for camelina stand establishment and seed yield. Field experiments were conducted for three years at four distinct rainfed agro-environments in the Pacific Northwest, USA. Average crop-year precipitation at the sites during the three years was: Lind WA, 9.0 inches; Pendleton OR, 16.6 inches; Moscow ID (one year only), 29.9 inches; and Corvallis OR, 39.1 inches. Camelina was planted on an average of five dates at each site (n=55) from early October to mid April at a rate of 5 lbs/acre by either drilling seed at a shallow depth or broadcasting seed on the soil surface. Although camelina has excellent cold hardiness, the best plant stands were achieved with the late-winter and early-spring plantings. Four divergent planting date yield responses across sites were: no yield differences at Lind; increased yield with later planting dates at Pendleton; reduced yield with later plantings at Moscow (one year data) and; a curvilinear response at Corvallis with the lowest yields from plantings in early fall and those after March 1 and highest yields from late-fall and mid-winter plantings (Fig. 1). Both drilling and broadcast were effective for planting camelina with no overall advantage of either method. Seed yields ranged from < 100 lbs/acre during an extreme drought year at Lind to 2600 lbs/acre at Moscow. Averaged across the four Pacific Northwest agro-environments in this study, we recommend: (i) late February-early March as the best overall planting date because of optimum stands and seed yield and having effective control of winter-annual broadleaf weeds with herbicide applied just prior to planting, and (ii) the broadcast method of planting as it generally equaled or slightly exceeded drilling for plant stand establishment and seed yield and can be accomplished more quickly at less expense.

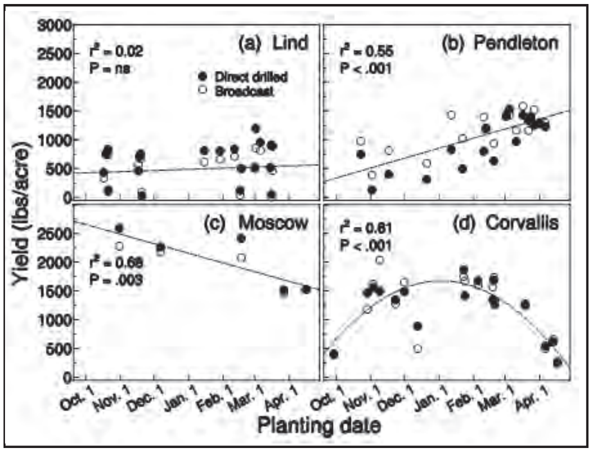

Fig. 1. Effect of planting date and method (direct drilled or broadcast) on camelina seed yield at four locations over three years.

Camelina: Seed Yield Response to Applied Nitrogen and Sulfur

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Camelina has received worldwide attention in recent years as a biofuel crop and as a rotation option for producers of small grain cereals. The objective of our study conducted during the 2008, 2009, and 2010 crop years was to determine camelina seed yield and nitrogen use efficiency (NUE) as affected by six applied nitrogen (N) rates at four sites in the Pacific Northwest. An N + sulfur (S) variable was also included. In 2010, seed oil as affected by applied N and S was also evaluated. The four sites and their average annual crop-year precipitation during the three years were: Lind, WA (9.0 inches); Pendleton, OR (16.6 inches); Moscow/Pullman, ID (27.4 inches); and Corvallis, OR (42.7 inches). The majority of the average annual precipitation at these sites is distributed in the winter and summers are comparatively dry. Camelina responded differently to applied N among sites based upon precipitation and available soil N. Seed yield did not respond to N rate treatments at Lind, presumably due to sufficient soil residual N and limited precipitation. Response of seed yield to applied N was mediated by increased precipitation at Pendleton, Moscow/Pullman, and Corvallis. Maximum seed yield increases attributable to applied N ranged from 19% at Pendleton to 93% at Moscow/Pullman. Based upon the results of this study, camelina seed requires about 5 lbs N per acre per 100 lbs of expected seed yield. Camelina NUE was greatest at Moscow/Pullman although it decreased gradually with increasing applied N rates at all sites. Lind, Pendleton, and Corvallis were the same with a NUE of -0.06 pound of seed for every added pound of N. Nitrogen use efficiency was greatest at Moscow/Pullman and Corvallis, and least at Lind. Camelina did not respond to applied sulfur at any site. Seed oil content was not affected by applied N or S.

Wind Erosion Challenges for Oilseed Cropping Systems

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The volatility of petroleum reserves, rising price of petroleum products, and climate change has created a worldwide interest in renewable fuels. The United States has set a goal of producing 36 billion gallons of biofuel by 2022 with 21 billion gallons being derived from advanced biofuels. The Pacific Northwest is expected to contribute 5% of this need for advanced biofuels. Although a considerable effort is now underway to ascertain the potential of growing oilseeds for advanced biofuels, little is known concerning the environmental impact of growing oilseed crops in rotations in this region. Of interest is the impact of growing oilseeds on wind erosion and PM10 (particles ≤10µm in diameter) emissions, which are acute environmental concerns in the drier areas of the Columbia Plateau.

In September 2011, we examined the potential for wind erosion and PM^{10} emissions at the end of the fallow phase of a winter wheat-fallow versus a winter wheat-camelina-fallow rotation at Lind, WA and a winter wheat-fallow versus a winter wheat-safflower-fallow rotation at Ritzville, WA. An undercutter implement was used for primary spring tillage and then a rodweeder was used to control weeds for the duration of the fallow phase of the rotations at both sites. A portable wind tunnel (Fig. 1) was used to assess total horizontal sediment flux and PM^{10}concentrations after sowing but prior to wheat emergence. Total sediment flux was measured using an isokenetic wedge-shaped sampler while PM^{10}concentrations were measured using Dusttrak aerosol monitors. Our results indicate a 15% increase in sediment flux in the camelina rotation at Lind and an 80% increase in sediment flux in the safflower rotation at Ritzville compared with the winter wheat-fallow rotation. Most apparent was lower residue cover following the oilseed crops, which likely contributed to the higher sediment flux from fallow after the oilseed versus winter wheat crop. Our results suggest that, even with conservation tillage best management practices, wind erosion may be accentuated by growing oilseeds in tillage-based fallow systems in the Columbia Plateau.

Fig. 1. A portable wind tunnel was used to measure soil sediment flux and PM^{10} emissions, shown here at the Ron Jirava farm near Ritzville.

Biofuels Research in Western Washington

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Biofuel crop production research in western Washington has included canola, camelina, rapeseed, mustard, and flaxseed, with different experiments focused on seeding rate and date, and on nitrogen (N) fertilizer timing, rate, and source. The experiments were done at WSU Mt. Vernon and WSU Puyallup from 2008-2011.

Canola was the most successful biofuel crop grown in the western Washington experiments. We identified mid August to early September as the fall planting window, with later plantings likely to yield poorly or fail. Fall planted canola yielded 3000-5000 lbs/acre. Spring planted canola (late April planting) averaged 2000-4000 lbs/acre. Organically-managed canola competed well against weeds when planted within the fall window, and our research indicated that it could be a viable rotation crop in western Washington. The organic canola oil would have much greater value as a food crop than a biofuel crop. Volunteer canola plants showed the potential to become problem weeds in subsequent crops under organic management, and would need to be managed carefully.

Additional experiments with canola focused on biosolids as a nutrient source, and showed similar production using two very different biosolids sources (heat-dried biosolids with 6% N and lagooned/dewatered biosolids with 2% N) each applied at two rates. Spring planted canola competed well against weeds in these experiments. Rapeseed yields were similar to canola and may also be a viable biofuels crop.

Camelina was much less successful than canola, with variable yields in the experiments (often less than 1500 lb/acre) and one crop failure. Neither winter nor spring plantings were productive, and we did not identify a successful camelina production strategy for western WA. Flax also performed poorly; yields in 2008 ranged from 1100-1600 lbs/acre, but only from 300-500 lbs/acre in 2009. Getting flax to harvest maturity is a major concern with this species, as seed pods in both years were quite wet at harvest.

Mustard also had variable and generally low yields, ranging from about 800-2800 lbs/acre. Mustard was an excellent competitor against weeds, and may have more of a role as a niche cover crop than a biofuels crop.