

# SPRING CAMELINA PRODUCTION GUIDE

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For the Central High Plains

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Ryan M. Lafferty, Charlie Rife and Gus Foster



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## INTRODUCTION

Camelina, [*Camelina sativa* (L.) Crantz, Brassicaceae] is an old world crop newly introduced to the semiarid west of the United States. Camelina is promising new spring-sown rotation crop due to its excellent seedling frost tolerance, a short production cycle (60-90 days) and resistance to flea beetles. Camelina has a high oil content (~35% oil) and improved drought tolerance and water use efficiency (yield vs. evapotranspiration (ET)) when compared to other oilseed crops.

Camelina is a member of the Brassicaceae (Cruciferae) family. Brassicaceae is comprised of about 350 genera and 3000 species. Important crops in this family include canola/rapeseed, (*Brassica napus* and *B. rapa*); mustards, (*B. juncea*; *Sinapis alba*; *B. nigra*); vegetables (*B. oleacea*); and others. The differences between the genera, Camelina and Brassica include plant height (Camelina is shorter), leaf shape (Camelina is narrower) and seedpod shape (Camelina is nearly round capsule and Brassica is long and bean shaped-pod). Camelina does not cross pollinate with Brassica's.



**Figure 1. Camelina flower and seed pods**

Archeological records indicate camelina was first grown in Europe during the Bronze Age. Known by its Roman name Gold of Pleasure, it was widely cultivated in Russia and Eastern Europe prior to the 1940's. Production of camelina in Europe declined as rapeseed/canola production increased.

There is presently renewed interest in camelina. This interest is partially generated by the high omega-3 content of the oil and its perceived health benefit. Livestock fed camelina meal or oil produce products (eggs, meat) with higher omega-3 fatty acids content. Camelina seed is primarily processed using low capital costs mechanical press technology. Mechanical presses leave 10-12% oil in the meal. Camelina meal contains about 40% protein and 10-11% fiber which is comparable to soybean meal.

As of December, 2009 the Association of American Feed Control Officials, Inc. (AAFCO) has provided a "no objection to use" statement for up to 10% of beef and broiler meal and up to 2% of swine diets to contain camelina meal. If the FDA does not write a regulation under the rules for an FAP 21 CFR 571.1 then they publish a definition for the chemical or material and its use in the AAFCO Official Publication (OP) for state and federal regulatory reference.

This document is available for purchase at the AAFCO website. Research is ongoing and increased feeding levels are expected to be established in the future.

Camelina is adapted to marginal growing conditions. Preliminary water use efficiency research conducted in Akron, CO at the Great Plains Research Center indicates that it has the highest water use efficiency of the tested oilseed crops (canola, juncea, and sunflowers). Camelina is planted early spring (March) and is harvested in early to mid July. Camelina is adapted (low-water use and short production cycle) to fit into the winter wheat based crop rotation systems of the semiarid (10-15 inches precipitation) High Plains.

The historic crop production system of winter wheat/fallow/winter wheat (WW/F/WW) has evolved to a more intensive production system of winter wheat/summer crop (corn/millet/sunflower)/fallow (WW/SC/F). This more productive crop rotation is successful due to the development of no-till/reduced-till production methods. More soil moisture is retained in the field with these techniques which allows for a more intense crop production system. Camelina has unique potential to be successful during the fallow period of these cropping systems in the semiarid High Plains.

## CAMELINA PRODUCTION MANAGEMENT

Even though camelina is an ancient crop, experience and research with camelina production in modern agriculture is limited. Production management information in this publication is a combination of research experience, observations of commercial production, and interpretations of recommendations for related crops (primarily canola). Best Management Practices (BMP) will continue to be developed over the next few years as experience with the crop increases. As with most crops, BMP for camelina will vary from region to region. Growers are encouraged to share experiences, with other growers and researchers working with camelina.

This guide provides preliminary production advice based on research conducted over the last six years. Colorado's "ACRE" (Advancing Colorado's Renewable Energy) grant supported research on planting date, seeding rate, fertility, and the production of this guide. This updated production guide includes data and interpretation from a planting date and nitrogen use study conducted during the unusually cool and wet 2009 season and preliminary information from Sun Grant Camelina Project, a four location coordinated camelina study being conducted in the Pacific Northwest.

## Field Selection and Rotation:

Field selection is a critical first step for camelina production. No herbicides with broadleaf control are currently labeled for use in camelina. As a result it is important to select fields where weed growth has been controlled and field sanitation practiced. Camelina has the ability to precede winter wheat in a WW/F/WW or WW/SC/F rotation. Camelina is an opportunity crop that can displace the fallow portion of these crop rotation systems when soil moisture conditions allow. Other rotational considerations of importance include residual herbicides applied to the previous crop. Research on camelina's susceptibility to herbicide carryover is incomplete. The best reference for seeding camelina is to follow plant-back restrictions specified for canola.

## Varieties:

Only limited plant breeding work on camelina has been undertaken in North America. Several European varieties have been imported and used in the U.S. The most prominent varieties are 'Calena', 'Celine' and 'Lagina'. Blue Sun Biodiesel established a breeding program near Torrington, Wyoming five years ago and has been evaluating camelina germplasm. Blue Sun released the first spring camelina variety developed in the United States and began marketing seed of 'Cheyenne' in 2007 and will be releasing a new variety, Platte for spring planting 2010. Platte is targeted for stable yields in dry challenging environments. It achieved a 4 to 6% yield increase over Cheyenne and nearly 1% higher oil content than Cheyenne and Calena. In multiple trials conducted in NE Colorado, SE Wyoming, and Western Nebraska, Calena and Cheyenne outperformed other entries. Montana State University has released two public varieties, 'Blaine Creek' and 'Suneson'.

## Establishment:

In the semiarid High Plains, shallow (¼ to ½ inch deep) drilling into a firm alfalfa type seed bed has been most successful. Best results with dryland camelina have been achieved when the crop was seeded into soils with a good moisture profile (2-3 feet of soil moisture). Seeding rate recommendations in Europe and Australia are 6-8 lbs/acre. Seeding rates of 3-5 lbs/acre have given good stands in Colorado, Nebraska, Montana, and Wyoming when seeding conditions were good. However camelina seed is small, about 400,000 seeds/lb, making it difficult for most grain drills to plant only 3 lbs/acre. When grain drills are not capable of achieving low seeding rates, filler, such as corn grit or rice hulls can be used.



Figure 2. Camelina seeds

Camelina has also been planted by broadcasting the seed onto a clean seed bed followed by a packer. Good seed-soil contact is critical and more difficult to achieve with broadcast

seeding methods. Early planting is particularly advantageous when broadcast seeding because it allows time for the seed to be incorporated into the soil by weather events. It is advisable to increase rates if seed is broadcast, conditions are very dry, or seeding date is early (maximum 10 lbs/acre). An ideal camelina seedbed should be firm, moist, weed free, and allow for good seed-soil contact. Failure to establish is much more common when the seed is broadcast as opposed to shallow drilling.

One broadcast seeding method worth exploring is the use of a grass seed planter, such as those made by Brillion. These turf planters broadcast the seed, cover the seed, and pack the bed in a single pass. Research conducted under the Sun Grant Camelina project in the PNW during 2008 and 2009 generally confirms that direct sowing is better than broadcast seeding, however, the 2009 Pendleton Oregon results showed broadcast seeding performed significantly better than sowing when they switched to a Brillion drop seeder for the broadcast seeding method (1). Another experimental seeding method is to broadcast the seed in the middle of winter, termed as "dormant seeding". Research on these planting methods has not been completed, so dormant seeding and broadcast seeding is not currently recommended.

## Discussion

Camelina is a spring seeded crop that benefits from early planting dates. An oilseed phenology study conducted by Pavlista et al., in Scottsbluff, Nebraska 2005 showed a clear yield advantage for the March 24<sup>th</sup> planting date (1,024 lbs/acre) versus the February 24<sup>th</sup> planting date (472 lbs/acre) (2). Rapid stand establishment associated with warmer soil temperatures in March appear to have translated to increased yield. A planting date study conducted by CSU extension at Great Plains research station in Akron, CO in 2009 concluded that April 15<sup>th</sup> planting date was better than the earlier planting dates (Table 1). However, 2009 was an abnormally cool year (as indicated by the August 13<sup>th</sup> harvest date vs. the expected early to mid July timeframe). Also note the low yields are probably attributable to low fertility, as the site was not fertilized and residual N is estimated at ~25 lbs.

Planting Date	YIELD/acre	
8/13/09		
3/20/09	325	c
3/26/09	313	c
4/3/09	342	c
4/7/09	380	b
4/15/09	427	a
4/23/09	404	ab

Table 1. Planting date

In NW Colorado successful spring camelina crops have been planted from mid-March through mid-April. Germination occurs rapidly after soil temperatures reach 38-40°F. Camelina seedlings have excellent frost and cold tolerance. Seedlings have withstood temperatures in the low teens without damage at multiple locations. Acceptable

stands should have about 10 to 25 plants per square foot. Extremely narrow row spacing (3" to 4") should provide increased competition for weed competitiveness. If equipment row spacing is 6" to 11" then crosshatching is another potential method that should increase plant density and weed competitiveness.

No-till planting system is the preferred method because of improved soil moisture retention, shallow firm seed bed and reduced field/machinery time. Due to the lack of labeled crop aids for broadleaf weed control conventional tillage such as a mold board plow has been used to provide a clean seed bed. All planting options have benefits and drawbacks. Regardless of planting method, consistent good seed-soil contact is necessary for germination and uniform stand establishment. A firm alfalfa type seed bed allows for good seed-soil contact while only planting the seed 1/4 inch deep. Avoid heavy plant residue in the seed furrow. An ideal camelina seedbed should be firm, moist, weed free, and allow for good seed-soil contact. Lack of rapid uniform emergence is perhaps the biggest challenge facing first time camelina growers.

#### 2008 On-farm Experience

Duane Sellmer of Nutri-Turf farms in Fort Collins experimented with a broadcast seeding method that used a blend of seed/fertilizer applied with an air fertilizer applicator. The fertilizer was used as the carrier for camelina. A high seeding rate of 10 lbs/acre was used to compensate for early seeding and wind. Approximately 40 units N per acre were applied. The seedbed was firm with a frost line about three inches below surface. Good seed/soil contact was insured by going over the field with a mulcher (teeth down to 1 inch resulting in 1/2 inch seed set depth). A snow-rain mix was predicted for the next day but did not occur. Despite planting in early February, no moisture was received until 4/16/08. Good emergence did not occur until a week after the precipitation event and the weeds came right along with the late camelina.



**Figure 3. Broadcast seeding with air machine**

Figure 4 shows the late camelina directly below the pen, kochia directly above and the pen points to a rare early camelina plant that emerged soon after planting.



**Figure 4. Two camelina emergence dates**

Unfortunately this field was eventually abandoned due to weed pressure, but the authors are confident that a more timely precipitation event would have allowed all the camelina to emerge before the weed population directly resulting in better competition and a harvest.

#### **Soil Fertility:**

Limited research has been completed pertaining to camelina's fertility requirements on the High Plains. Camelina has been promoted as being productive without additional fertility. However, like other crops, adequate fertility is required to produce optimum yields. A camelina crop will require about 1 lb of N per 25 lbs of seed yield. Grower production practices have trended toward using 35 to 40 lbs of N/acre.

A nitrogen fertility trial conducted by CSU extension in Haxtun, CO showed no significant differences in seed yield, however, there was a trend toward higher yields with increasing nitrogen fertilizer (Figure 5). It appears the test was conducted on a field with adequate residual nitrogen (~25 to 30 lbs/acre). The entire test received an application consisting of potassium (40 lbs/acre), Sulfate (35 lbs/acre), and phosphate (40 lbs/acre). Available water during the production period was about 15 inches. Yields were below that expected for the amount of water and fertility available. The authors divided the data into two groups due to the peak yield occurring with just 35 lbs N and inserted the trend lines for the respective groups to illustrate how camelina is unresponsive to elevated levels of nitrogen (greater than 75 lbs N/acre) (Figure 5).

For canola, phosphate and potassium should be available to the crop in an N:P:K ratio of 5:3:4. Research with camelina is incomplete at this time but this recommendation should be adequate. Sulfur does not appear to be as critical as with other related crops but it should be amended if the soil is low in S. If wheat has responded to S amendments, camelina will likely respond to additional S on that field. Utilize soil tests to insure minimum levels of PKS are available.

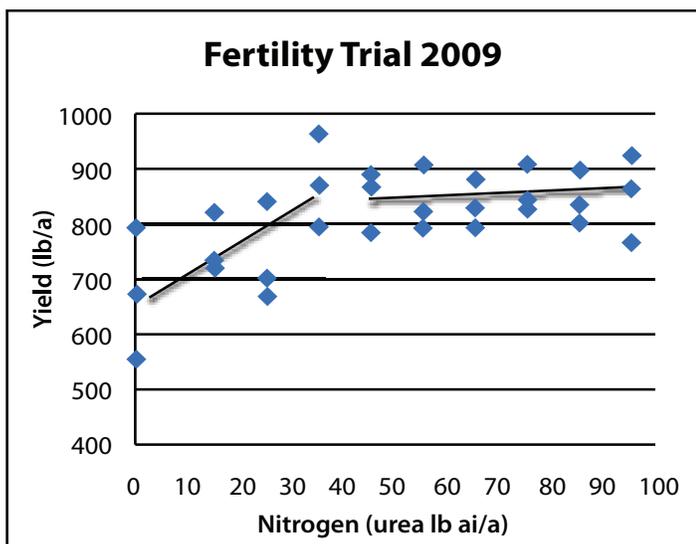


Figure 5. Fertility Trial (Haxtun, Colorado, 2009)

#### Discussion - P K S

In general camelina has not been shown to respond to phosphorus (P), potassium (K) and sulfur (S) fertility. However, these constituents should be available at minimum levels: 12 ppm, 30 ppm and 15 lb/acre for P, K, and S respectively. One study in Montana showed a response to phosphorus when soil levels of phosphorus were near zero (below 12 ppm) (3). This same study concluded that camelina was unresponsive to sulfur but the soil levels of sulfur were all excellent (above 78 lbs/acre). Therefore, it is recommended that a minimum level of P, K, and S be present in the soil. The Montana study pinpointed the requirement for P at 12 ppm or above and recommended growers apply 15 lb P<sub>2</sub>O<sub>5</sub>/acre if needed. Potassium (K) is typically required at a slightly higher level than P in oilseed crops indicating that 16 ppm is a bare minimum and we recommend insuring the soil has 30 ppm K to be sure the nutrient is not a limiting factor. Similarly, we recommend that 15 lb/acre of sulfur be available.

#### Discussion - N

In general, camelina production is attractive because it has low production costs and yields can be profitable in spite of very low available moisture (6 to 15 inches). Most of the studies have shown a maximum nitrogen need and a slope of decreasing return. Table 2 indicates a flat response to nitrogen and a threshold seeding rate above 2lb/acre. (However, note that for farm situations the higher seeding rate may help with weed competition which was not a factor in this controlled study.) A review of other nitrogen fertility studies indicates that there is a clear slope of diminishing return. More research trials are needed to define the optimum economic nitrogen fertility rate. Most fertility studies are irrigated trials because it allows for good yield response curves from various fertility rates. However, for dryland farmers in the semiarid High Plains water is the limiting factor which means it is prudent

to error on the low side of nitrogen rate. Finally, it is highly recommended that minimum levels of nitrogen are available (30-40 lbs/acre).

Table 2: The effect of nitrogen and seeding rate on yield in the 2008 irrigated camelina agronomy trial, Yellow Jacket.

Variety	Seeding Rate (lb/ac)	Nitrogen Rate (lbs/ac)			Average Seeding Rate (lb/ac)
		22	82	142	
Calena	11	2071	2176	1977	2075
Calena	5	2026	1999	2019	2014
Calena	8	2089	2044	1872	2002
Calena	14	2025	2106	1849	1993
Calena	2	1561	1755	1652	1656
Average Calena		1954	2016	1874	1948
Cheyenne	8	1822	1887	1941	1884
Cheyenne	14	1863	1819	1815	1833
Cheyenne	11	1784	1910	1776	1823
Cheyenne	5	1916	1891	1575	1794
Cheyenne	2	1575	1516	2275	1789
Average Cheyenne		1792	1805	1876	1824
<b>Average N</b>		1873	1910	1875	
<b>LSD<sub>(0.05)</sub></b>					139
<b>CV (%)</b>					14
<b>Trial Average</b>					1886

\*Yield Converted to 8.5% moisture

#### Water Use Efficiency:

Camelina demonstrated a water use efficiency of Camelina “Yield=127lbs/acre-inch\*(ET-3.04)” over a 3-year gradient irrigation study (4). This is the best water use efficiency for oilseed crops evaluated at the Golden Plains Area Extension Service in Akron, Colorado.

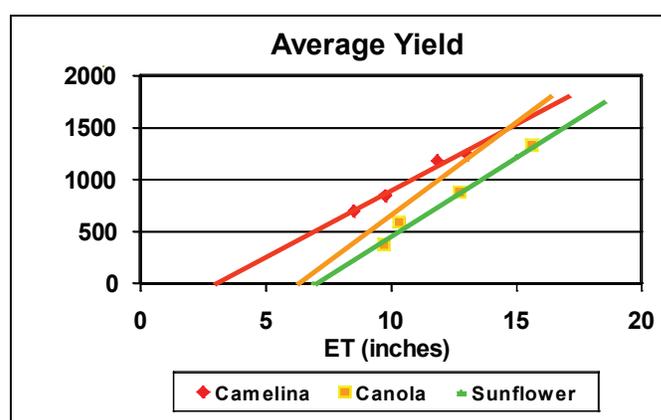


Figure 6. Oilseed crop water use efficiency

#### Pest Control:

Sethoxydim (Poast) is the only herbicide registered for use on camelina. BASF received this label for ‘Gold of Pleasure’ (camelina) in 2008 (5). Poast is a post emerge herbicide effective on most grasses if applied at the correct

stage of growth. It has no effect on broadleaf weeds. As with all pesticides, follow label instructions. Several other herbicides have been successfully used on research trials and seed increases. Labels are being sought for some of the compounds that appear most useful. Glyphosate (Roundup) is being investigated as a burn down treatment prior to camelina emergence. Camelina seedlings are not very competitive for a couple of weeks after emergence but are very competitive once established. Successful camelina production is currently dependant on using good field sanitation practices and field selection and getting the crop off to a better start than the weed populations.

Currently, no insecticides or fungicides are registered for use with camelina. However, spring camelina appears to be tolerant to most insect pests, including Flea beetles which are a concern for canola production in the region. In the semiarid conditions of the High Plains, diseases causing economic damage to camelina have not been observed. If insect or disease damage is observed in your production, please contact your county agent, crop consultant, or one of the many researchers in the region working with camelina.

### Harvest:

Harvest dates vary from early to mid July depending on the seeding date, precipitation, temperature, and harvest method. In general, direct harvesting of camelina is preferred over swathing. The extra swathing harvest step is probably not necessary unless green weed populations are large enough to adversely affect harvest. If swathed, it should be done when pod color changes from green to about 65% yellow.

Harvest should begin at 8% seed moisture to ensure proper storage quality. At this point the lower stems may still be green. The crop matures rapidly and needs to be harvested within a few days of maturity. Camelina has good shatter tolerance when the pods are green but will shatter during weather events when mature. When direct cutting, camelina will shatter if the pods are batted by the reel, therefore reel speed should match ground speed. Header height should be set as high as possible while ensuring the entire crop is being harvested. The concave should be opened up to allow for easy passage of the plant material. Producers have reported that a 9/64" screen installed over the lower sieves produces good separation of the seed from the seed pod and stem pieces. Use settings as for canola and adjust accordingly.

### Volunteer Camelina:

Germination of camelina seed that makes good soil contact after harvest will occur within three weeks of the first significant rain event. Volunteer camelina is easily controlled with typical fall chemical fallow operations. Volunteer camelina left uncontrolled can nearly achieve maturity before the first fall freeze. This weather event can act as a

natural desiccant. There may be opportunity to harvest two camelina crops in one year, but further research is needed to establish its viability.

### Market:

Camelina is a specialty crop and producers should be sure they have a contracted buyer before planting.

### Additional Information:

Additional information can be obtained by contacting Blue Sun: 303-865-7700 or go to [www.goBlueSun.com](http://www.goBlueSun.com).



Figure 7. Camelina seedlings 20 days after seeding



Figure 8. Camelina in flower



Figure 9. Developing camelina seed pods

## References:

- (1) Karrow, R. Sun Grant Quarterly Report, DOT-Funded Projects, Development of Camelina as a Low-Input Oilseed Crop for Oregon, Idaho and Washington; Oregon State University, September 2009.
- (2) Pavlista, A. and Baltensperger, D. Phenology of Oilseed Crops for Bio-Diesel in the High Plains. Issues in New Crops and New Uses. 2007. ASHS Press.
- (3) Jackson, G.D. 2008. Response of Camelina to Nitrogen, Phosphorus, and Sulfur. Fertilizer Facts, Number 49. Montana State Univ, Extension Service.
- (4) Nielsen, D. and Schneekloth, J. Personal communication. January 2009.
- (5) Poast Herbicide Supplemental Label. For use in Gold of Pleasure. EPA Reg. No. 7969-58. BASF. <http://www.pdis.org/AgAlerts/ViewFile.aspx?ID=34511&type=pdf>.

### Camelina Production Basics:

- ✓ Good quality seed
- ✓ Firm seedbed
- ✓ Clean field sanitation
- ✓ 1 lb N  $\approx$  25 lbs seed production
- ✓ or 35-40 lbs N for 1000lb yield\*  
\*provided good moisture and low weed pressure
- ✓ Seeding rate  $\approx$  3 to 5 lb/a
- ✓ Row spacing: 8" or less
- ✓ Planting date: Mid-March to mid-April  
( $\approx$  35 to 40°F soil temp)
- ✓ **Timely harvest**



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### Blue Sun Agriculture Research & Development

14143 Denver West Parkway #100  
Golden, CO 80401

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