sweep nets to collect all insects and identified them to functional group (pollinator, parasite, predator, herbivore).

At our field trial site, pest herbivores (mostly pea aphids) were significantly higher in Pea only plots ($P < 0.001$, GLMM, Fig. 1). Beneficial insects, including pollinators, parasitoid wasps, and ladybugs, were significantly higher in Peaola trails compared to either peas or canola ($P = 0.0107$, GLMM, Fig 2). Consequently, even though Peaola contained peas and was located at the same site, the intercropping strategy greatly reduced the threat of pea aphids. This was likely driven by the presence of more beneficial insects in peoala, including two primary biocontrol agents for aphids (wasps and ladybugs). In terms of LER (Land Equivalence Ratio) Peaola trials did not have significantly higher yield than monoculture peas or canola ($P = 0.849$, GLMM, Fig 3) Given that Peaola may require fewer pest management inputs (Fig. 1, Fig. 2), this intercropping strategy may be profitable in years or locations where pest outbreaks occur. Further research may be able to demonstrate if canola yield is proportionally higher due to higher pollinator abundance, and if reduced reliance on pesticides for control of dry pea pests (aphids) may be an economic and ecological benefit of Peaola.

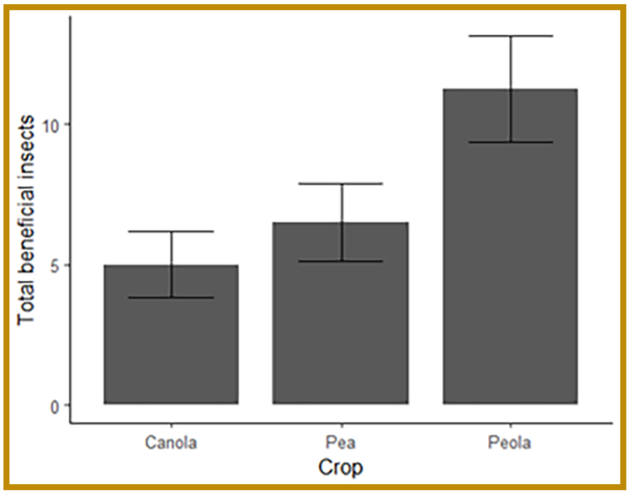

Figure 1. Average counts of beneficial insects (and estimated standard errors) based on 2020 field survey. Bars with error bars that do not overlap are significantly different. Output estimates from negative binomial generalized linear mixed model.

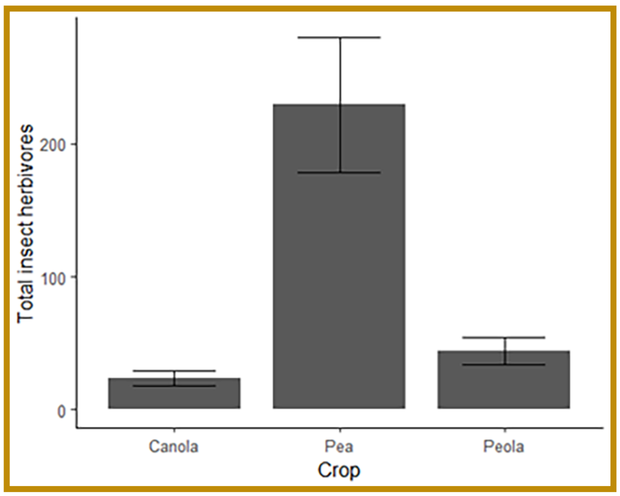

Figure 2. Average counts of insect herbivores (and estimated standard errors) based on 2020 field survey. Bars with error bars that do not overlap are significantly different. Output estimates from negative binomial generalized linear mixed model.

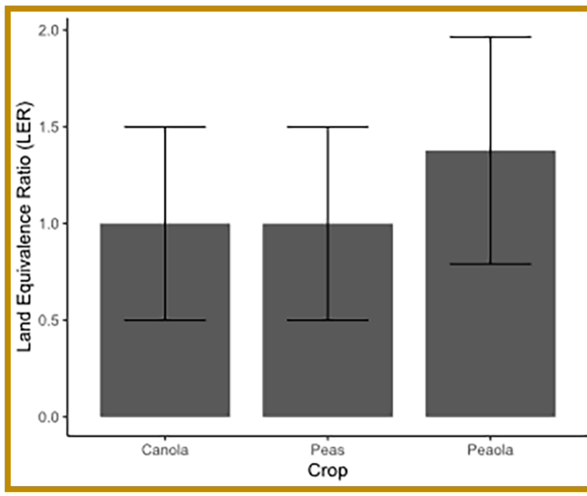

Figure 3. Land Equivalence Ratios (LER) for both canola seed and dry pea seed (and estimated standard errors) based on 2020 field trial. Bars with error bars that do not overlap are significantly different. Output estimates from negative binomial generalized linear mixed model.

Canola Rotation Effects on Soil Microbiology and Subsequent Wheat Yield

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We are investigating the effects of canola, winter triticale, and winter wheat on soil fungal and bacterial communities and the grain yield of subsequent spring wheat. The study was initiated in 2016 on the Ron Jirava farm west of Ritzville. These are 3-year rotations with a year of fallow after the spring wheat. Spring canola is substituted for winter canola when adequate winter canola stands are not achieved. There are 36 plots with each phase of the three, 3-year rotations present each year. Individual plots are 500 feet long and 30 feet wide.

This experiment is now in its 6th year, thus all three rotations are truly "in rotation". We closely monitor soil water dynamics from all phases of all rotations and collect accurate grain yield data. Soil microbial activity is currently being assessed using DNA sequencing of rhizosphere soil (i.e., soil adhering to roots) as well as phospholipid fatty acid analysis (PLFA) of bulk soil. Such data can only be obtained through long-term cropping systems experiments.

During the past five years, significantly less overwinter precipitation has been stored in the soil in canola stubble in three years (Fig. 1). Averaged over the five years, canola stubble has stored significantly less over winter precipitation in the soil than winter triticale or winter wheat stubble. These differences were particularly pronounced during a winter of heavy snow accumulation in 2017. There were no significant differences in water storage among treatments during winters with little snow (such as 2019 and 2021). Average spring wheat grain yields for the first four year after canola, winter triticale, and winter wheat have been 33, 41, and 39 bushels/acre, respectively (Fig. 1).

Every year to date, spring wheat grain yields have been significantly related to soil water content measured in early April (Fig. 2). However, as can be seen from the simple linear regression equations in Figure 2, soil water content is not telling the full story on spring wheat yield. We suspect soil microbial activity may play an important role and we look forward to fully analyzing the soil DNA sequencing and PLFA data during this next year.

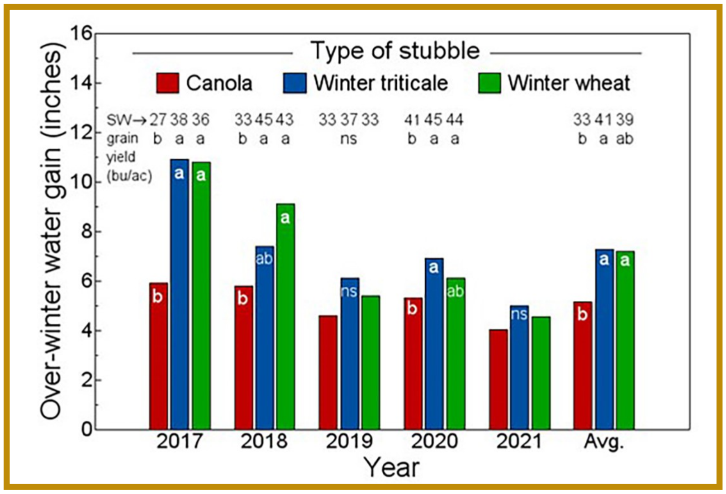

Figure 1. Soil water content in early spring near Ritzville, WA for five years where the previous crop was canola (either winter or spring canola), winter triticale, or winter wheat. Soil water at harvest of these crops was essentially identical every year and stubble remained standing and undisturbed over the winter. Spring wheat grain yield in 2017, 2018, and 2019, and 2020 as well as the 4-year average as affected by the preceding crop is shown above the soil water content bars. Within-year soil water and spring wheat grain yield data followed by a different letter are statistically different at the 5% probability level. ns = no significant differences.

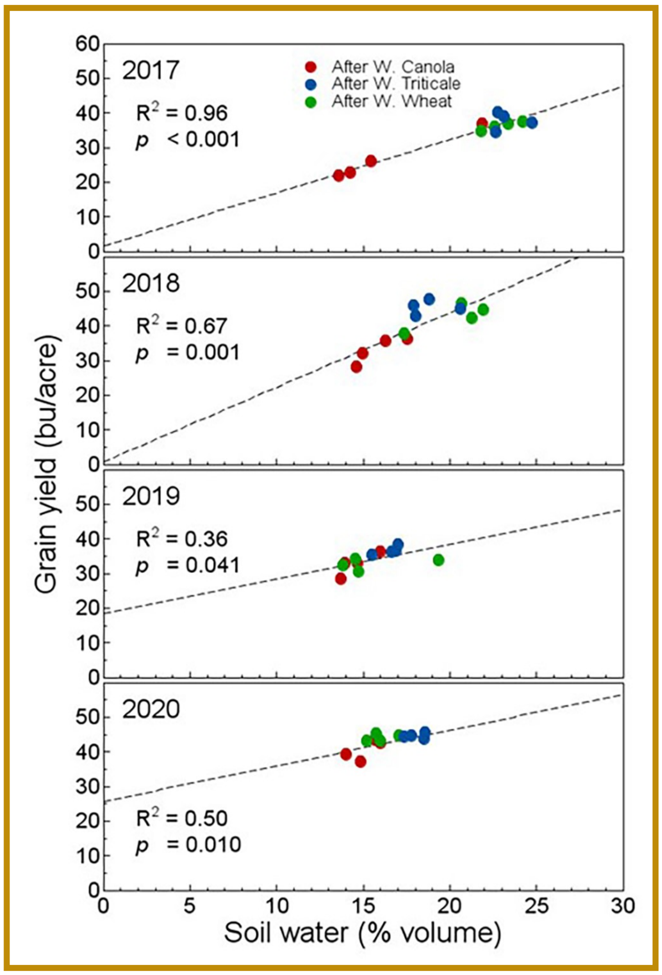

Figure 2. Relationship between soil water content in the 6-foot profile measured at time of planting of spring wheat and the subsequent grain yield of spring wheat where the preceding crop was winter wheat, winter triticale, or canola during four years near Ritzville, WA. Data show that spring wheat grain yield was significantly related to soil water content in early spring, but soil water is only part of the story.