Intercropping Small Grains and Pea for Organic Dryland Cereal Production

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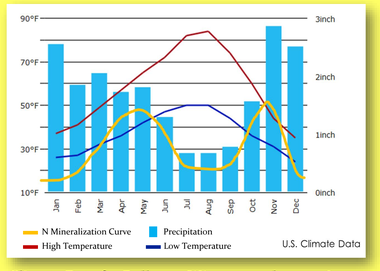
Introduction

- The Inland Pacific Northwest (PNW) has a Mediterranean climate (hot, dry summers)
- These conditions limit nitrogen (N) release via mineralization during summer, which organic systems rely on for N fertility
- As a result, organic wheat often has grain protein levels insufficient for bread making
- External N inputs like manure are often cost-prohibitive
- *Hypothesis*: Intercropping wheat with legume green manures increases grain protein and subsequent yields by increasing available N throughout the season, relative to poultry manure



Climate Data for Pullman, WA, averaged over 1981-2010.

Methods

Table 1. Monocropped and intercropped treatments in years 1 and 2 (treatments were repeated on same plots in year 2). In year 3, a winter wheat catch crop was planted over all treatments.

Treatment	Crop	Years 1, 2	Year 3
1	HR Spring Wheat	Monocropped	Winter Wheat
2	Spring Pea (green manure control)	Monocropped	Winter Wheat
3	Spring Forage Triticale	Monocropped	Winter Wheat
4	Spring Grain Triticale	Monocropped	Winter Wheat
5	HR Spring Wheat + Pea	Intercropped	Winter Wheat
6	Forage Triticale + Pea	Intercropped	Winter Wheat
7	Grain Triticale + Pea	Intercropped	Winter Wheat

* HR = hard red wheat, the type used for bread making

- Monocropped treatments: planted every row
- Intercropped treatments: planted every other row
- Intercropped pea green manure terminated with sweeps
- Monocropped pea green manure (control) mowed

Analysis

- Randomized complete split-block design:
  Whole plot = cropping Split plot = poultry manure
- Compare intercropping to:
  1) no fertility treatment
  2) manure application
  3) pea green manure control

Results Years 1 and 2

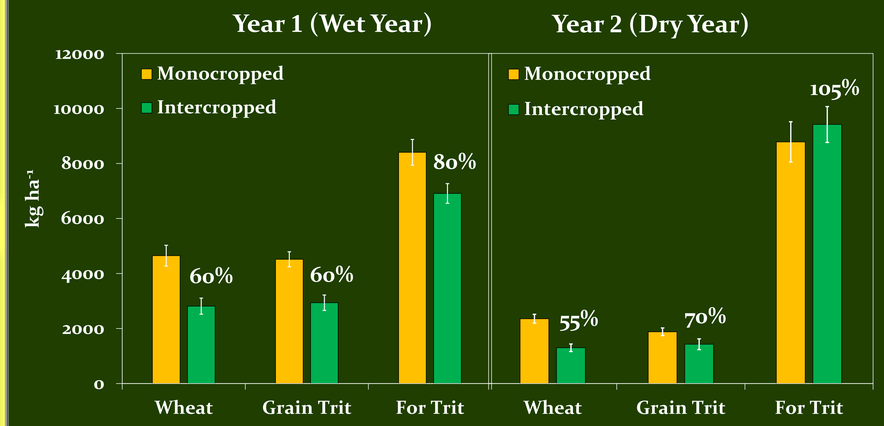


Figure 1. Spring grain (HR Wheat and Grain Triticale) and hay (Forage Triticale) yields. Percentages indicate the proportion of intercrop to monocrop yields.

Table 2. HR spring wheat and grain triticale protein content, and forage triticale crude protein. Asterisks indicate significant differences (α=0.05) between manured and non-manured treatments. P-values are the result of contrasts between mono- and intercropped treatments.

	Monocropped		Intercropped		Mono vs. Inter
	No Manure	Manured	No Manure	Manured	
	% grain protein				
Wheat					
Year 1	10.1%	10.5% *	11.7%	12.0% *	<0.001
Year 2	12.1%	13.5% *	12.8%	13.9% *	0.748
Grain Triticale					
Year 1	11.3%	11.7% *	12.7%	13.5% *	<0.001
Year 2	9.2%	10.3% *	11.3%	12.0% *	0.033
	% crude protein				
Forage Triticale					
Year 1	8.8%	9.3%	9.6%	10.9%	0.003
Year 2	7.7%	8.7%	9.4%	9.5%	0.019

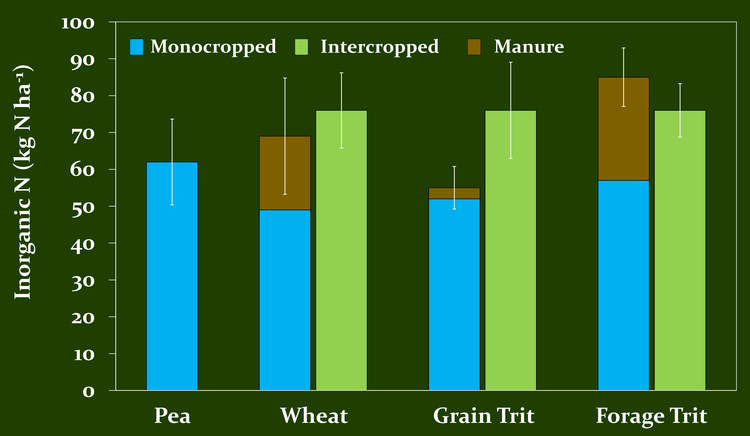


Figure 2. Available N (NH_4^+ and NO_3^-) following Year 2 mono- and inter-crops. The brown bars show the increase in soil inorganic N from poultry manure application, relative to no fertility treatment.

Results Year 3 Winter Wheat

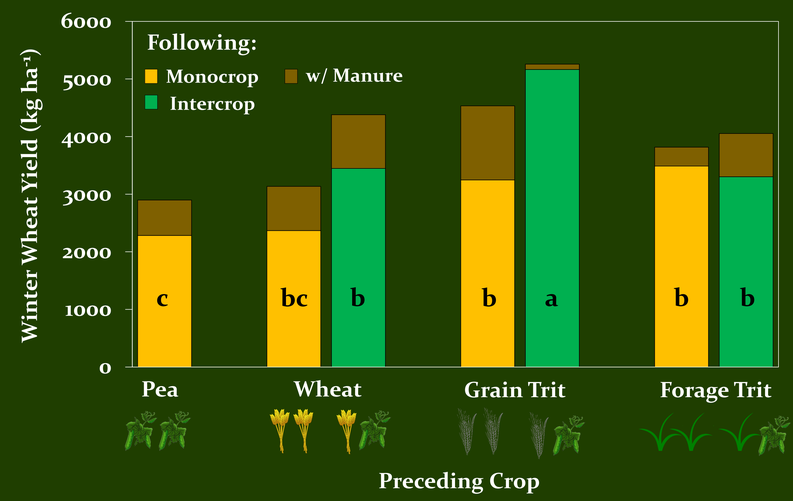


Figure 3. Year 3 winter wheat yields, following mono- and intercrops. Brown bars signify the increase in yield obtained from poultry manure application, compared to non-manured treatments.

Table 3. Increased productivity, from intercropping and poultry manure, averaged over the two study years. Numbers depict increases in yield, grain protein, and hay crude protein (CP) relative to no fertility treatment (monocropped cereals without manure).

Cereal	Fertility Treatment	Grain Protein (YR 1 and 2)	Hay Yield (YR 1 and 2)	Hay CP (YR 1 and 2)	YR 3 Winter Wheat Yield
Wheat	Intercropped	+ 1.7 %	+198 kg ha^{-1}	+ 1.2 %	+ 1035 kg ha^{-1}
	Manure	+ 0.7 %	–	–	+ 760 kg ha^{-1}
Triticale	Intercropped	+ 1.7 %	+ 460 kg ha^{-1}	+ 0.7 %	+ 1185 kg ha^{-1}
	Manure	+ 0.7 %	–	–	+ 615 kg ha^{-1}

Conclusions

- Intercropping cereals with pea green manure resulted in greater yields per unit area planted
- Intercropped hay displayed greater resilience during a dry year than monocropped hay
- Greater winter wheat yields were observed following intercropped treatments than the monocropped pea green manure (control)
- Intercropping had a greater effect on grain protein and subsequent winter wheat yields than poultry manure

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