Growth, Seed Yield, and Oil Production of Three Winter Canola and One Camelina Cultivars, Seeded on Five Fall Dates in the Klamath Basin, 2007-2008

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Introduction, Justification, and Objectives

The recent increase in energy prices and political instability in the Middle East has sparked renewed interest in alternative energy sources and technologies both locally and nationally. As described in our other studies (Roseberg et al., 2007; Roseberg and Shuck, 2008a and 2008b), we have begun testing the agronomic requirements of canola and camelina as potential sources of oilseed crops for biodiesel production. In these studies, canola has grown well and produced fairly good yields relative to existing production areas. However, in the Klamath Basin, spring-seeded crops are highly

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dependent on irrigation. To our knowledge, testing of fall-seeded canola has not been done. Like other crops, fall seeding may allow the grower to take advantage of winter precipitation and a longer growing season before flowering, potentially resulting in higher yields if winter survival and low temperatures during pollination do not reduce stand vigor or seed formation. Thus the objective of this study was to test the ability of several fall-seeded canola varieties to germinate, overwinter, flower, and produce a harvestable seed yield the following summer.

Procedures

Three varieties of canola were tested in this study along with a commonly grown cultivar of camelina (Calena) for comparison[2]. Canola varieties included Athena, Ericka, and the Idaho numbered variety 06UIWC5. This study was seeded at KBREC in a Poe fine sandy loam soil following a triticale cover crop in 2007. Trifluralin (Treflan®) herbicide was applied August 10 at 2.0 pint/ac (1.0 lb a.i./ac) incorporated before seeding with a roto-tiller. No additional herbicides were applied during the study. All plots were fertilized with 12 lb/ac N, 12 lb/ac P_2O_5, 12 lb/ac K_2O, and 15 lb/ac S banded at seeding (applying 12-12-12-15 fertilizer at 100 lb/ac). The study area also received 84 lb/ac N as ammonium sulfate broadcast on June 4, 2008.

The plots were 20.0 by 4.5 ft, (9 rows at 6-inch spacing), with a harvested area of 14.0 by 4.5 ft. Seed was seeded one quarter inch deep at the rate of 7.0 lb/ac of raw seed for the canola varieties and 8.0 lb/ac of raw seed for the camelina with a tractor-mounted Kincaid (Kincaid Equipment Mfg.) plot seed drill. All entries were seeded on five dates in the fall of 2007 (Aug. 14, Aug. 28, Sept. 11, Sept. 25, and Oct. 9). The study was laid out as a split plot design, with seeding date as the main plot and cultivar as the sub-plot, and three replications.

Solid-set sprinklers arranged in a 40- by 40-ft pattern were used for irrigation. The area was irrigated during initial seedbed preparation, twice between the Aug. 14 and Aug. 28 seeding dates, and once each after the Aug. 28, Sept. 11, and Sept. 25 seeding dates. Sufficient rainfall precluded the need to irrigate in October (Table 1). The entire study area received the same rate of irrigation in spring 2008 as the concurrent winter camelina cultivar study grown nearby. All plots were swathed on Aug. 1 using a Swift Mfg. plot swather, and combined on Aug. 5 using a Hege (Hans-Ulrich Hege) plot combine with a 4.5-ft-wide header.

Weather and soil temperature data was collected at the nearby US Dept. of Reclamation Agricultural Meteorological (AgriMet) weather station at KBREC (US Bureau of Reclamation, 2008). Crop data measured at KBREC included crop vigor, grain yield, test weight, plant height, flowering timing, and lodging percent. Cleaned seed samples were sent to the Brassica Breeding and Research Lab (Dr. Jack Brown) at the University of Idaho to measure seed oil content, which also allowed calculation of oil yield.

All measured parameters were analyzed statistically using SAS® for Windows, Release 9.1 (SAS Institute, Inc.) software. Data was analyzed as a split plot design, with seeding date as the main plot and variety as the sub-plot. Treatment significance was based on the F test at the P=0.05 level. If this analysis indicated significant treatment effects, least significant difference (LSD) values were calculated based on the student's *t* test at the 5% level.

Results and Discussion

Canola germination and stand density were good for the first four seeding dates, although plants from the Sept. 25 date were clearly smaller when winter arrived. Some plants emerged from the Oct. 9 seeding date, but were very small and did not survive the winter. There was a significant difference between seeding dates for canola vigor rating on May 19, with the first two seeding dates having more vigorous stands than the third date, which in turn was more vigorous than the fourth date (Table 2).

The camelina germinated fairly well but did not persist well through the winter and produced very low seed yields in all cases. There was a significant difference in seed yield due to both seeding date and cultivar, although the cultivar difference was mainly due to the poor seed yield for camelina. Canola seed yields decreased as the seeding dates got progressively later, especially for the Sept. 11 and Sept. 25 seeding dates. There was no harvestable yield from the Oct. 9 seeding date. There was a significant difference in oil content due to both seeding date and cultivar. Canola seed oil content gradually deceased with later seeding dates. The significant difference between cultivars was mainly due to the lower oil content of camelina, but Ericka tended to have lower oil content than the other canolas.

Oil yield, calculated by multiplying seed yield by oil content, was significantly different between seeding dates and between cultivars. The difference between cultivars was mainly due to the very low seed yields of camelina. Despite some differences in oil content, the ranking of oil yield followed the same pattern as seed yield, both in terms of relative differences between cultivars and in differences between seeding dates, with oil yield decreasing with the later seeding dates.

There was a significant difference in test weight between seeding dates and cultivars, but because there was a significant seeding date by cultivar interaction, the pattern of test weight treatment differences was not consistent. There was a significant difference between cultivars for height, but this was mainly due to the shorter stature of camelina. Among the canolas, Ericka tended to be shorter than the others. The differences in height between seeding dates were close to being significant (P=0.065), with early seeding dates tending to be taller. There was a significant difference between seeding dates for maturity as measured by degree of flowering observed on May 19. This followed a clear pattern, with earlier seeding dates resulting in earlier flowering.

In all these discussions, it should be noted that the winter of 2007-08 was fairly cold (Fig. 1), but unusually heavy snowfalls occurred, especially in January and February. Thus the area was covered with deep snow for most of the winter. In 2007-08, established seedlings of all the cultivars seemed to survive the winter fairly well, but winter survival and performance under bare soil conditions in other years may differ.

Summary and Future Prospects

Under consistent fall irrigation, the winter canola cultivars we tested germinated well, grew well in the fall, survived the winter, and produced harvestable seed from all but the Oct. 9 seeding date. Seed yield decreased dramatically as seeding date progressed later into September, suggesting that winter canola should seeded by late August or early September if irrigation water is sufficient. Under good conditions, fall-seeded canola produced seed yields approaching two tons/ac in our first attempt at a fall seeding. The Aug. 14 and Aug. 28 seeding dates resulted in higher yields than we observed in the 2008 spring-seeded irrigated canola study grown nearby (Roseberg and Shuck, 2008a). Although our studies do not allow direct statistical comparison between fall and spring-seeded canola yield, this observation fits with yield comparisons often seen with other fall-seeded crops compared to spring-seeded crops, assuming appropriate cultivars are used in each case.

The camelina results were poor, despite reasonable stands from the earlier seeding dates. Even where camelina had reasonably good stands in the fall, seed yields were much poorer than what we observed from other cultivars seeded in the nearby winter camelina study (Roseberg and Shuck, 2008b). It may be that the ‘Calena’ cultivar we seeded in this study is less winter-hardy under Klamath Basin conditions, or perhaps the weather was not conducive to pollination at the time of flowering in the spring.

A commercial biodiesel production facility is currently in operation near Klamath Falls, and a Willamette Valley-based company has been scouting for grower contracts in this area, but high grain prices have led growers to seed wheat and barley instead of the more speculative canola and camelina. Depending on relative prices and tax incentives between canola and small grains, canola may find a profitable place in Klamath Basin crop rotations. Although it is not considered a low-input crop, it may be useful as a broadleaf crop in a long-term cereal grain rotation, and may provide other rotation benefits to other crops such as potatoes, but such comparisons are beyond the scope of the present study.

References

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Table 1. 2007-08 Precipitation & irrigation for the winter canola variety x seeding date trial. Klamath Basin Research & Extension Center, Klamath Falls, OR.

Month	Precipitation (inch)	Irrigation (inch)	Irrigation Applications
August	0.18	2.66	4
September	0.15	1.96	2
October	1.74	0.00	0
November	0.78	0.00	0
December	1.60	0.00	0
January	2.63	0.00	0
February	0.65	0.00	0
March	0.53	0.00	0
April	0.19	0.00	0
May	1.69	3.36	1
June	0.66	0.84	1
July	0.03	3.78	3
Total	**10.83**	**12.60**	**11**

Table 2. 2007-08 Results for the winter canola variety x seeding date trial.
Klamath Basin Research & Extension Center, Klamath Falls, OR.

Entry	Seeding Date	Seed Yield (lb/ac)	Rank	Test Weight (lb/bu)	Rank	Height (inch)	Rank	Flowering (% on May 19)	Rank	Vigor	Rank	Oil %	Rank	Oil Yield (lb/ac)	Rank
Athena	Aug 14	3626	2	49.53	7	44.7	1	110	1	4.00	3	38.2	6	1385	2
Colina	Aug 14	47	13	nm	-	nm	-	nm	-	nm	-	33.9	15	21	13
Ericka	Aug 14	3502	3	50.98	3	40.3	3	107	3	4.33	2	37.7	10	1320	3
06UIWC5	Aug 14	3965	1	51.33	2	42.0	2	110	1	3.33	6	39.2	1	1555	1
Athena	Aug 28	2431	6	49.93	6	37.0	6	90	5	3.67	4	39.2	1	950	6
Colina	Aug 28	20	14	nm	-	nm	-	nm	-	nm	-	36.1	12	7	15
Ericka	Aug 28	2840	5	50.27	4	25.3	12	100	4	3.33	6	38.1	7	1082	5
06UIWC5	Aug 28	3377	4	51.39	1	39.7	4	90	5	5.00	1	38.9	3	1305	4
Athena	Sept 11	1014	9	50.07	5	33.0	7	8	10	3.67	4	38.3	5	395	9
Colina	Sept 11	17	15	nm	-	nm	-	nm	-	nm	-	38.0	8	7	14
Ericka	Sept 11	1411	8	49.46	8	30.3	10	33	7	3.33	6	37.8	9	543	8
06UIWC5	Sept 11	1770	7	49.24	9	38.0	5	15	8	2.33	9	38.6	4	682	7
Athena	Sept 25	199	12	nm	-	27.7	11	5	11	1.00	12	36.0	13	73	12
Colina	Sept 25	8	16	nm	-	14.5	13	nm	-	1.00	12	32.3	16	2	16
Ericka	Sept 25	350	11	nm	-	31.0	9	10	9	1.33	11	36.0	13	126	11
06UIWC5	Sept 25	381	10	nm	-	31.7	8	5	11	2.33	9	37.3	11	143	10
Athena	Oct 9	0	17	na	-	na	-	na	-	na	-	na	-	0	17
Colina	Oct 9	0	17	na	-	na	-	na	-	na	-	na	-	0	17
Ericka	Oct 9	0	17	na	-	na	-	na	-	na	-	na	-	0	17
06UIWC5	Oct 9	0	17	na	-	na	-	na	-	na	-	na	-	0	17
Mean		1560		50.28		34.0		64		3.03		37.6		625	
***P* (Seeding Date)**		**<0.001**		**0.001**		**0.065**		**<0.001**		**<0.001**		**0.005**		**<0.001**	
LSD (0.05)- Seeding Date		552		0.96		NSD		15		0.70		1.1		210	
CV Seeding Date (%)		35.4		0.4		22.4		19.6		15.3		2.6		38.0	
***P* (Entry)**		**<0.001**		**0.003**		**0.023**		**0.311**		**0.912**		**<0.001**		**<0.001**	
LSD (0.05)- Entry		404.1		0.5		15		NSD		NSD		0.8		180	
CV Entry (%)		30.7		0.7		21.5		17.5		46.3		2.4		29.2	
***P* (Seeding Date X Entry Interaction)**		**<0.001**		**0.002**		**0.559**		**0.485**		**0.373**		**0.584**		**<0.001**	

Fig. 1. Air and Soil Temps 2007-2008
Winter Canola and Camelina, Klamath Basin Research & Extension Center