REGION 3
Central WA irrigated

Title: Double-Cropping Dual Purpose Irrigated Biennial Canola with Green Pea

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Background:

Of the 1.24 million irrigated acres in the inland Pacific Northwest (PNW), about 16% remains in fallow after the main crop has been harvested. Very few acres are dedicated to oilseed crops in the region. In fact, the U.S., including Washington State, meets its canola oil and meal demands through imports from abroad, primarily from Canada (Ash, 2011). Growers are reluctant to convert their land for sole biofuel feedstock canola due to the low yield of canola compared with other crops such as wheat, which is commonly grown in the region. However, when planted as a biodiesel crop, canola can play a significant role in curbing the import of petroleum-based fuel and can contribute to a reduction in CO₂ emissions. The results of recent research conducted in the central PNW have suggested that with deficit irrigation, canola seed yield can reach 3500 lbs/A (Davenport et al., 2011). Canola can reduce the total cost of irrigation water and the amount of labor needed to raise the crop, both of which can then be expended on other crops (Tesoamariam et al., 2010).

A number of factors result in the double-cropping system having strategic agricultural benefits. In this region, there is significant dairy and beef cattle production, with a demand for locally grown animal feed. The sandy soils are susceptible to nitrate leaching and wind erosion if there is inadequate crop cover over the winter and spring periods when traditional summer crops are not grown. Rotational designs are needed to address market and environmental issues (Pullins and Myers, 1998). In addition, a well-designed double-cropping system can result in significant savings from intensive use of the land and fertilizer carryover from previous crops (Wesley, 1999; Heggenstaller et al., 2008).

Green pea can contribute a significant amount of N to the succeeding crop because the fresh residue quickly decomposes to provide the early season N demands of the succeeding crop (Jans-Hammermeistert et al., 1994). This is of particular interest for canola because the N needs during the early growing period are high (Smith et al., 2010). The crop can also generate additional in-season income for growers. The average annual value of green pea between 1995 and 2010 was $21 million in Washington State (USDA/NASS, 2011), suggesting that there is a reasonable market for the crop. A green pea-canola-teff/buckwheat cropping system can provide new opportunities for growers in the region through i) providing additional annual farm income with the production of green pea and canola...
forage, ii) protecting the soil from wind erosion through vulnerable periods (late summer through spring) with crop coverage, iii) producing canola seed in the subsequent year for oil (biofuel or food) and high-protein meal (animal feed), and (iv) preventing the decline of soil health while enhancing soil and water quality.

Objectives:
The overall objective of this project is to develop dual-purpose biennial canola as a viable rotational crop in the irrigated arid Columbia Basin. Specific objectives are:
1. Quantify the seasonal nitrogen recovery of biennial canola
2. Quantify the N contribution from green pea to the succeeding canola crop
3. Assess potential soil and water quality impacts of the double-crop system
4. Assess forage and feed quality of biennial canola
5. Assess the feasibility and estimate the overall profitability of the double-crop dual purpose biennial canola
6. Conduct outreach activities on double crop dual purpose canola to increase awareness of growers and industry

Methods (Previous year and this year of the biennial canola stand):
We began the first cycle (2012/13) of the study in April 2012, at the Paterson USDA-ARS research site located near Paterson, WA, with the planting of peas. The second cycle of the study is currently in progress, and the third will begin with the planting of peas in April 2014. The soil at Paterson is Quincy loamy sand (mixed, mesic Xeric Torripsamments) with 80% sand, 4% clay, and 4 inches of available water storage capacity. Surface (0-12 inch) soil samples from the study area were collected before planting to establish the initial soil chemical properties of the trial site.

The experiment was conducted in a split-plot design with 4 replications. The main plots were biennial canola purposes (dual or single). The dual-purpose biennial canola treatment was cut for forage in fall, allowed to regrow, and harvested for seed the following year. The single-purpose biennial canola was grown only for seed. Subplots were 3 x 3 factorial combinations of N (0, 100, and 200 lb/A) and S (0, 30 and 60 lb/A) fertilizer rates in a randomized complete block design. The main plots were 180 ft wide by 50 ft long, whereas subplots measured 20 ft wide by 50 ft long.

Green pea cultivar *Prevail* was planted at 240 lbs/A seeding rate on April 26, 2012, and harvested on June 30, 2012 for total biomass and fresh pea seed yield from an area of 9 ft². The canola cultivar *Griffin* was planted using a Brillion planter at a seeding rate of 6.8 lbs/A pure live seed following pea residue incorporation and ground work. The strips intended for forage were harvested using a John Deere F935 (John Deere, Moline, IL) at a height of 4 inches above the crown at the rosette (28-29 or 8 to 9 leaf, BBCH scale) stage. Both fresh and dried biomass/forage yields were estimated from a 3 ft x 50 ft area in each subplot. Wet weight of forage was recorded on-site and subsamples were withdrawn for determination of moisture content and feed quality. Total biennial canola forage N content, crude protein, acid detergent fiber (ADF), and total digestible nutrients (TDN) were determined using NIRScout™ 5000/6500 Feed and Forage Analyzer (Eden Prairie, MN).
Biennial canola was allowed to grow and remain *in situ* over the winter. After the winter, live plants were counted from a 9 ft² area from all plots to document the winter survival of the biennial canola crop. Additionally, we used a 1–9 scale to estimate winter hardiness of the dual- and single-purpose plots. On June 29, 2013, the biennial canola was harvested with a Hagie combine (Hagie Manufacturing Company, Clarion, IA) from a 5 ft wide by 50 ft long area. Seed yield of biennial canola was determined, and sub-samples were collected for oil content analysis.

Post-harvest soil samples were collected from each subplot to a depth of 36 inches using Kauffman’s hydraulic soil sampler (Albany, OR). Samples were then sectioned into depth increments of 12 inches. Soil NH₄-N and NO₃-N were extracted and quantified at Brookside Lab Inc. (New Bremen, OH) using established methods.

To document nitrate leaching, we installed lysimeters in three replicates using ceramic end vacuum suction lysimeters to 4 ft depth following biennial canola planting in selected plots. We were unable, however, to capture soil water. We adjusted the depth to 2 ft after the winter, although we captured water samples only from a few plots.

All collected data were subjected to statistical analysis using the MIXED procedure in SAS 9.3 (SAS Institute, Cary, NC). Additionally, orthogonal polynomial contrasts were used to assess trend in biennial canola yields and forage quality parameters in response to increases in N and S fertilizer rates.

**Preliminary Results**

**Yields**

The first cycle of this double cropped biennial canola cropping sequence was completed in July 2013, and the second cycle is currently underway. Average green pea (shelled) yield was 5.6 ton/A in 2012 and 3.1 ton/A in 2013 (Fig. 1), uniform across replicates. Pea stand was poor in 2013. Average biennial canola seedling population was 7.3 ft⁻² ± 0.8 ft⁻² and 5.5 m⁻² ± 1.1 ft⁻² in 2012 and 2013, respectively. This represents a 24.7% smaller population in 2013 compared with the 2012 biennial canola emergence season. The seedling distribution was not statistically different (p> 0.05) for N, S, and N*S interactions.

![Figure 1. Green Pea yield (ton/Ha) averaged over 36 plots at Paterson, WA in 2012 and 2013.](image)
Sixteen-percent moisture adjusted biennial canola dry matter yield from growth stage 28–29 was 1949 and 1147 lb/A in 2012 and 2013, respectively. Poor establishment reduced the forage yield in 2013. In 2012, there were no significant differences in forage yield between plots that received N and the check (Fig. 2a). No trend was observed for forage yield with an increase in N rates. The lack of difference to applied N or S compared to the check indicated that N mineralized from pea residue was presumably adequate for vegetative growth at least until the forage harvest date. Unlike 2012, in 2013, biennial canola forage yield increased with an increase in N rate (Fig. 2a). This is not surprising, considering the poor pea stand we had before the biennial canola crop. The inorganic N in the soil prior to pea planting was approximately 2 lb/A in the first 6 inches of the soil, much lower than what was documented before biennial canola planting (22 lb/A). In both years, no response to S fertilizer was observed for biennial canola forage (Fig 2b). In 2012/13, biennial canola seed yield was 2245 and 2392 lb/A for the dual- and single-purpose biennial canola, respectively (Fig. 3). Yield was not significantly different, suggesting the removal of biennial canola forage in the fall for hay might not reduce the seed yield. Both N (Fig. 4) and S had no significant effect on biennial canola seed yield at p<0.05 (data not shown). This could be due to the same reason indicated above for forage yield; i.e., N contribution from pea possibly reduced the yield penalty in the check plot and did not dramatically change due to high rates of N. When completed, the analysis of the 15N enriched pea residue and 15N labelled urea fertilizer may help to explain if, indeed, pea residue contributed significant N to ensuing biennial canola. Detailed N balance analysis is underway.

Winter damage
In 2012, we did not find significant winter damage between the dual- and single-purpose biennial canola systems (data not shown). Winter survival tended to be high, due to good fall plant regrowth in the case of the dual-purpose system. Additionally, no extreme temperatures were recorded during the winter of 2012/13.

**Return**

In 2012/13, the green pea dual-purpose biennial canola system may give growers up to $800/A in marginal profit. This suggests that the crop has enormous potential to fit into the existing cropping system, with benefits to growers and the agroindustry.

**Potential Impact/Potential Outcomes:**

1. **Increase the N contribution of green pea to succeeding biennial canola by the end of the project.** The goal is to reduce N fertilizer cost by using green pea and organic amendments. Reduce N fertilizer applied by 50 lb/A from the recommended rate of 200 lb N/A applied to a biennial canola crop to 150 lb/A. With current average price of $0.61/lb of actual N, the saving is $30.50/A. This translates to $3.05 million per cropping cycle saving in nitrogen fertilizer if 100,000 acres are dedicated to double-cropped dual-purpose biennial canola. This assumes no added cost of using “better” N management practices than the conventional methods.

2. **Increase income by adding green pea into biennial canola based double-crop system.** It is expected that green pea harvest adds about 5 ton/A of green pea yield. This translates to $65/A net profit after all costs are subtracted ($100/ton revenue and $87/ton total cost). Assuming an area of 100,000 acres conversion to the dual-purpose biennial canola system, the net profit is $6.5 million.

3. **Increase income by adding biennial canola as forage/hay under double-crop.** It is expected that the project will add additional revenue to adopting farmers. For a producer, harvesting biennial canola hay adds $60/A gross margin after accounting variable costs. Assuming an area of 100,000 acres, conversion to the dual-purpose biennial canola system will result in $6.0 million in gross margin to farmers. The biennial canola hay/silage can be blended with animal ration to improve quality and add value to the ration. Canola hay/silage has high protein level.

4. **Assess the effect of the cropping systems on water quality.** The system will also reduce leaching of nitrogen and improve soil health thereby enhancing the sustainability and productivity of agricultural land. It is expected to reduce nitrate leaching by 60% compared with a conventional system.

**Presentations and Publications:**


**Proposed Future Research/Extension for 2014/2015:**

We will continue to conduct biennial canola forage quality analysis, monitor current biennial canola plots, start N recovery and balance analysis, and collect water from lysimeters to track NO₃ from a depth of 2-4 ft. In March, we will assess winter damage in the dual- and single-purpose biennial canola stand.

We will continue data collection throughout the biennial canola growing season. Simultaneously, we are also documenting seasonal N accumulation by biennial canola. A new set of study will be initiated by planting biennial canola in spring 2014. Different from the previous year, a fallow component will be included to generate baseline information to compare the green pea contribution to subsequent biennial canola. The number of replications will be reduced to three to better manage the study. We will begin developing manuscripts for extension and referred journal publications.

**References:**


**Tables/Graphs:**

![Double cropped dual-purpose biennial canola study locations 2012-2015](image)

Locations of biennial canola experiments at Paterson USDA/ARS Research Farm.
Biennial canola forage cutting at growth stage 19 (nine leaves unfolded, BBCH system), 49 days after planting on Oct 10, 2012 at Paterson, WA.

Romulus Okwany (PhD) collecting water samples from lysimeters on April 8, 2013, Paterson, WA.

Jason Mieirs harvesting biennial canola using Hagie combine on July 2, 2013, Paterson, WA.