block with four replications. Individual plots are 30 ft wide x 250 ft long. All phases of both crop rotations are present every year (total of 20 plots). Camelina is broadcast directly into winter wheat stubble in October with an air drill and lightly pressed into the soil with an attached coil packer (Fig. 1). Of critical concern is whether we can maintain adequate surface residue during fallow after camelina to protect the soil from wind erosion. Therefore, the undercutter conservation tillage method for non-inversion primary spring tillage plus aqua nitrogen fertilizer delivery is used to optimize surface residue retention. Measurements include soil water use, weed ecology, surface residue, grain yield and, ultimately, farm economics. The WSU Biofuels Initiative provided funding to start this project.

Fig. 1. An air drill is used to broadcast camelina seed on the soil surface followed by a coil packer to press the seed into the soil.

Developing Weed Control Methods for Biofuel Crops

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Increased interest in biofuel production in the state of Washington has lead to state funding for the development of biofuel crops. However, adaptability of these crops to eastern Washington is somewhat lacking. The most common oil seed crops grown in the U.S. in 2005 included soybean (72 million acres) cottonseed (14 million), sunflower (2.7 million), peanut (1.6 million) canola (1.2 million), flax (1 million), and safflower (169,000). Unfortunately, the oilseed crops with the greatest potential for adaptability to eastern Washington production are those with the fewest acres nationally. Not surprisingly, these minor crops have few to no pesticides labeled for use in their production. Current and previous WSU research into minor oilseed crops has focused on the development of herbicides and other weed management practices for their production. Recent research on weed control for oilseed crops has included work on meadow foam, safflower, yellow mustard, canola, and sunflower. Specific studies in eastern Washington are:

Safflower: Since 1998, herbicide evaluation was done at Ritzville and Lind WA. Efficacy and crop safety studies identified the value of labeled herbicides and potentially labeled herbicides as candidates for InterRegional-4 or other labeling programs. These include herbicides which are effective in controlling grass species or particularly troublesome broadleaf weeds such as Russian thistle.

Yellow Mustard and Canola: Also since 1998, herbicides have been evaluated for potential labeling in these commodities. Generally, yellow mustard appears to be agronomically the best suited crop in eastern Washington. Research on weed management programs in winter and spring canola has included both single component and systems work. Currently, canola has a greater number of labeled pesticides than other brassica crops. Moreover, herbicide resistant (Roundup Ready, LibertyLink, and Clearfield) varieties of canola are available. Herbicide-resistant varieties have been an important part of much of the systems research currently underway.

Canola and Camelina Fertility: Review of Literature and Initiation of New Studies

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A review of existing literature reveals that canola generally requires more nitrogen, phosphorus, potassium, and sulfur per unit of yield than cereals such as wheat or barley. Due in part to a low harvest index (proportion of aboveground plant dry matter that is seed) and high nutrient concentration in the residue, canola also leaves more nutrients in the field after harvest than comparable yields of cereals. Cycling of nutrients in this residue to subsequent crops is one important rotational benefit of canola. Fertilizer rates for canola are a function of residual soil nutrient levels and the yield potential of the site. For optimum yields, canola requires approximately 6 to 8

lbs of N supply (fertilizer+soil sources) per 100 lbs expected seed yield. Phosphorus, potassium, and sulfur recommendations can be based on soil test levels with interpretations similar to those of cereals. Canola has a lower tolerance of seed-placed starter fertilizers than cereals so rates of nitrogen+potassium should not exceed 5 lb/acre.

There are several unknowns regarding canola fertility. In existing literature, nitrogen recommendations for canola are quite variable, ranging from 4 to 11 lbs nitrogen supply per 100 lb seed yield. There is also debate over the optimum timing of nitrogen application for winter canola to ensure high yields but minimize the potential for winterkill. Optimal placement of banded fertilizer at planting and canola root responses to banded fertilizer is poorly understood. Relatively little is known about how fertility management affects oil yield and quality in canola since the majority of studies assess only management effects on seed yield. Finally, very little is known about camelina nutrient requirements to optimize oil yield.

This project involves a series of experiments designed to assess canola and camelina seed and oil yield responses to nutrient rates and application timing. Studies are located near Prosser, Davenport and Pullman, WA. Winter canola studies were initiated at each location in fall 2007. Spring canola and camelina studies are planned for 2008 at Davenport and Pullman. Treatments include nitrogen and sulfur rates, fall-spring nitrogen application timing, and phosphorus rate responses. In fall 2007, winter canola failed to establish at Pullman due to inadequate seed zone moisture. Establishment was spotty at Davenport. Fall establishment of winter canola is a major challenge that will have to be overcome in order for this crop to be successfully grown in dryland environments.

Links to other extension resources on canola fertility:
Ontario, Canada: http://www.omafra.gov.on.ca/english/crops/pub811/8fert.htm#table81
Great Plains, U.S.: http://www.oznet.ksu.edu/library/crpsl2/mf2734.pdf
North Dakota: http://www.ag.ndsu.edu/pubs/plantsci/soilfert/sf1122w.htm
Montana: http://landresources.montana.edu/FertilizerFacts
Oregon State University: http://extension.oregonstate.edu/catalog/pdf/em/em8943-e.pdf

Management of Rhizoctonia Damping-off of *Brassica* Oilseed Crops in the PNW

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Rhizoctonia solani can cause pre and post-emergence damping off of *Brassica* oilseed species with adverse effects on stand establishment. In greenhouse experiments, we have examined resistance to two groups (AGs) of *Rhizoctonia solani* among various *Brassica* species and varieties. *R. solani* AG 2-1 is among the most virulent strains and can drastically reduce seedling emergence. *R. solani* AG 8 can cause seedling stunting and also infects wheat. A few *B. napus* canola varieties appeared more tolerant to both groups of the pathogen in greenhouse experiments. The hybrid cultivars Flash and Sitro, from the German company DSV, and the open-pollinated DeKalb variety CWH687 showed the best tolerance to the two *Rhizoctonia* groups. Camelina was similar in susceptibility to most canola varieties, as were yellow, brown and Ethiopian mustards. We have examined various chemical seed treatments on the incidence of seedling damping-off of canola in the greenhouse, inoculated with *R. solani* AG 2-1. We found the seed treatments to be mostly ineffective. Since the pathogen attacks the young hypocotyls, these tissues were not protected by non-systemic seed treatments. We are now developing assays to determine if the differences in greenhouse resistance among the canola varieties can be observed in the field.

Tall Wheatgrass Feedstock Evaluation

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Only a handful of grasses grow in Washington that produce enough biomass volume to warrant biofuel attention. Switchgrass has received the lion's share of the attention because it produces large volumes of biomass that can be