total for spring canola

Treatment ID	Seed Ratio[a,b]	N Fertilizer Input[c]
TRT 1	Canola monoculture check	100% N
TRT 2	1/3 pea + 2/3 canola	0% N
TRT 3	1/2 pea + 1/2 canola	0% N
TRT 4	2/3 pea + 1/3 canola	0% N
TRT 5	1/3 pea + 2/3 canola	50% N
TRT 6	1/2 pea + 1/2 canola	50% N
TRT 7	2/3 pea + 1/3 canola	50% N
TRT 8	1/3 pea + 2/3 canola	100% N
TRT 9	1/2 pea + 1/2 canola	100% N
TRT 10	2/3 pea + 1/3 canola	100% N
TRT 11	Pea monoculture check	0% N

[a]*Winter pea cultivar Vail (Pure live seed count: 2,700 seeds/lb.), inoculated with Rhizobia bacteria*
[b]*Spring canola cultivar NCC101S (Pure live seed count: 86,000 seeds/lb.)*
[c]*N fertilizers used were dry starter (16-20-0-14.5) and dry urea (46-0-0)*

- **Soil sampling:** Post-harvest bulk soil samples at 0-4 in. and 4-8 in. depths
- **^{15}N sampling:** Ripened pea and canola biomass, root-zone soil collected prior to harvest
- **Microbial community structure:** Phospholipid fatty acids (PLFA) method[1]
- **%Ndfa analysis:** $\delta^{15}N$ natural abundance solid sample analysis
- **Statistical analysis:** ANOVA using mixed-model in SAS

Study Site

Image 1: *Peaola growth on June 6, 2025 (Photo by Lauren Stubbs)*

Image 2: *Peaola growth on June 14, 2025 (Photo by Lauren Stubbs)*

Results

Table 2: Comparisons of treatment means for microbial classes following PLFA extraction

Microbial Community Composition		
Microbial Class	p-values 0-4 in.	p-values 4-8 in.
Gram Positive Bacteria	0.82	0.52
Gram Negative Bacteria	0.92	0.69
Gram Positive:Gram Negative	0.83	0.41
Eukaryotes	0.81	0.59
Anaerobes	0.97	0.47
Actinomycetes	0.86	0.13
Total Fungi	0.83	0.57
Arbuscular Mycorrhizal Fungi	0.61	0.68
Fungi:Bacteria	0.64	0.95

✓ No significant difference between treatments at the p ≤ 0.05 level for any microbial class at either sampling depth

Table 3: Ratios and descriptions of stress response ratios used to evaluate soil microbial community status

Microbial Community Stress Response Ratios[2,3]		
Name	Ratio	Description
Branch response ratio	(10Me16:0/16:0)	Indicates an increase in microbe cellular fluidity
Gram-negative stress indicator	(cy17:0 + cy19:0)/(16:1ω 7c + 18:1ω 7c)	Indicates poor growing conditions, an increase in microbe cellular fluidity, and greater fatty acid structural diversity
Metabolic response ratio	(cy17:0/16:0)	Indicates bacteria are adapting to limited substrate availability via stationary growth
Stress response ratio	(cy19:0/18:0)	Indicates bacteria are experiencing stress, or are unable to achieve lipid homeostasis

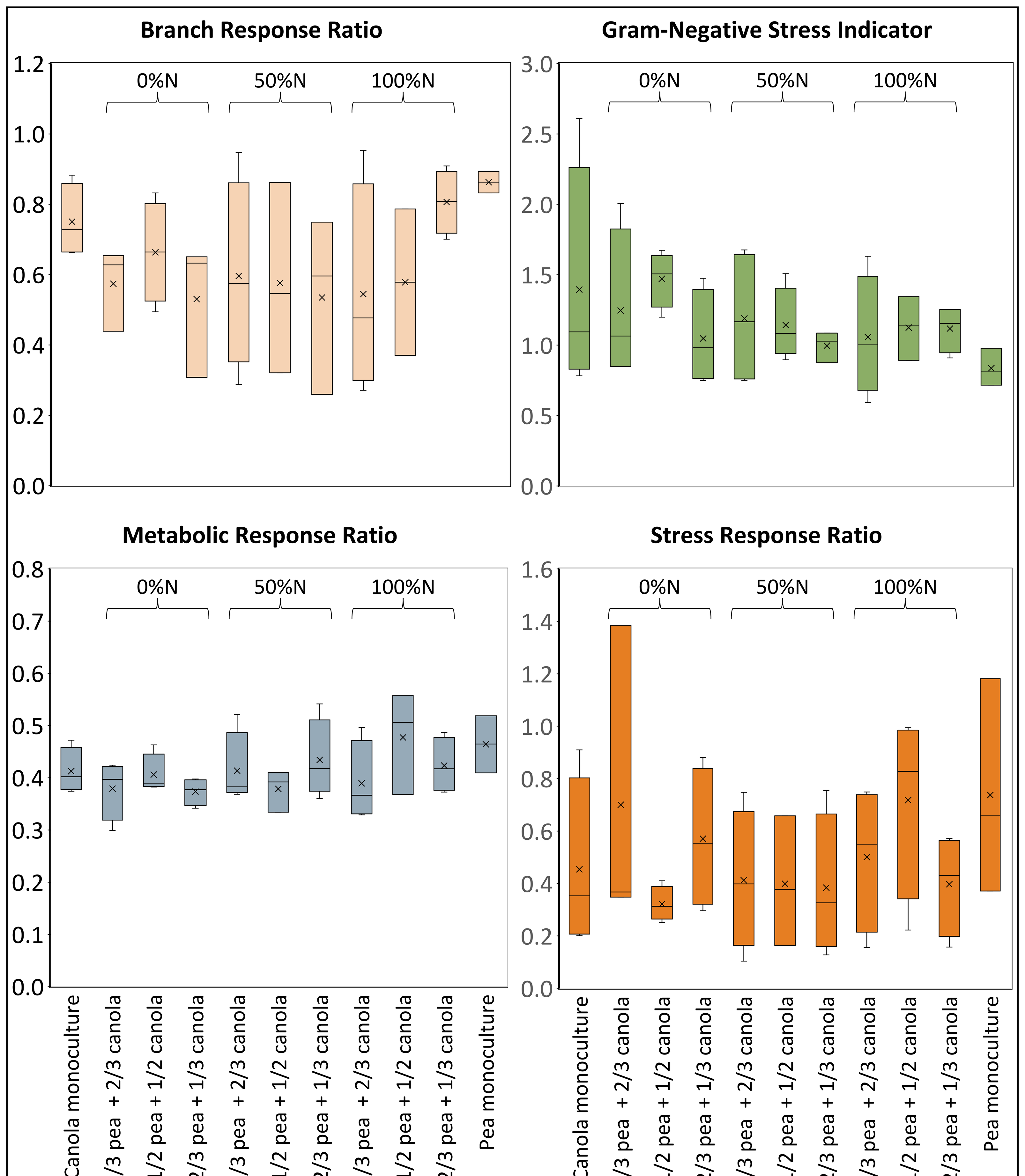

Figure 1: *Stress response ratios of each treatment (Pea + Canola) at 4-8 in. sampling depth*

✓ No significant difference between treatments at the p ≤ 0.05 level for any microbial stress response ratio

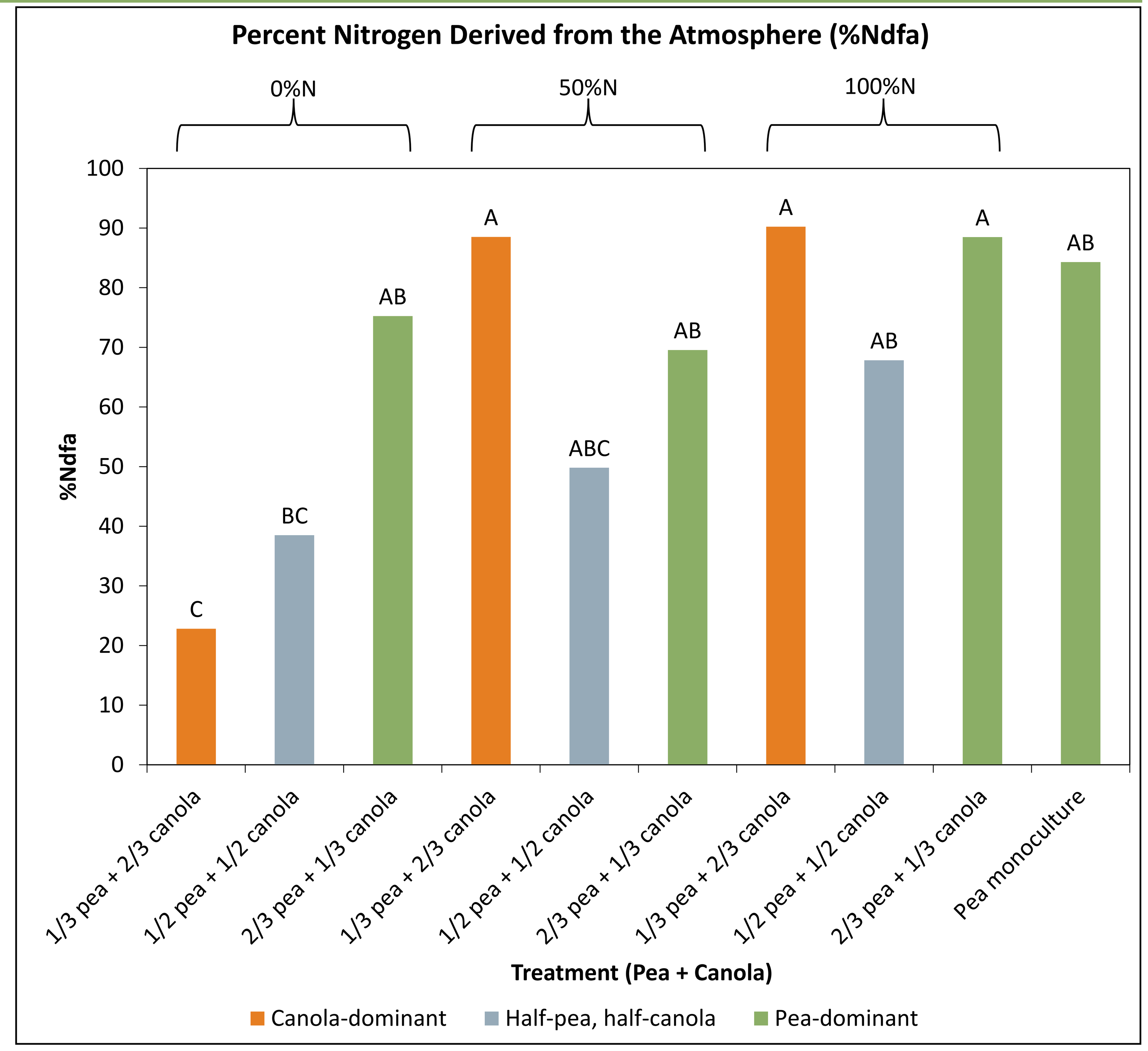

Figure 2: *%Ndfa by treatment. Letters shared between treatments indicate no significant difference between %Ndfa values*

Conclusions

- There was no significant difference between the microbial community compositions of each treatment at either sampling depth (Table 2)
- There was no significant difference between microbial community stress response ratio profiles of the treatments (Figure 1)
- Pea-dominant treatments that received ≥50% N did not fix quantities of N that were significantly different from pea-dominant treatments that received 0% N (Figure 2)
- Pea-dominant peaola mixtures have the potential to improve on-farm sustainability, as they fix significant quantities of N without the addition of N fertilizers (Figure 2)
- Resulting data was collected from the first year of the trial; it is anticipated that more consistent trends will be observed after a second year of investigation

Implications

- Upon completion, this will provide research-based information for diversifying WW-F systems with peaola intercrops in the intermediate precipitation zone of the iPNW
- This research is expected to serve as justification for further investigating sustainably intensified oilseed-based cropping systems in the iPNW's intermediate rainfall zone
- Future investigations might include long-term assessments of peaola crops to measure their impact on soil health indicators, agroecosystem resilience, and wheat crop yields

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