# Growing Biofuel Crops in Western Washington

Timothy W. Miller[1], Craig G. Cogger[2], Andrew I. Bary[2], Carl R. Libbey[1], and Elizabeth A. Myhre[2]

[1]Washington State University Northwestern Washington Research and Extension Center, Mount Vernon, WA
[2]Washington State University Puyallup Research and Extension Center, Puyallup, WA

**Abstract:** Testing of biofuel crops in western Washington has intensified during the last five years. A number of crops have been grown experimentally at Washington State University's western Washington Research and Extension Centers at Mount Vernon and Puyallup. It is not known whether any of the biofuel crops currently grown for oil production can be economically produced in western Washington. Previous testing at Mount Vernon has shown that, while meadowfoam, safflower, flax, and sunflower can be grown in the region, their yield or other production factors may not allow them to be produced profitably by growers (Figure 1). Recent testing, therefore, has focused on canola, camelina, and mustard (Figure 2). Agronomic production guidance is scarce for these crops in this region; therefore, research thus far has focused on determining seeding dates, seeding rates, fertilizer requirements, harvest factors (seed moisture, maturity, etc.), and other production factors (Figure 3). Canola can only be produced in certain areas west of the Cascades, but yields ranging up to 4000 lbs/acre were obtained in tests in Monroe and Montesano in 2006 and to over 6000 lbs/acre in Puyallup in 2008, although only from 1500 to 2000 lbs/acre in 2009. Yield of winter canola at WSU Puyallup in 2009 exceeded 5000 lbs/acre when seeded in August, but was about 3000 lbs/acre when seeded in mid-September (Table 4). Fertilizing organic winter canola with nitrogen in the fall tended to improve crop cover and weed control in the fall, although yield was not significantly improved compared to a split application (1/3 in fall, 2/3 in spring) or all applied in the spring. Spring canola, rapeseed, and mustard have been variable producers, although April appears to be the best seeding date for spring oilseeds (Table 5). Camelina has not yielded more than 1500 lbs/acre in western Washington trials (Tables 1, 2, and 3). Infrastructure remains a problem for widespread biofuel production in the region. Combines are not widely owned, and much of the grain is custom harvested. 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. 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. 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.

Figure 1. Biofuel crops that haven't panned out:

Flax
*Linum usitatissimum*

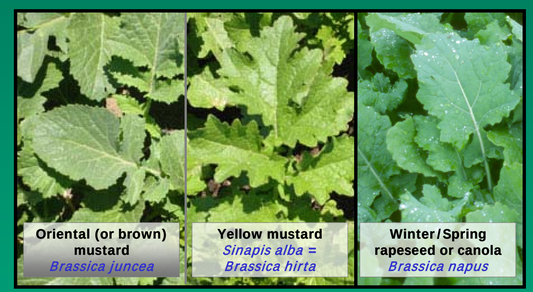
Meadowfoam
*Limnanthes alba*

Sunflower
*Helianthus annuus*

Safflower
*Carthamus tinctorius*

Figure 2. Biofuel crops that are still under investigation:

Camelina
*Camelina sativa*



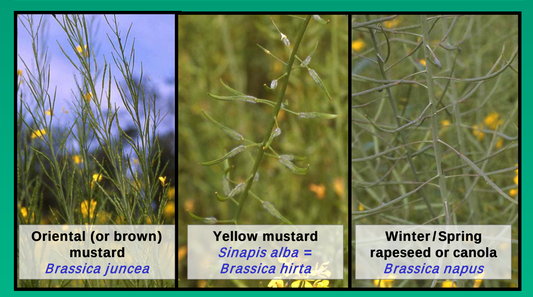




Figure 3. Canola problems at WSU Puyallup:

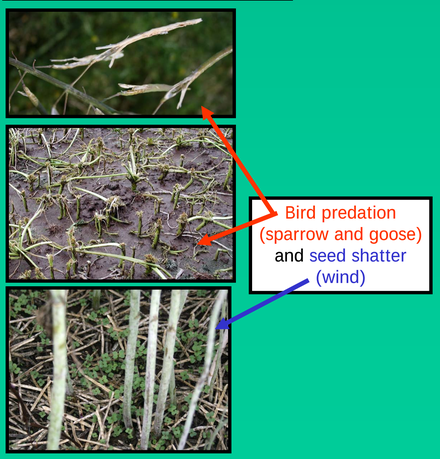



Table 1. Effect of pre-plant incorportated herbicides in camelina at WSU Mount Vernon (2008).

| Treatment | Rate | Weed control | Crop injury | Crop density | Yield |
|---|---|---|---|---|---|
| | product/acre | % | % | plants/1.67 ft$^2$ | lbs/acre |
| Prowl H2O | 3.2 pt | 100 a | 13 bc | 50 a | 1224 a |
| Dual Magnum | 1.6 pt | 100 a | 2 c | 58 a | 1559 a |
| Outlook | 1.3 pt | 98 a | 23 b | 36 a | 1367 a |
| Treflan | 2.7 pt | 100 a | 13 bc | 52 a | 1189 a |
| Curbit | 2.7 pt | 98 a | 7 c | 52 a | 1318 a |
| Simazine | 1.1 lb | 98 a | 47 a | 21 a | 1551 a |
| Nontreated | --- | 93 b | 0 c | 55 a | 1059 a |

Table 2. Effect of seeding date in camelina at WSU Mount Vernon.

| Seeding date | Crop cover | Weed control | Yield |
|---|---|---|---|
| | % | % | lbs/acre |
| October 2, 2008 | 92 a | 95 ab | 985 ab |
| October 16, 2008 | 90 a | 93 ab | 1017 ab |
| October 30, 2008 | 78 b | 78 c | 763 ab |
| February 3, 2009 | 18 c | 95 ab | 873 ab |
| February 17, 2009 | 17 cd | 88 b | 743 ab |
| March 2, 2009 | 10 cd | 93 ab | 866 ab |
| March 26, 2009 | 8 de | 90 b | 518 b |
| April 20, 2009 | --- | 100 a | 1128 a |
| May 4, 2009 | --- | 100 a | 1221 a |

Table 3. Effect of several seeding rates in camelina at WSU Mount Vernon.

| Seeding rate | Crop cover | | Yield | |
|---|---|---|---|---|
| | 2008 | 2009 | 2008 | 2009 |
| lbs/acre | % | % | lbs/acre | lbs/acre |
| 3 | 98 a | 65 b | 1364 a | 803 a |
| 4 | 98 a | 72 ab | 1195 a | 849 a |
| 5 | 97 a | 68 b | 1312 a | 886 a |
| 6 | 97 a | 73 ab | 1205 a | 842 a |
| 7 | 97 a | 77 ab | 1256 a | 888 a |
| 8 | 97 a | 82 a | 1166 a | 928 a |

Table 4. Vegetative and reproductive measurements of 'Athena' winter canola grown under organic conditions at WSU Puyallup.

| | Crop cover | | Weed cover | Goose browsing | Flood damage | Crop density | Yield |
|---|---|---|---|---|---|---|---|
| | Oct 1, 2008 | Jan 30, 2009 | Jan 30, 2009 | Feb 2, 2009 | Feb 2, 2009 | Jul 23, 2009 | Jul 23, 2009 |
| Seeding date | % | % | % | % | % | plants/1.67 ft$^2$ | lbs/acre |
| August 13, 2008 | 72 a | 61 a | 6 c | 72 a | 69 a | 10.8 ab | 5400 a |
| August 26, 2008 | 34 a | 50 b | 17 b | 72 a | 0 b | 8.0 b | 4999 a |
| September 12, 2008 | --- | 42 c | 54 a | 11 b | 11 b | 12.9 a | 2861 b |
| Fertilizer regime | | | | | | | |
| All fall | 62 a | 35 b | 38 a | 75 a | 24 a | 7.9 b | 4616 a |
| 1/3 fall, 2/3 spring | 53 ab | 38 ab | 39 a | 72 a | 32 a | 10.0 ab | 4424 a |
| All spring | 44 b | 41 a | 41 a | 44 b | 17 a | 13.8 a | 4221 a |

Table 5. Vegetative and reproductive measurements of spring canola and mustard grown under organic conditions in 2008 at WSU Puyallup.

| Hybrid/crop | Crop cover | | | | | Weed cover | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Apr 8 | Apr 18 | May 6 | May 19 | Mean | Apr 8 | Apr 18 | May 6 | May 19 | Mean |
| | % | % | % | % | % | % | % | % | % | % |
| HyLite 292 | 78 c | 100 a | 82 c | 85 c | 86 | 22 a | 0 a | 18 a | 15 a | 14 |
| Hyola 401 | 95 ab | 100 a | 90 ab | --- | 95 | 5 d | 0 a | 10 b | --- | 5 |
| Hyola 420 (a) | 92 b | 100 a | 87 bc | --- | 93 | 15 b | 0 a | 13 ab | --- | 9 |
| Hyloa 420 (b) | 95 ab | 100 a | 82 c | 90 bc | 92 | 12 b | 0 a | 18 a | 10 ab | 10 |
| Pioneer 45H72 | 98 a | 100 a | 92 a | 93 ab | 96 | 8 cd | 0 a | 8 b | 7 b | 6 |
| IdaGold | --- | --- | --- | 95 a | 95 | --- | --- | --- | 5 b | 5 |
| Pacific Gold | --- | --- | --- | 95 a | 95 | --- | --- | --- | 5 b | 5 |
| Mean | 92 | 100 | 86 | 92 | --- | 12 | 0 | 14 | 8 | --- |

| Crop density | | | | | Yield | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Apr 8 | Apr 18 | May 6 | May 19 | Mean | Apr 8 | Apr 18 | May 6 | May 19 | 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 |
| 27ab | 38 ab | 27 c | 34 b | 32 | 5115 a | 6565 a | 5163 a | 5278 a | 5530 |
| 26 ab | 37 ab | 39 a | --- | 34 | 3596 b | 4496 c | 4173 a | --- | 4089 |
| 32 a | 35 ab | 37 ab | --- | 35 | 4360 ab | 5509 abc | 4380 a | --- | 4750 |
| 22 b | 41 a | 26 c | 35 b | 31 | 5316 a | 5741 ab | 4523 a | 4500 ab | 5020 |
| 24 b | 34 b | 26 c | 44 a | 32 | 4154 ab | 3282 d | 2830 b | 2696 c | 3241 |
| --- | --- | --- | 34 b | 34 | --- | --- | --- | 3629 bc | 3629 |
| --- | --- | --- | 32 b | 32 | --- | --- | --- | 770 d | 770 |
| 26 | 37 | 31 | 38 | --- | 4508 | 5119 | 4214 | 4158 | --- |