IS DUAL-PURPOSE CANOLA FEASIBLE IN THE PNW?

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Abstract: We conducted field and laboratory studies in the PNW of both winter and spring canola for dual-purpose production, e.g., forage followed by seed / grain. Not widely discussed, but both canola types have tremendous axillary meristem activity, which allows these crops to regenerate if grazed or harvested for silage / greenchop. Over six field seasons, we have never lost a canola stand, but winter canola stands have thinned over winter but not due to dual-purpose use vs single-purpose (grain only) use. Dual-purpose winter canola requires 12 months to complete: planting in August, silage harvest in October and grain harvest in July. Whereas dual-purpose spring canola requires six months: planting in April, silage harvest in June and grain harvest in September. At silage harvest, both crop types are low dry in matter (DM) but excellent silage has been produced from monoculture stands, mixed with alfalfa cubes at time of ensiling or grown in mixed stands with spring barley or triticale. Dual-purpose forage harvests rarely reduce final grain production yields compared to single purpose management. In the irrigated regions of the PNW, successes should be expected with both winter and spring canola types when managed as forage plus grain. The major impediment is lack of diversity from removal of livestock on farm so grazing or need for silage is limited while livestock producers have specialized with fewer acres dedicated to annual crop production. The demand for valuable canola oil for human food has constantly been increasing while supplies are variable.

Introduction: Originally derived from rapeseed (*Brassica napus*), which is widely used for oil, e.g., rapeseed oil and bio-diesel, canola was developed in the 1960's by Canadian plant breeders to be low in both erucic acid (which damages muscles in animals) and glucosinolates (which reduces nutritional value for animals). Canola was discovered to possess active axillary stem meristems, which promote branching after defoliation by grazing or mechanical silage harvesting. This positive canola attribute, when managed correctly, contributes to branched regrowth for successful dual-purpose production. Dual-purpose use of crops has been used with winter wheat in AR, KS, OK and TX for decades, e.g., wheat pasture in fall and winter followed by wheat harvest in May-June (Beck and Jennings, 2015). Spring canola is mainly grown in Australia, Canada, and northern Europe. Winter canola is grown in southern Europe, southern regions of the U.S. and the PNW. It is assumed that where winter wheat grows, winter canola will survive, but risks are much greater for canola than wheat to survive winters in the northern regions. Neely et al. (2015) conducted a multi-year, dryland, dual-purpose, multi-seeding date winter canola study in the PNW. They found May planting yielded more silage than June or July planting dates. They found high quality silage and no grain yield losses through dual-purpose management. In the PNW, both spring and winter canola may offer an opportunity for dual rather than single purpose production.

Materials and Methods: Three winter and spring canola studies are reported here for dual-purpose management at WSU Prosser. Roundup Ready winter canola field plots were established in August 2014 and 2015 at the Prosser station. This graduate student project compared nitrogen and sulfur rates when managed as dual-purpose or single purpose. Plots were harvested for yield, at the eighth to tenth leaf stage, with selected treatments ensiled in October either with or without alfalfa cubes to absorb excess crop moisture. Silos were

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opened about 45 days after ensiling. Mature canola was harvested for grain each July. Winter canola was 2015 and 2016 both on-station and off-station on plot land that was previously fallow or planted to spring peas. Peas were harvested for forage yield and pods each July. Peas and canola plots were irrigated using solid set at both locations. Half of the plots were harvested for forage, at the eighth to tenth leaf stage, each October (dual-purpose) and half were not (single purpose). Mature canola was harvested for grain the following July. Roundup Ready spring canola was planted in early April 2017-2019 as monoculture stands or mixed with early or late maturing barley or triticale. All treatments were harvested when spring canola was in late flowering, early pod set and cereals were in boot stage of growth (Canola Encyclopedia). Selected treatments were ensiled the day following forage harvest. Monoculture and mixed canola-cereal canola's were allowed to regrow from the axillary meristems and were harvested for grain in late September / early October. Because spring canola continued growing after several mild frosts, all treatments were sprayed with Gramoxone® one week before grain harvest. Grain samples were weighed, dried in forced air ovens, weighed again followed by seed cleaning to remove all trash left from combining.

Results and Recommendations: Figures 1 and 2 show axillary meristem (branching) regrowth in spring and winter canola, respectively. Figure 2 was taken shortly after October silage harvest and axillary meristems continue to regrow and soon cover the soil with leaf vegetation.

Figure 1

Figure 2

Figure 1 shows the flail knife cut edge on spring canola stems. We discovered that a four-inch stubble height was insufficient to promote abundant axillary meristem resulting in lower first year grain yields than when a six-inch stubble remained. Winter canola, Figure 2, has abundant axillary meristem activity during vegetative growth and after silage harvest in October. We learned to leave a five or six-inch stubble was adequate for winter canola regrowth and winter survival.

Growers are always concerned that removal of forage for dual-purpose will harm stands. We found dual-purpose stand counts of 36.2 and single purpose stands of 36. 4 plants / m^2, respectively. Winter canola plant counts in fall averaged 51.2, but in spring stands thinned to 20.4 plants / m^2, respectively. PNW winters can be harsh and influence winter canola stands, but luckily with the axillary meristem activity shown in Figure 2, they can branch and

recover producing excellent grain yields. Interestingly, growing peas before winter canola planting resulted in reduced stands compared to fallow, even though the pea trash appeared to be worked into the soil. This suggests soil surface trash may reduce winter canola stands even before winter impacts stands. Peas increased soil nitrate from 6.1 ppm before peas to 26.0 ppm after peas were planted. Most of the soil nitrate was deposited in the top two feet of soil from the peas. Winter canola forage yield following peas or fallow averaged 7.3 and 9.2% dry matter (DM) in 2015 and 2016, respectively. This low DM can cause ensiling issues and animal heath problems if fed as a sole source forage. Forage yields averaged 1440 and 2780 kg/ha in 2015 and 2016, respectively. Subsequent winter canola grain yields were for single purpose and dual-purpose for 2016 and 2017 were 2048, 1976, 1521 and 1557 kg/ha, respectively. No differences in canola grain yields were found between single or dual-purpose uses within a year, but differences between years were found with lower yields in 2017.

A graduate student led project compared different rates of nitrogen and sulfur over two years for dual-purpose winter canola where selected treatments were ensiled. He found forage crop DM at harvest differed by rate of N and year, averaging 11.6 and 10.1; and 19.7 and 15.2 % DM at application of 100- and 200-pounds N for 2014 and 2015, respectively. These results first indicated the low DM concentration of October winter canola fresh forage with the question if we could reduce silage effluent by mixing with alfalfa cubes. His control treatment averaged about 140 L/Mg, which was reduced to 7 L/Mg when mixed with cubes to achieve 35% DM. Silage pH for control averaged 4.3, and with cubes averaged 4.6. Lactic acid was high for both silages, indicating excellent fermentation. Thus, mixing alfalfa cubes at the time of ensiling winter canola forage reduce environmental pollution while yielding excellent quality forage for ruminant rations. Our student found averaged forage DM yield in October of about 2.1 and 2.2 Mg/ha DM for 2014 and 2015, respectively. Summer harvested canola grain yield was not different between single and dual-purpose management within years. The only difference found in grain yield was lower yields for single purpose between years, but no difference in grain production for dual-purpose between the two years. These results suggest irrigated winter canola in the PNW can be successfully used as a dual-purpose crop, satisfying the need for fall / winter forage through grazing or ensiling, without reducing summer grain production.

The question emerged if it were possible to manage spring canola for dual-purpose within five to six months vs winter canola dual-purpose over 12 months? Knowing the tremendous axillary meristem activity of winter canola and the problem of very low crop DM at forage harvest, we designed a study to investigate mixing spring barley and triticale with spring canola compared to monoculture spring canola. Over three years, spring canola and cereals were planted in early to mid-April, harvested for forage with selected treatments ensiled then allowing canola to regrow, yielding a grain crop in the fall. The first year, 2017, of this study we harvested all crops with four-inch stubble remaining. Immediately we found spring canola is more sensitive to cutting height than is winter canola. Figure 1 shows new axillary meristem development on spring canola stems after a six-inch stubble height, which was implemented in 2018 and 2019. Forage crop DM % averaged about 27.1, 19.2 and 21.2 for 2017, 2018 and 2019, respectively. Over years, monoculture spring canola DM averaged about 20.4%, lower than most mixed canola-cereal treatments and monoculture cereals.

Thus, mixing with alfalfa cubes, similar to winter canola forage, will be necessary to avoid effluent losses and environmental pollution. Averaged over treatments, monoculture spring canola and mixed canola forage yields differed by year with highest yields in 2017 (lower stubble height) about 9900, in 2018 about 5700 and 2019 about 5540 kg/ha DM. Raising the cutter bar reduced forage yields, but increase subsequent fall harvested grain. Regrowth monoculture canola grain yielded about 533 kg/ha over three years, lower than most mixed canola-cereal treatments, but often not lower than monoculture cereals which were tilled and replanted with the same spring canola after the June forage harvest and allowed to grow until fall for grain yield. One note regarding spring canola, early light fall freezing temperatures will not kill the plant or stop it from growing. A 'chemical fallow' may be required.

Recommendations: The following are brief summary thoughts and recommendations when growing irrigated spring or winter canola for dual-purpose management in the PNW.

- It is possible to grow both canola types for grain if the crop has been previously harvested as forage. Fall harvesting winter canola through grazing or ensiling, but silage should be mixed with alfalfa cubes or other high DM crops to avoid effluent losses and environmental pollution.
- Stubble heights with harvest management are key to promote rapid regrowth from axillary meristems on canola stems. Suggest not cutting or grazing below six-inch stubble.
- Both spring and winter canola forage produce very high quality and may need to be mixed with lower quality forage to avoid feeding out issues. Concerns with higher sulfur fertilization could produce forage high sulfur concentrations that could be harmful to livestock.
- Canola grain yields are often year dependent for both types. Grain crop DM at harvest is usually higher for summer harvested winter canola than fall harvested spring canola. It maybe necessary to dry spring canola seed from fall harvesting.
- Plant both types in clean fields as small amount of crop litter on soil surface may reduce canola stands. Winter canola stands will thin over winter, often half the stand will be lost, but the abundant axillary meristems will branch and regrow a thick canola stand for grain production.
- Minimum fertilization is needed for either crop. About 100 pounds of N/A is needed with adequate P, K and S. Canola does not respond to high amounts of nitrogen fertilizer.

Resources:

Beck, P. and J. Jennings. 2015. Fall and winter grazing of wheat. University of Arkansas Wheat Production Handbook. Chapter 12, 4 pgs.

Canola Encyclopedia. https://www.canolacouncil.org/canola-encyclopedia/growth-stages/

Walker, E. V. 2017. Dual-purpose biennial canola (Brassica napus L.); forage, silage, and grain production in the Pacific Northwest. M.S. Department of Animal Science, Washington State University, Pullman, WA.