REGION 4
Western WA

Title: Growing Biofuels in Western Washington

PIs: Tim Miller, Craig Cogger

Objectives:

1. Canola
   - A. Conduct fertilization regime trials with fall canola on organic ground at WSU Puyallup.
   - B. Conduct planting date trials with spring canola on organic ground at WSU Puyallup.
2. Camelina
   - A. Conduct herbicide trials with camelina at WSU Mount Vernon.
   - B. Conduct seeding rate trials with camelina at WSU Mount Vernon.
3. Conduct seeding rate trials with flax at WSU Mount Vernon.
4. Conduct seeding rate trials with mustard at WSU Mount Vernon.
5. Conduct crop density trial with sunflower at WSU Mount Vernon.

Materials and Methods:

1A. Fall canola trial. Fall canola (cv. 'Athena') was seeded at approximately 8 lbs/a into 10- by 20-ft plots on October 5, 2007 on freshly-tilled ground at WSU Puyallup. Craig Cogger's crew applied one of three fertilization regimes to the canola: 200 lb total N/a applied (1) all in the fall, (2) all in the spring, or (3) split with 67 lb N/a in fall and 133 lb N/a in the spring; fall shrimp meal was incorporated into the soil prior to seeding, while spring treatments were surface-applied. All plots were raked by hand immediately after seeding to shallowly incorporate canola seed. Percent crop and weed cover was visually estimated June 18, 2008 and canola plants within a 12- by 20-inch quadrat were counted and clipped at ground level June 30. Excess stem material was trimmed off each plant, and remaining upper stems and racemes were placed into paper grocery bags and then stored in a screen house at WSU Mount Vernon NWREC for slow drying and seed ripening to occur (maximum daytime temperatures did not exceed 85 F during the drying process). After approximately three weeks of drying, seed was threshed by hand, passed over screens to remove large chaff, and freed of fine chaff and dust using a blower-style seed cleaner. Seed weight for each sample was then recorded. Yield data were analyzed using a general linear models procedure and means were separated using Fisher's Protected LSD at the P = 0.05 level. The design was a randomized complete block with three replicates.

1B. Spring canola trial. Spring canola hybrids (Pioneer 45H72 CL and Interstate Seed HyLite 292 CL [Clearfield® canola, imidazolinone tolerant] and conventional Interstate Seed canola hybrids Hyola 401 and two lots of Hyola 420 (Interstate Seed), all *Brassica napus*) were seeded at four seeding dates approximately two weeks apart (April 8, April 18, May 6, and May 19, 2008) on organic ground at WSU Puyallup. Plots were tillage shortly before the April and May 19 seedings; cotyledon-stage weeds were emerged at the May 6 seeding. All plots received feather meal at 150 lbs N/acre, applied immediately before or after seeding, and then plots were raked by hand to shallowly incorporate both fertilizer and seed. Due to lack of Hyola 401 and 420 seed for the May 19 seeding, two mustard species ('IdaGold' white mustard (*Sinapis alba*) and 'Pacific Gold' oriental mustard (*Brassica juncea*)) were seeded instead. Percent crop and weed cover was visually estimated June 18, 2008 and crop plants within a 12- by 20-inch quadrat were counted and clipped at ground level August 7 (April 8 seeding) and August 26 (remaining three seedings). Excess stem material was trimmed off each plant, and remaining upper stems and racemes were placed into paper grocery bags and then stored in a screen house at WSU Mount Vernon NWREC for slow drying and seed ripening to occur (maximum daytime temperatures did not exceed 85 F during the drying process). After approximately three weeks of drying, seed was threshed by hand, passed over screens to remove large chaff, and freed of fine chaff and dust using a blower-style seed cleaner. Seed weight for each sample was then recorded. Yield data were analyzed using a general linear models procedure and means were separated using Fisher's Protected LSD at the P = 0.05 level. The design was a randomized complete block with three replicates.

2A. Camelina herbicide trial. Plots (8 by 20 ft) were established at WSU Mount Vernon June 3, 2008. Herbicides were applied that day using a CO_2-pressurized backpack sprayer delivering 31 gallons/acre. Rainfall was sufficient (~2 inches) to incorporate herbicide prior to seeding (June 14). Seeding rate was approximately 8 lbs/acre, equivalent to 13 g of camelina (cv. 'Celine') per plot. Seed was scattered over the soil by hand, then shallowly incorporated with a drag harrow immediately following seeding. Crop injury and weed control was visually estimated August 11 and crop plants within a 12- by 20-inch quadrat were counted and clipped at ground level September 26. Excess stem material was trimmed off each plant, and remaining upper stems and racemes were placed into paper grocery bags and then stored in a screen house at WSU Mount Vernon NWREC for slow drying and seed ripening to occur (maximum daytime temperatures did not exceed 85 F during the drying process). After approximately three weeks of drying, seed was threshed by hand, passed over screens to remove large chaff, and freed of fine chaff and dust using a blower-style seed cleaner. Seed weight for each sample was then recorded. Yield data were analyzed using a general linear models procedure and means were separated using Fisher's Protected LSD at the P = 0.05 level. The design was a randomized complete block with three replicates.

2B. Camelina seeding rate trial. Plots (8 by 20 ft) were established at WSU Mount Vernon June 14, 2008. Seeding rate was approximately 8 lbs/acre, equivalent to 13 g of camelina (cv. 'Celine') per plot. Seed was scattered over the soil by hand, then shallowly incorporated with a drag harrow immediately following seeding. Crop and weed cover were visually estimated August 11 and crop plants within a 12- by 20-inch quadrat were counted and clipped at ground level September 26. Excess stem material was trimmed off each plant, and remaining upper stems and racemes were placed into paper grocery bags and then stored in a screen house at WSU Mount Vernon NWREC for slow drying and seed ripening to occur (maximum daytime temperatures did not exceed 85 F during the drying process). After approximately three weeks of drying, seed was threshed by hand, passed over screens to remove large chaff, and freed of fine chaff and dust using a blower-style seed cleaner. Seed weight for each sample was then recorded. Yield data were analyzed using a general linear models procedure and means were separated using Fisher's Protected LSD at the P = 0.05 level. The design was a randomized complete block with three replicates.

3. <u>Flax seeding rate trial</u>. Plots (8 by 20 ft) were established at WSU Mount Vernon June 14, 2008. Flax seed (unknown cv.) was scattered over the soil by hand, then shallowly incorporated with a drag harrow immediately following seeding. Crop and weed cover were visually estimated August 11 and crop plants within a 12- by 20-inch quadrat were counted and clipped at ground level September 26. Excess stem material was trimmed off each plant, and remaining upper stems and racemes were placed into paper grocery bags and then stored in a screen house at WSU Mount Vernon NWREC for slow drying and seed ripening to occur (maximum daytime temperatures did not exceed 85 F during the drying process). After approximately three weeks of drying, seed was threshed by hand, passed over screens to remove large chaff, and freed of fine chaff and dust using a blower-style seed cleaner. Seed weight for each sample was then recorded. Yield data were analyzed using a general linear models procedure and means were separated using Fisher's Protected LSD at the P = 0.05 level. The design was a randomized complete block with three replicates.

4. <u>Mustard seeding rate trial</u>. Plots (8 by 20 ft) were established at WSU Mount Vernon June 14, 2008. Mustard seed ('IdaGold' white mustard (*Sinapis alba*) and 'Pacific Gold' oriental mustard (*Brassica juncea*)) was scattered over the soil by hand, then shallowly incorporated with a drag harrow immediately following seeding. Crop and weed cover were visually estimated August 11 and crop plants within a 12- by 20-inch quadrat were counted and clipped at ground level September 26. Excess stem material was trimmed off each plant, and remaining upper stems and racemes were placed into paper grocery bags and then stored in a screen house at WSU Mount Vernon NWREC for slow drying and seed ripening to occur (maximum daytime temperatures did not exceed 85 F during the drying process). After approximately three weeks of drying, seed was threshed by hand, passed over screens to remove large chaff, and freed of fine chaff and dust using a blower-style seed cleaner. Seed weight for each sample was then recorded. Yield data were analyzed using a general linear models procedure and means were separated using Fisher's Protected LSD at the P = 0.05 level. The design was a randomized complete block with three replicates.

5. <u>Sunflower crop density trial</u>. A trial was established at WSU Mount Vernon June 17, 2008. Sunflower ('IdaGold' white mustard) was seeded at 27,150 seeds/acre, then thinned to nine different crop densities July 18. Plots measured 7.3 by 20 ft and were centered on four rows of sunflowers. Sunflower heads within two meters of a single center row were collected October 28 and dried at 95 F for three days. Seed was separated from the dried heads using a Vogel thresher, then passed over screens to remove large chaff, and freed of fine chaff and dust using a blower-style seed cleaner. Seed weight has not yet been recorded. Yield data will be analyzed using a general linear models procedure and means were separated using Fisher's Protected LSD at the P = 0.05 level. The design was a randomized complete block with three replicates.

Results:

1A. Fall canola trial. Canola seedlings were very small in the fall and winter of 2007-08, resulting in the plots being infested by winter annual weed species (primarily shepherd's-purse, pineapple-weed, and henbit) and previous cover crops at the site (hairy vetch and cereal rye). These small canola plants began to grow early in spring, but flowering began when many of the plants were still less than 12 inches tall and it is suspected that yield of those plants was considerably lower than the yield potential for larger overwintered plants. By mid-June, canola cover ranged from 64-74%, with no difference from fertilizer regime (Table 1); weed cover also did not differ between fertilizer treatments at that evaluation date. Crop density and yield were similar across fertilizer regimes (Table 1).

Table 1. Fall organic canola at WSU Puyallup.

Fertilizer regime	Crop cover[a]	Weed cover[a]	Crop density[b]	Seed yield[b]
	%	%	plants/1.67 ft^2	lbs/acre
All fall	64	36	10	1696
All spring	64	36	20	1380
Split fall and spring	74	26	19	1565
$LSD_{0.05}$	ns	ns	ns	ns

[a]Crop and weed cover estimated June 18, 2008.
[b]Canola plants sampled June 30, 2008.

1B. Spring canola trial. Canola crop cover was maximized in mid-June in the April 18 seeding, followed by the April 8 and May 19 seeding, and was poorest when canola was seeded May 6 (Table 2). Weed cover was minimized in the same way (Table 2). At least some of the reduction in crop cover in the May 6 seeding likely resulted from weed pressure, as there were many cotyledon-stage weeds present in the plots at that seeding date and not all were removed by raking. Weed species present in all the plots included shepherd's-purse, henbit, common lambsquarters, and wild buckwheat. These data indicate that when optimally seeded (proper seeding date in a freshly-prepared seedbed) canola was very competitive with weed species. Even when seeded at the latest date, the two mustard species also competed well with weeds (Table 2). Canola crop density at the sampling date ranged from 22 to 44 plants/1.67 ft^2 (Table 3). Seed yield ranged widely, from 2696 to 6565 lbs/acre, although mean canola yields for each seeding rate indicated that planting date did not significantly affect yield (although April 18 was numerically the optimal seeding date) (Table 3). It is not clear how to interpret crop densities, however, other than to say that all seeding dates in this trial resulted in successful canola establishment. Mean canola densities of 32 plants/1.67 ft^2 for HyLite 292 and Pioneer 45H72 for example, resulted in mean yields of 5530 and 3241, respectively, the highest and lowest yields for canola across all four seeding dates. Mustard yield varied tremendously (Table 3), primarily due to excessive shatter and bird predation with Pacific Gold (*Brassica juncea*) in comparison to the more intact silicles of IdaGold (*Sinapis alba*).

Table 2. Spring organic canola at WSU Puyallup.

Hybrid/crop	Crop cover[a]					Weed cover[a]				
	Apr 8	Apr 18	May 6	May 19	Mean	Apr 8	Apr 18	May 6	May 19	Mean
	%	%	%	%	%	%	%	%	%	%
HyLite 292 CL	78	100	82	85	86	22	0	18	15	14
Hyola 401	95	100	90	--	95	5	0	10	--	5
Hyola 420 (lot 1)	92	100	87	--	93	15	0	13	--	9
Hyola 420 (lot 2)	95	100	82	90	92	12	0	18	10	10
Pioneer 45H72 CL	98	100	92	93	96	8	0	8	7	6
IdaGold	--	--	--	95	95	--	--	--	5	5
Pacific Gold	--	--	--	95	95	--	--	--	5	5
Mean	92	100	86	92	--	12	0	14	8	--
$LSD_{0.05}$	5	5	5	5	--	7	7	7	7	--

[a]Crop and weed cover estimated June 18, 2008.

Table 3. Spring organic canola at WSU Puyallup.

Hybrid/crop	Crop density					Yield				
	Apr 8[a]	Apr 18[b]	May 6[b]	May 19[b]	Mean	Apr 8[a]	Apr 18[b]	May 6[b]	May 19[b]	Mean
	plants/ 1.67 ft^2	plants/ 1.67 ft^2	plants/ 1.67 ft^2	plants/ 1.67 ft^2	plants /1.67 ft^2	lbs/acre	lbs/acre	Lbs/acre	lbs/acre	lbs/acre
HyLite 292 CL	27	38	27	34	32	5115	6565	5163	5278	5530
Hyola 401	26	37	39	--	34	3596	4496	4173	--	4089
Hyola 420 (lot 1)	32	35	37	--	35	4360	5509	4380	--	4750
Hyola 420 (lot 2)	22	41	26	35	31	5316	5741	4523	4500	5020
Pioneer 45H72 CL	24	34	26	44	32	4154	3282	2830	2696	3241
IdaGold	--	--	--	34	34	--	--	--	3629	3629
Pacific Gold	--	--	--	32	32	--	--	--	770	770
Canola mean	26	37	31	38		4508	5119	4214	4158	--
$LSD_{0.05}$	7	7	7	7	--	1170	1170	1170	1170	--

[a]Canola plants sampled August 7, 2008.
[b]Canola and mustard plants sampled August 26, 2008.

2A. Camelina herbicide trial. Weed control was excellent (93 to 100%) with all products, although camelina suppressed 93% of the weed growth even in nontreated plots (Table 4). Camelina injury was severe with simazine and Outlook (47 and 23% injury, respectively) (Table 4). This crop injury was more related to camelina growth than loss of stand, however, as the crop density resulting from the various herbicides did not statistically differ at the late September sampling date (Table 4). Somewhat surprisingly, yield also did not differ among the herbicide treatments (Table 4), indicating that camelina plants are perhaps well able to compensate for early injury.

Table 4. Effect of pre-plant incorporated herbicides in camelina.

Treatment	Rate	Weed control[a]	Crop injury[a]	Crop density[b]	Yield[b]
	product/acre	%	%	plants/1.67 ft^2	lb/acre
Prowl H_2O	3.2 pt	100	13	50	1224
Dual Magnum	1.6 pt	100	2	58	1559
Outlook	1.3 pt	98	23	36	1367
Treflan	2.7 pt	100	13	52	1189
Curbit	2.7 pt	98	7	52	1318
Simazine	1.1 lb	98	47	21	1551
Nontreated	---	93	0	55	1059
$LSD_{0.05}$	---	3	16	ns	ns

[a]Crop injury and weed control estimated August 11, 2008.
[b]Camelina plants sampled September 26, 2008.

2B. Camelina seeding rate trial. No camelina measurements were statistically significant across seeding rates (Table 5). Camelina cover was excellent for all tested seeding rates, ranging from 97 to 98% cover by the August evaluation. Camelina plant density ranged from 36 to 60 plants/1.67 ft^2, and yield ranged from 1166 to 1364. There was no clear trend in the data between these parameters and seeding rate.

Table 5. Effect of several seeding rates in camelina.

Seeding rate	Crop cover[a]	Crop density[b]	Yield[b]
lbs/acre	%	plants/1.67 ft^2	lbs/acre
3	98	36	1364
4	98	41	1195
5	97	43	1312
6	97	40	1205
7	97	60	1256
8	97	41	1166
$LSD_{0.05}$	ns	ns	ns

[a]Crop injury estimated August 11, 2008.
[b]Camelina plants sampled September 26, 2008.

3. Flax seeding rate trial. No flax measurements were statistically significant across seeding rates (Table 6). Neither flax flowering percentage in August nor crop density in September closely followed seeding rate. Weed cover, however, was high for all tested seeding rates, ranging from 45 to 70% cover by the August evaluation. Flax yield ranged from 1099 to 1565.

Table 6. Effect of several seeding rates in flax.

Seeding rate	Flowering[a]	Weed cover[a]	Crop density[b]	Yield[b]
lbs/acre	%	%	plants/1.67 ft^2	lbs/acre
25	32	63	54	1099
30	40	45	80	1540
35	28	62	54	1164
40	48	50	87	1565
45	28	70	70	1258
$LSD_{0.05}$	ns	ns	ns	ns

[a]Flowering percentage and weed cover estimated August 11, 2008.
[b]Flax plants sampled September 26, 2008.

4. Mustard seeding rate trial. While weed cover in August did not differ significantly by seeding rate or mustard species, mustard was able to provide 88 to 95% weed suppression (5 to 12% weed cover) (Table 7). While crop density was generally higher at the 10 lb/acre seeding rate, Pacific Gold (*Brassica juncea*) density was 2- to 3-fold that of IdaGold (*Sinapis alba*), likely due to the smaller seed size of Pacific Gold. Intra-specific competition may have also been more intense with IdaGold than with Pacific Gold. Yield did not differ by seeding rate, with neither species producing an acceptably high seed yield.

Table 7. Effect of several seeding rates in two mustard species.

	IdaGold			Pacific Gold		
Seeding rate	Weed cover	Crop density	Yield	Weed cover	Crop density	Yield
lbs/acre	%	Plants/ 1.67 ft^2	lbs/acre	%	Plants/ 1.67 ft^2	lbs/acre
4	12	11	136	7	21	190
6	5	13	218	7	26	153
8	5	11	224	8	36	176
10	5	19	207	8	30	71
$LSD_{0.05}$	ns	8	ns	ns	8	ns

[a]Weed cover estimated August 11, 2008.
[b]Mustard plants sampled September 26, 2008.

5. Sunflower crop density trial. Sunflower plant density in the plots ranged from 13,065 to 35,706 plants per acre (Table 8). Neither head dry weight nor seed weight differed significantly by plant density. Seed yields ranged from 1288 to 1759 lbs/acre. Plots were hand weeded once at thinning, and crop competition (coupled with a dry soil surface until fall) was such that weeds weren't particularly troublesome during this cropping year.

Table 8. Effect of several plant densities in sunflower.

Plant density	Head weight[a]	Seed weight[b]
1000 plants/acre	lbs/acre	lbs/acre
13.1	3980	1357
16.5	4376	1452
20.2	3764	1346
22.6	3830	1288
25.9	4458	1488
29.0	4524	1759
33.1	4206	1444
34.5	4040	1441
35.7	4228	1498
$LSD_{0.05}$	ns	ns

[a]Dry weight of sunflower heads (including seed) from 2 m of row, harvested October 28, 2008.
[b]Cleaned seed weight from dried heads; shells were included in the weight.

Conclusions:

1A. Fall canola trial. It appears that October 4 was too late for seeding fall canola at Puyallup, as the canola was very small through the fall and winter and almost certainly fell short of its yield potential. Predation by birds was also very high in this study, although that would not likely be as great a problem in a full-sized field as it was in these small plots.

1B. Spring canola trial. Spring canola growth was good for all four seeding dates tested in this trial, but canola productivity was generally the best with the April 18 seeding. This trial wasn't really aimed at evaluating particular cultivars; rather, we wanted to evaluate a relatively broad range of hybrids under western Washington conditions. It appears that productivity was good, although, like the fall canola, bird predation and seed shatter was problematic. In addition, wild buckwheat was a problem in several of the plots, and would have made combining the crop difficult. The April 8 seeding date resulted in an early August harvest window, a time when weather is relatively good for harvest in western Washington. The April 18 seeding date could probably have been harvested before the sampling date in this trial, but the May seeding dates would have resulted in field harvest during inclement weather.

2A. Camelina herbicide trial. The seeding date for camelina was delayed until mid-June due to extremely high May precipitation. The late seeding date most likely reduced seed yield below its potential for western Washington. All tested herbicides provided excellent weed control, but crop injury was severe from both simazine and Outlook, although these products didn't result in significantly lower camelina stand nor yield. Injury was considerably more likely to occur this year than under standard conditions, given the wet soil at the time of seeding and herbicide application. Continued testing of Prowl H_2O, Dual Magnum, Treflan, and Curbit, applied alone and in combination, is warranted based on these data.

2B. <u>Camelina seeding rate trial</u>. The seeding date for camelina was delayed until mid-June due to extremely high May precipitation. The late seeding date most likely reduced seed yield below its potential for western Washington. Given the excellent crop cover and impressive weed control (see herbicide trial above), however, continued testing of camelina is warranted.

3. <u>Flax seeding rate trial</u>. The seeding date for flax was delayed until mid-June due to extremely high May precipitation. The late seeding date most likely reduced seed yield below its potential for western Washington. Perhaps also because of the late seeding date, weed suppression was very poor with flax compared to either mustard species or camelina. Herbicide applications will likely be required to profitably produce flax on weedy sites, to reduce weed competition and to harvest a quality product that isn't contaminated with weed seeds (particularly ladysthumb and pale smartweed, common lambsquarters, and shepherd's-purse). It was also apparent that this late seeding date delayed seed maturity and would have resulted in field harvest during inclement weather.

4. <u>Mustard seeding rate trial</u>. The seeding date for mustard was delayed until mid-June due to extremely high May precipitation. The late seeding date reduced seed yield far below its potential for western Washington. Weed suppression was excellent, however, indicating that perhaps the best use of late-planted mustard is as a cover crop.

5. <u>Sunflower crop density trial</u>. Sunflowers grow very well under western Washington conditions, but harvest will almost always be delayed or otherwise impacted by late summer rains and fogs. The seeding date in 2008 was very late; consequently, harvest would have been difficult at best, and seed would certainly have to be dried prior to crushing or storage. There was not a clear trend in the data indicating which sunflower plant density will be optimum for western Washington conditions.

Future plans:

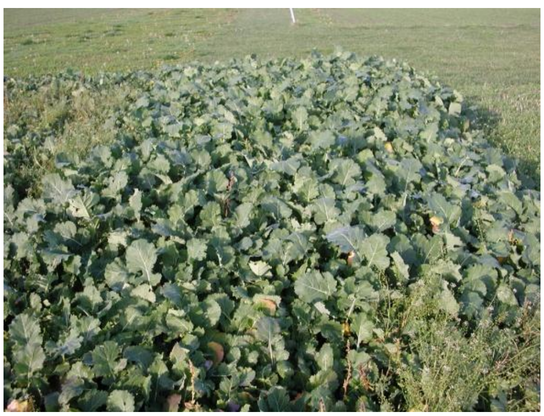
Biofuel trials that Craig Cogger and I are currently conducting in western Washington are predominantly focused on agronomic issues of biofuel crops, including species (canola, mustard, sunflower, flax, and camelina), seeding rate, seeding date, fertilizer choice for organic production, herbicide selectivity, and harvest issues in western Washington. Trials in 2009 will be similar to these 2008 trials, based on 2008 results. We have initiated an organic canola trial at WSU Puyallup including four fall seeding dates, to be followed by four spring canola and mustard seeding dates. In a similar way, camelina was seeded at three fall dates at WSU Mount Vernon, to be followed with five spring seeding dates. Flax, sunflower, and mustard will also be seeded at several timings and seeding rates at WSU Mount Vernon in 2009. Oil quantity and quality analysis will be conducted in Pullman for most of these species to determine their suitability for biofuel production under western Washington conditions.

"Busts" for western Washington oilseed testing to date have been many.
Safflower. Spring-seeded safflower did not yield any seed in Mount Vernon during 2007, despite a healthy-looking crop. Fall-seed safflower at the same site did not survive the winter of 2007-08. New safflower varieties with greater winter hardiness have been identified, however, so testing may be conducted this winter.
Meadowfoam. Fall-seeded meadowfoam winter-killed in one of two years of testing at Mount Vernon; no further testing of meadowfoam is anticipated.
Canola. Due to concern by cabbage seed producers in northwestern Washington, canola production in those counties will be severely limited. Consequently, canola testing is being conducted only at Puyallup. Canola harvest has been the biggest issue in western Washington (Snohomish and Grays Harbor counties). Both small and large plot sampling has shown that spring canola is very productive here, but because the crop ripens during late summer when morning fogs are prevalent, seedpods become wet daily and seed moisture is often too high for seed storage. Harvest conditions therefore are only suitable for combine operation during a few hours after the morning dew/fog has evaporated and before evening relative humidity becomes too high for optimal seed collection. Further, most canola seed has to be dried following harvest to allow before storage or oil extraction is possible. Therefore, identification of optimal planting dates may be the most critical factor to be determined. Fall canola was not initially thought to be a good choice for western Washington conditions, due to field flooding during the winter and significantly higher disease potential, and because we wanted to keep canola from blooming at the same time as cabbage seed crops (synchronous bloom increases the chance of cross-pollination which could be disastrous for a cabbage seed producer). WSDA has recently been taking on the issue of identifying production areas for canola, however, and these regions will shortly be set. This greatly reduces the chance of unintentional cross-pollination between canola and cabbage seed, and at least opens the window for expanded testing of winter canola in western Washington. It may turn out that disease management and water-logged soils will not be allow widespread production of canola, but small plot testing should identify whether that concern is perhaps overemphasized.
Sunflower. Sunflowers have been productive in large plots at Mount Vernon for the past two summers (sampling estimated yield at 2500 lbs/a) but harvest has been a concern, mostly for the same reasons listed for canola (see previous paragraph). Plots have gone largely unharvested, although a very late harvest (November) was conducted in 2006. As with canola, high moisture seed will be problematic for oil extraction and seed storage.
Mustards. Winter hardiness has been lacking in the mustard varieties that we have tested for cover cropping options at Mount Vernon, particularly in the yellow (or white) mustard, *Sinapis alba*. This has resulted in crop failure or poor yields, as well as increased weed pressure in spots in the field where the mustard plants died. Harvested seed from both yellow and brown mustard tested in Snohomish county during 2006.
Camelina had never been tested in Mount Vernon prior to this year, to my knowledge.

Future biofuel trials. Trials in 2010 and 2011 will probably expand varietal testing, once species are identified that showed potential for biofuel production in western Washington. Research will also continue to look at planting date, seeding rate, and fertility studies under organic conditions in Puyallup and conventional/organic in Mount

Vernon. Herbicide screening may be necessary for camelina and mustard; flax, sunflower, and canola are widely planted enough to have several herbicides already registered. Mustards will continue to be tested as part of this project, and ancillary work with mustard seed meal will continue (we have seen efficacy of meal for suppression of fusarium wilt in spinach and weed control in potato and strawberry).
Infrastructure is a problem for widespread production in western Washington. Combines are not widely owned, and much of the grain is custom harvested. Increased acreages may improve that situation, as may the recent increases in small grain prices. Storage space is limited or nonexistent for oilseed crops, necessitating transportation to central Washington or construction of storage facilities prior to crushing. High moisture seed will need to be dried prior to crushing/storage, necessitating purchase of seed driers (propane or natural gas/methane heat source). It is not likely that drying seed will be sustainable, given the high cost of that operation and the low value of biofuel seed on a pound-for-pound basis, and since burning one fuel to produce another seems counter-productive. The production of methane from dairy waste or other materials may provide a previously unavailable source of fuel for seed drying, however, so testing should continue. In light of these concerns, it appears that economic analysis of production of the crop and the biodiesel should be a top priority for future trials.

Citations: None



Planted Aug. 13, 2008

Planted Aug. 25, 2008

Planted Sept. 15, 2008

Planted Oct. 1, 2008

Planting date x fertilizer application research plots at WSU-Puyallup, Nov.17, 2008.