Forever Green Initiative

Winter Camelina Growers Guide for the Upper Midwest

University of Minnesota Forever Green Initiative
with support from USDA-ARS, NDSU, Cargill

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Winter Camelina at a Glance

Overview: Winter camelina is a very winter hardy Brassica related to canola. The seed has a high concentration of oil (36–42%) that is highly desirable for making low carbon biofuel. The oil and meal are also being explored for food-grade and feed-grade uses. Winter camelina is also an excellent, winter hardy cover crop option for the upper Midwest. There are winter and spring types; be sure to select winter types.

Seeds Per Pound: ~400,000–450,000; 50lb bushel

Planting Date: September 20–October 20
Estimated date range for Minnesota, North Dakota, South Dakota & Wisconsin

Seeding: Plant 6–8 lbs/acre, ½–¾ in. deep. 6–7.5 in. spacing, population of 15 plants/sq ft.

Seeding Equipment: Drill, air seeder, Brillion, or broadcast & roll.

Varieties: 'Joelle', 'Dakota Early Riser'

Yield: 600–1200 lbs/acre

Harvest: Direct combine. Can desiccate or swath. Harvest time frame is ~June 20–August 1 based on latitude. Harvest moisture <12%.

Site Selection: Prefers medium to well-drained soils. Avoid poorly drained or saturated soils.

In Rotation: Best planted after spring small grains, early soybeans, dry beans, silage corn, sunflowers, canning crops.

Fertility: 40–60 lbs N/acre for maximum yield potential. No formal guideline for P, K & S but do soil testing to ensure adequate levels for production.

Weed Control: Highly competitive with weeds once established. Refer to herbicide section below.

Diseases/Pests: Camelina is a host for white mold. Camelina is susceptible to downy mildew and Aster Yellows.

Concerns: Watch herbicide rotational restrictions, especially any carryover chemistry on grain corn or soybeans ground. Cannot emerge through deep residue.

Winter Camelina Markets: Oil for Fuel, Feed & Food

Due to its industrial and refining properties, as well as its limited input costs, camelina oil is highly desirable as a feedstock for making low-carbon intensity biofuel. The airline industry, fuel oil companies and large agricultural supply chain companies all have growing vested interest in intermediate oilseed crops like winter camelina. Additionally, winter camelina oil has high levels of alpha-linolenic acid or ALA. This is one of the omega-3 fatty acids that are held in high regard by nutritionists due to their heart health properties. Camelina oil also contains a natural antioxidant called tocopherol (also known as vitamin E) that helps prevent oxidation of its unsaturated fatty acids. Camelina meal is a byproduct from processing which can be used in the diets of broiler chickens, cattle fed in confinement for slaughter and laying hens.

Winter Camelina Growth & Development

Winter camelina seeds germinate and emerge relatively quickly after planting. Seedlings produce rosettes before freeze up. Rosettes are circular bundles of seedling leaves that may be 1”– 6” in diameter by late fall. Winter camelina is very winter hardy (at least equivalent to winter rye) and can vernalize as very small seedlings. The plant has been reported to survive temperatures as low as -20°F for 3–4 days with minimal snow cover. Most winter injury happens in February–March with repeated freezing/thawing and ice sheeting. Even with very late plantings through mid-October, with seedlings only in the cotyledon stage by early November, the young camelina plants still reliably survive Minnesota winters.

As the snow melts in March or April, the rosettes resume growth. Typically they produce more leaves and by mid to late April they begin “bolting.” Bolting refers to the initiation of flower stalks. Yellow flowers usually are visible in early to mid-May. The flowers are self-fertile (they pollinate themselves), but many insect pollinators, including honey bees, also will visit the flowers for nectar and pollen.

Small pear-shaped pods (silicles) develop from the flowers. Each silicle contains 12–25 small seeds. The capsules tend to be mature and are ready to harvest by late June or early July. At that time the plants are about 30” tall, with most of the seed capsules in the upper half of the plant. Standard machinery can be used to harvest the crop’s small seeds directly.

Rosette (Early April)

Bolting (Early May)

Initial flower (Mid-May)

Variety Selection

The vast majority of winter camelina research in Minnesota has been performed with ‘Joelle’. It has superior cold and freezing tolerance.

The University of Minnesota has initiated a breeding program for winter camelina to hasten flowering time and increase seed yield. Consequently, new and productive varieties with equally high cold tolerance to ‘Joelle’ are expected to be released in the future for Minnesota. In the meantime, our recommendation for Minnesota and other upper Midwest growers is to plant ‘Joelle’ or ‘Dakota Early Riser’.

Site Selection

Winter camelina is drought-tolerant and grows well on many soil types. However, it does not tolerate waterlogging, so clay soils and fields with poor drainage should be avoided. When sown in depressions that collect water in spring, death of rosettes has been noted.

It is critical to choose herbicides in the preceding crop (or two crops) carefully to avoid using products that will hurt camelina emergence and growth. Because winter camelina has not been widely planted in the US, it is not listed as a rotational crop on most herbicide labels. (Note: herbicide labels that do list camelina typically use the name “gold of pleasure” or “false flax”).

Camelina often responds to herbicides similarly to canola, as they are closely related. Table 1 lists herbicide active ingredients used in corn, soybean, small grains, sugar beet and potato and the label guidelines for the time period between herbicide application and when canola or crops not listed on the label (camelina) may be planted (Table 1).

Winter camelina is most likely to be negatively affected by herbicide carryover in the soil from ALS-inhibiting herbicides (Group 2, sulfonylureas, imadazilinones) and Photosystem-II inhibiting herbicides (Group 5, triazines). Drought or cool temperatures slow herbicide degradation in the soil. It is always useful to conduct a bioassay where you dig some soil from the field and plant camelina into it a few weeks before you intend to plant to make sure that residues remaining in the soil are not great enough to reduce stand or injure seedlings. Cover crop rotational guidelines are also a good proxy for winter camelina – herbicides that affect radish, rapeseed, or turnip will hurt camelina.

Table 1. *Replant intervals for canola and camelina for herbicides used in corn, soybean, small grains, sugarbeets and potatoes. Mode of Action (MoA) is the herbicide mode of action group. The product label listed is the one used to determine the replant interval for this table. If a different product is used that contains the same active ingredient, please consult that label.*

-------- months --------

Active Ingredient	MoA	Product Label	Canola	Camelina
clethodim	1	Select	0	0
fluazifop	1	Fusilade DX	1	1
quizalafop	1	Assure II	0	0
sethoxydim	1	Poast	0	0
chlorimuron	2	Classic	18	30
chlorosulfuron	2	GleanXP	bioassay	bioassay
cloransulam	2	FirstRate	18	18
florasulam	2	Starane Flex, Orion	9	12
flucarbazone [a]	2	Everest	9	bioassay
flumetsulam	2	Python	26	26
halosulfuron	2	Permit	15	36
Imazamox	2	Raptor	18	18
imazaquin	2	Scepter	18–26	18
Imazethapyr [b]	2	Pursuit	40	40
nicosulfuron	2	Accent Q	10	18
primisulfuron	2	Beacon	18	18
propoyxcarbazone	2	Olympus	22	24
pyroxsulam	2	PowerFlex	9	12
Rimsulfuron [c]	2	Resolve Q	10–18	18
thiencarbazone	2	Varro	9	bioassay
thifensulfuron	2	Harmony SG	1.5	1.5
tribenuron	2	Express	1.5	2
triflusulfuron	2	Upbeet	0.5	0.5
pendimethalin [d]	3	Prowl H2O	12–20	12–20
trifluralin	3	Treflan	0	0
2,4-D choline	4	Enlist One	1	1
clopyralid	4	Stinger HL	0	0
dicamba	4	Clarity	4	4
fluroxypyr	4	Starane Ultra	4	4
halauxifen	4	Elevore	0.5	9
MCPA	4	MCPA	0	1
atrazine	5	Aatrex	2 CS	2 CS
linuron	5	Linex/Lorox	4	12
metribuzin	5	Mauler	18	18
simazine	5	Princep	2 CS	2 CS
bentazon	6	Basagran	0	0

			-------- months --------	
Active Ingredient	**MoA**	**Product Label**	**Canola**	**Camelina**
bromoxynil	6	Moxy 2E	1	1
pyridate	6	Tough	2	2
glyphosate	9	Roundup	0	0
glufosinate [e]	10	Interline	0	0
clomazone	13	Command	16	16
acifluorfen	14	Ultra Blazer	3	3
carfentrazone	14	Aim	0	0
flumiclorac	14	Resource	1	1
flumioxazin [d]	14	Valor	4–12	4–18
fluthiacet	14	Cadet	0	0
fomesafen	14	Flexstar/Reflex	18	18
lactofen	14	Cobra	0	0
pyraflufen	14	Vida	1 day	1 day
saflufenacil [d]	14	Sharpen	4–9	4–9
sulfentrazone	14	Spartan	12	24
tiafenacil [d]	14	Reviton	4–6	4–6
acetochlor	15	Surpass NXT/Harness	18	18
Dimethenamid [d]	15	Outlook	4–6	6–9
EPTC	15	Eptam	NCS	NCS
Ethofumesate [d]	15	Nortron	6–12	6–12
flufenacet	15	Define SC	12	12
Pyroxasfulfone [d]	15	Zidua SC	12–18	18
s-metolachlor	15	Dual II Magnum	12	12
diflufenzopyr	19	Status	4	4
paraquat	22	Gramoxone	0	0
bicyclopyrone	27	Acuron, Acuron Flexi, Talinor	18	18
isoxaflutole	27	Balance Flexx	18	18
mesotrione	27	Callisto	10	18
pyrasulfotole	27	Huskie	9	bioassay
tembotrione	27	Laudis	10	18
tolypralate	27	Shieldex	9	12
Topramezone [d]	27	Armezon/Impact	9–18	18

Bioassay – a field bioassay should be conducted before planting to ensure there is no injury to the crop.
2 CS – 2 cropping seasons (approximately 24 months)
NCS – next cropping season (approximately 12 months)
[a] 24 month replant interval listed for mustard.
[b] Field bioassay also required.
[c] For canola, longer interval (18 months) in Red River Valley or if less than 15" precipitation received during growing season
[d] Depends upon herbicide rate, tillage practice, rainfall, or application time, or a combination of those factors
[e] Some glufosinate formulations have a 6 month replant interval.

Planting Time and Seedbed Preparation

In Minnesota successful plantings occur anytime from September 20–October 20. There is no advantage to planting winter camelina earlier than September 15; in fact, overly mature camelina rosettes going into winter are more susceptible to winterkill vs. smaller seedlings.

It is recommended that winter camelina seeds be drilled, no-till drilled, air seeded or broadcast & rolled into a prepped seedbed or no-tilled into spring wheat, soybean, dry bean, sunflower, or silage corn residue. Most research plots were planted into spring wheat stubble; this was done initially to ensure overwintering by trapping an insulating layer of snow amongst the wheat stems. However, winter survival was equally high even in years without much snowpack.

Growers on-farm have successfully planted winter camelina following oats or other spring grains, silage corn, soybeans, canning crops, and terminated perennial forages. Fall growth of seedlings is greater in the absence of residues from previous crops, and survival is equally good. However, high amounts of residue like after grain corn harvest, can hinder seedling establishment unless the residue is incorporated. Avoid seeding into fields with a history of pennycress or other winter annual weeds and fields with a history of winter grain production (e.g. winter wheat, winter rye, winter triticale, etc.). These plants can grow in the new stand of camelina causing volunteer issues and poor harvest conditions.

Recent research has looked at broadcast seeding with a high clearance machine or aerial seeding into grain corn at tasseling and up to R6. Seedling establishment was quite high, but during the following spring the high levels of corn residue severely suppressed growth and development of the camelina. However, if the corn residue was baled and removed, and only 12 in. stalks remained in fall, camelina seedling growth was vigorous in spring.

Production Field of Winter Camelina; Greenbush, MN.

Seeding Depth

Winter camelina has very small seeds, each about 1 mm wide and 2 mm long, at about 400,000 – 450,000 seeds/lb.

Best results occur with a planting depth of ½–¾ in. If soil moisture is limited in the fall, deeper planting depths of 1 inch are recommended; the seeds are quite vigorous for their small size and have emerged from 1.5 in. seeding depth.

Seed using a well calibrated drill or no-till drill with press wheels, air seeder or Brillion grass seeder.

Broadcast seeding can lead to very inconsistent stands, especially without incorporation. If seed must be broadcast, a harrow or roller-packer should follow to ensure good seed-to-soil contact. If broadcast seeded into any amount of previous crop residue, residue needs to be managed especially before growth of camelina rosettes in spring. Broadcast seeding is not recommended if planning on relay-cropping soybeans.

Seeding Rate, Row Spacing, and Plant Population

Recommended seeding rate for winter camelina is 6 to 8 lbs/acre for drilling, 8 to 10 lbs/acre for broadcasting to assure sufficient stands. Successful camelina stands and harvest populations have been achieved on-farm with 4 lbs/acre with the appropriate equipment and metering. If you do not have access to those tools, go with the recommended rate of 6-8 lbs/acre. Narrow row spacing of 6”–7.5” is recommended for maximum yield potential and good weed suppression.

Although a target density of about 15 plants per square foot is desired, plants in sparse populations branch readily. Consequently, thin stands and low seeding rates still can produce high yields.

It’s recommended to terminate field-scale stands of less than 7 plants/sq ft to avoid weed competition and harvest losses. If you are already contracted with a buyer, make sure to check with them before termination. In a research context, stands of only 4 plants/sq ft sometimes yielded as much or more than those at the target density. However, higher densities near the targeted

amount do a much better job of suppressing fall and early summer weeds.

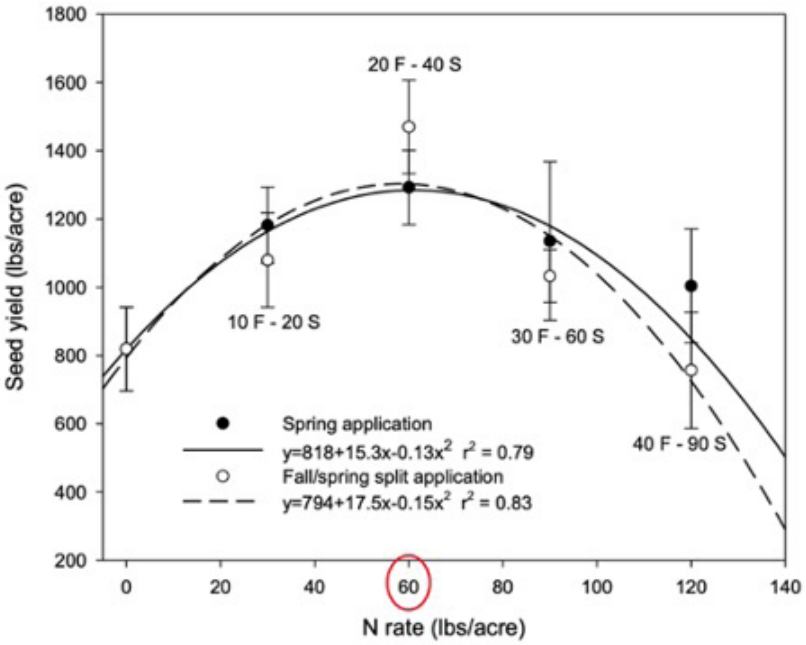
Stands and stand counts should be evaluated in the spring after green up.

Fertility

For maximum yield potential of 1000–1300 lbs/acre; it is recommended to spring apply 40–60 lbs N/acre. Standard recommendations for P have not been determined but up to 25 lb/acre of P is advised for profitable production incorporated at planting time if soils have known deficiencies (<16 ppm P).

When calculating N needs, take into account the N credit from the previous crop (especially soybeans, dry beans, other legumes and manure history). The requirement for sulfur is not well understood for winter camelina as it is for some other oilseed crops, and many reports suggest extra sulfur is unnecessary.

Nitrogen response curve for winter camelina



Graph courtesy Russ Gesch, USDA-ARS.

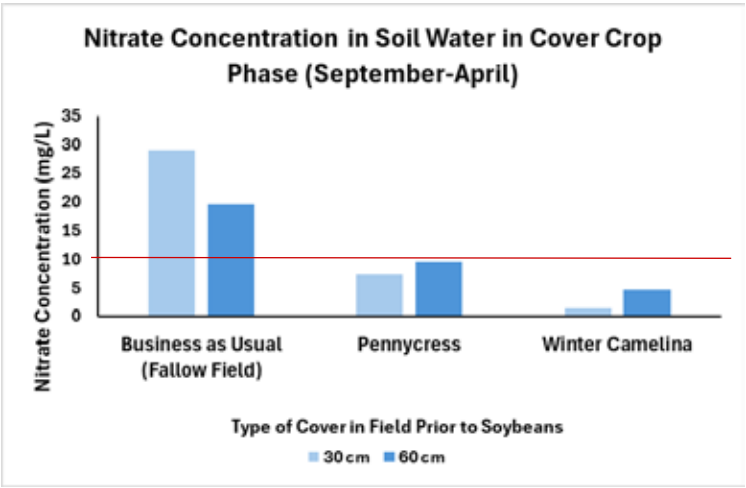
Winter camelina is effective at sequestering excess soil nitrate in the fall and spring, thereby preventing nitrogen leaching into groundwater or surface water. Research suggests it is just as effective at sequestering N as winter rye (see results below).

The best time to apply fertilizer is early spring before the winter camelina bolts in Mid-to-Late April (or whenever it's fit to apply in early spring). Winter camelina seedlings grow fast and more luxuriantly when fertilizers are applied at or near the time of bolting and does not hamper winter camelina's ability to sequester residual nitrates in fall and early spring. In Minnesota we have had good results with delaying broadcast fertilizer application until after snowmelt in late March or early April when the soil has begun to thaw. Research on using a split fall/spring application compared with spring-only applications has demonstrated that there is no yield advantage to using a split application, and there is a greater likelihood of unwanted nitrogen loss if fertilizer is applied in fall. Studies comparing the effects on plants and the environment of broadcasting versus incorporating fertilizers have not been conducted yet.

Measurement Method:
Lysimeters

Years:
2015 & 2016

Location:
Stevens County, MN



Note: Business-as-Usual = no-till management with fallow field prior to soybean planting

Source: Table 2, Weyers et al, 2019.

Weed control

Conventional Weed Management

There are a few herbicides labeled for use in camelina, usually listed as ‘’Gold of Pleasure” or ‘’False Flax” on the label (Table 2). Most of these herbicides include ‘’Gold of Pleasure” as a member of the Rapeseed Subgroup 20A.

Well established stands of winter camelina are vigorous and can provide suppression of spring germinating weeds. Camelina seedlings, however, are tiny and do not compete well with other plants; site selection is key to avoid fields with a history of problem weeds, winter grain, and/or winter annual weeds.

Fall plantings of winter camelina typically do not require pre-plant herbicide applications. However, special situations can arise where treatments may be necessary. For example, when no-till drilling into wheat stubble, if numerous spring small grain volunteers are present, then preplant glyphosate (e.g., Roundup), glufosinate (e.g., Interline), or some other burndown herbicide should be applied.

If high densities of summer-annual weeds are expected to be a problem, the herbicides listed in the below table safely can be applied preplant incorporated (PPI, shallowly incorporated in the soil) or preemergence (PRE; applied to the soil surface before the crop and weeds emerge). If camelina seedlings are intermixed amongst wheat volunteers, then a grass herbicide such as quizalofop (e.g., Assure at 5 oz/A) or sethoxydim (e.g., Poast at 1 pt/A), plus crop oil concentrate or surfactant, should be used to control volunteer wheat, and other grassy weeds, such as foxtail. If high densities of weeds are expected, there are a few herbicides that may be shallowly applied preplant incorporated (PPI) or preemergence (PRE : applied to soil surface before planting camelina) that may suppress weed growth and help establish a robust camelina stand.

Once camelina seedlings are well established by mid-to-late October, they form a carpet of rosettes that is competitive with weeds, not only in the fall, but also the following spring when summer annuals begin to emerge. However, some weeds, like dandelion, which likely germinated the previous fall, can thrive in camelina stands in spring.

Table 2. (Below) *Herbicide products registered for use on camelina. At the time this publication was prepared the products listed below were also registered for use in Minnesota.*

Use pattern	Active ingredient	Registered Product	Manufacturer
Preplant Burndown			
	Carfentrazone	*Aim*	*FMC*
		Antik EC	*Atticus*
		Longbow EC	*Nufarm*
	Caprylic/Capric Acid [a]	*FireWorxx* [b]	*OHP*
		HomePlate [b]	*Certis*
	Glufosinate [a]	*Interline*	*UPL*
	Glyphosate [a]	*Cornerstone K*	*Winfield United*
		Credit 41 Extra	*Nufarm*
		Credit 5.4 Extra	*Nufarm*
		Credit Xtreme	*Nufarm*
		GlyStar K-Plus	*Albaugh*
		Honcho K6	*Bayer*
		Roundup Powermax 3	*Bayer*
	Pyraflufen	*Vida*	*Gowan*

Use pattern	Active ingredient	Registered Product	Manufacturer
	Quizalafop	*Targa*	*Gowan*
Preplant Incorporated (PPI)			
	Trifluralin	*Agri Star Trifluralin 4EC*	*Albaugh*
		Treflan TR-10	*Gowan*
	Ethalfluralin	*Sonalan HFP*	*Gowan*
Preemergence (PRE)			
	Clomazone	*Caravel*	*Sipcam Agro*
Postemergence (POST)			
	Clethodim [c]	*Arrow 2EC*	*ADAMA*
		Avatar	*Innvictis Crop Care*
		Avatar S2	*Innvictis Crop Care*
		Ceridian	*Atticus*
		Clethodim 2E	*Albaugh*
		Tide USA Clethodim 2EC	*Tide International USA*
		Willowood Clethodim 2EC	*Willowood*
	Quizalafop [d]	*Assure II*	*AMVAC*
		Targa	*Gowan*
	Sethoxydim [d]	*Poast*	*BASF*
Harvest Aid or Defoliant			
	Saflufenacil [e]	*Sharpen*	*BASF*
Harvest Aid or Defoliant			
	Caprylic/Capric acid	*All products listed under preplant burndown*	*All products listed under preplant burndown*
	Carfentrazone	*All products listed under preplant burndown*	*All products listed under preplant burndown*
	Glyphosate	*All products listed under preplant burndown*	*All products listed under preplant burndown*

a Some products also allow for Preemergence burndown use (after camelina is planted but before it emerges).
b OMRI listed product (eligible for use on certified organic farms).
c 70 day preharvest interval
d 60 day preharvest interval
e Do not apply to camelina grown for seed production.

Organic Weed Management

Certified Organic growers have raised good quality crops of winter camelina. Choose sites with a history of good weed control or low weed seed-banks. Avoid fields with a history of winter grain production.

A well-established stand is critical for controlling weeds in an organic system.

We did hear reports of one organic producer who aggressively tine weeded their stand of winter camelina early in the spring to control emerging weeds; with good weed control results.

Swathing camelina is an option to even out harvest maturity and manage weed escapes in organic systems.

Diseases & Pests

Not much is known about diseases & pests of winter camelina in the upper Midwest as the crop is so new to the area.

Winter camelina is a known host for white mold so watch for rotations with susceptible crops (sunflower, soybeans, etc.), avoid fields with a history of white mold and choose resistant varieties of subsequent crops.

Like canola, winter camelina is susceptible to Aster Yellows; a phytoplasma disease spread by leafhoppers. Cool, wet conditions will favor the spread of the disease as will high levels of migratory leafhoppers. The disease is primarily cosmetic and is not reported to reach economically damaging thresholds. Scouting fields and spraying for leafhoppers can be considered at high thresholds but there are no curative treatments for infected plants.

Typical symptomology of Aster Yellows in Camelina; reddish coloration and deformed flowers.

Downy Mildew infected seed pods in Camelina.

Winter Camelina is susceptible to downy mildew, a fungal-like disease that thrives in cool, wet conditions. Avoid overhead irrigation, do not plant infected seed and rotate fields out of production with known issues (esp. to non-host grass crops) for at least four years. Infections are rarely severe enough to be economically damaging; there are no labeled fungicide products for camelina.

To date there are no reported economically damaging insect pests of winter camelina though some growers did report sporadic lodging on field edges due to a type of weevil boring into stems. Pests will be categorized and investigated as production acres increase.

Winter Camelina Seed, Meal & Oil. Photo courtesy of AURI.

Harvest & Harvest Settings

Camelina seeds should be harvested when two-thirds of pods are mature, grayish-brown in color. Seeds rattle when capsules are shaken and mature seeds have a reddish-brown color. Seed moisture at physiological maturity is 35–40%. Camelina is typically ready to harvest in late June to early July but weather conditions can influence maturity. Although the seed capsules stay intact for weeks, severe wind and rainstorms during this time can lead to high seed shattering losses. Seed moisture at harvest should be 12% or less but growers have reported easier harvest with moisture at 10% or less. Post-harvest drying may be required to dry the seed to 8%.

Stored camelina must be monitored for heating and spoilage.

Standard combines using straight headers, flex headers or stripper headers can be used to harvest winter camelina. Plug any openings in harvest machinery with duct tape, fine mesh screen, cardboard, etc.

A small grains kit for your combine make/model is recommended for harvesting camelina (small wire concave and concave cover). Use small grain sieves, ideal screen size being 3mm fixed hole (top/chaffer) 10mm fixed hole (bottom). Plan harvests for sunny days and start combining in the afternoon and stop in the evening to avoid moisture or dew build-up.

Additional adjustments to combine settings may be needed.

For example:

- Refer to your machinery owner's manual to explore recommended manufacturer settings
- Start with canola, alfalfa, bluegrass or flax settings on your combine make and model and adjust from there
- Concave should be ¼" or less (nearly all the way closed). Keeping the concave closed can result in excessive trash in the tank. If the grain threshes freely from the pods you can open the concave more. If there are more pods in the tank then reduce concave clearance.
- Top sieve (chaffer): ¾ to 100% open. Use caution as this can result in a lot of material in the returns and over the bottom sieve and can cause the machine to plug.
- Bottom sieve: Closed
- Wind speed: 600–700 rpm or as low as you can get
- Cylinder speed: 450–500 rpm,
  Rotor Speed: 350–550 rpm

- Reel speed low to prevent shattering
- Draper head preferable
- Lock flex heads to rigid to prevent shatter losses
- Drive fast enough to keep combine full: 1.5–2 mph
- Check behind the combine several times to assess losses. Adjust one setting at a time if there is excessive trash/pods in the tank or unacceptable losses out the back: fan speed, top sieve (chaffer), lower sieve in that order
- Clean the combine well after harvest to prevent volunteer seeding
- Tank sample will have some FM/pods in it; it's nearly impossible to get 100% clean harvest samples

You can spray a broad spectrum desiccant (i.e. Roundup) when the crop is physiologically mature to hasten maturity and eliminate green weeds. At physiological maturity pods will be yellow to brown in color and seed moisture is 35–40%. Allow the crop to dry down at least 7–10 days before combining. Swathing is also an option though best management practices are currently in development.

Once you start combining, stop the combine and shut off the motor after ~100 yards and check for any camelina seed leaks. Seal or tape any openings shut. Some amount of harvest loss is inevitable with winter camelina.

Bulk dirty sample of winter camelina.

Harvested camelina seed will have a certain percentage of hulls in the tank. Typically 3 to 4% pods in the sample is acceptable upon delivery to a commercial facility merchandising camelina for processing. To remove excess pods and other foreign material (FM), it is recommended to consider installing the top sieve to a round hole sieve using a similar sieve used to harvest alfalfa or clover.

Pods can also be removed using a simple sieve mill or rotary screen cleaning unit prior to putting seed into the storage bin, wagon or loading into a truck.

Example Manufacturer Setting for Canola
John Deere 9500 Combine

CANOLA (U.S.WINTER)

Cylinder Speed (rpm)	450-500
Cylinder-to-Concave Indicator	4-6
Beater Grate	Up
Fan Speed (rpm)	840
Precleaner	Closed
Chaffer Setting	10 mm (3/8 in.)
Sieve Setting	5 mm (3/16 in.)
Extension Setting	10 mm (3/8 in.)

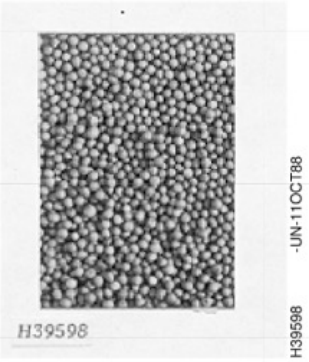


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Image of heated vs. normal quality grain. Heated grain has a dark almost black appearance (left) while normal quality grain has a red/tan color (right). Image courtesy of Cargill Inc.

Drying & Seed storage

It is recommended to store harvested camelina in hopper bins with aeration vs. flat storage bins. Due to the small seed size you need to make sure the aeration tube/panel perforations are small enough to restrict the camelina seeds from dropping through it. Care must also be taken to prevent losses by sealing openings in harvest equipment, grain carts, augers, legs, and beds of trucks. Camelina seed flows like water so take time to prepare your intended storage space before unloading.

Hopper bins are preferred for storing camelina. They are easy to seal up to prevent leakage and are easier to unload. If using a concrete bottom bin use a grain aeration unit. Full-floor aeration bins have openings that are too large for camelina seed. Some growers have experimented with covering holes in airfloor bins with mosquito screen, bedsheets, weed barrier fabric or some other permeable material to allow airflow while preventing seed leakage.

Semis and wagons are usually not an effective long-term storage solution. If used, store the wagons under cover and periodically load & unload grain to circulate and promote airflow.

Put air on the grain immediately after harvest and run non-stop for at least 2–3 weeks post-harvest. Camelina grain is very dense and will require significant aeration to move air through the bins. The deeper the height of the grain pile, the more static pressure and higher HP fan required. You are often better off with shallower piles in multiple bins if you don't have a powerful enough fan.

Grains need to breathe, don't cover harvested grain with tarps or store in totes without airflow. Seeds must be dried to 8% to 9% seed moisture to maintain quality. Excessive FM, weeds, or pods will cause the grain to heat and spoil. If FM or pods are excessive in the finished harvest, use a rotary screener or cleaner before longer-term storage.

Relay planted soybeans in Camelina; Ypsilanti, ND.

Relay-Cropping and Double-Cropping with Soybeans or Other Crops

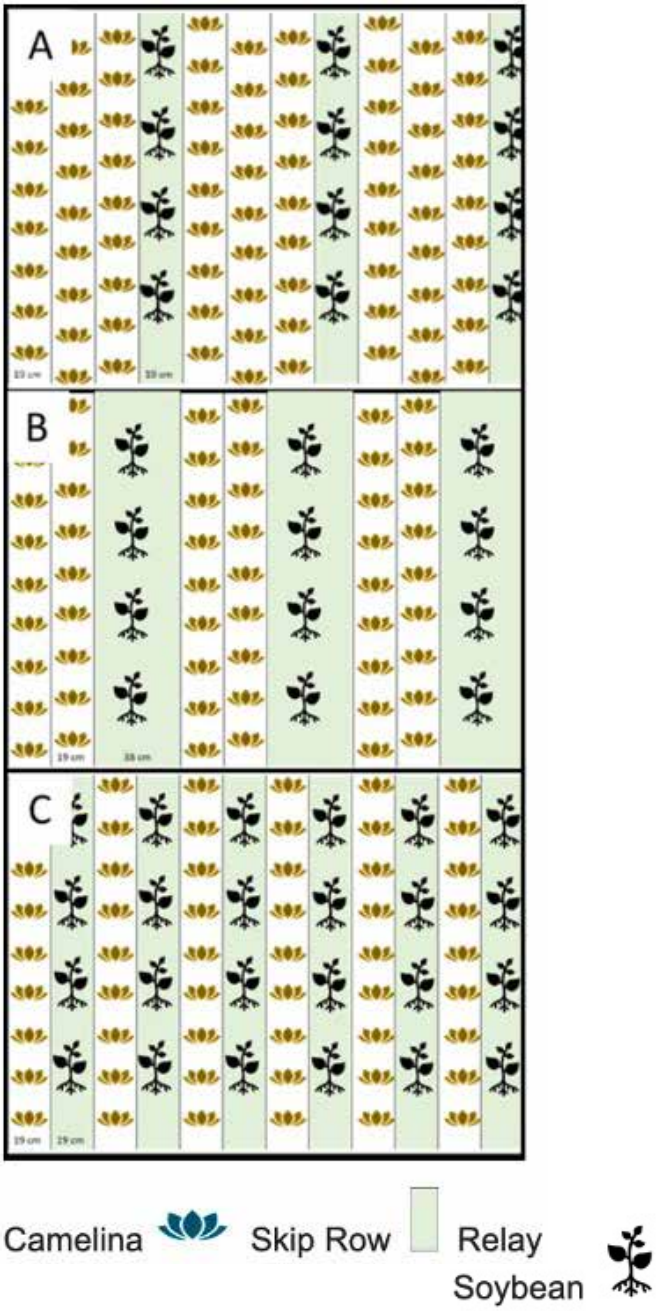
Camelina is an economically viable crop when it is double-cropped or relay-cropped with soybean in Minnesota and North Dakota. Small-plot research results indicate that net per-acre oil yield can increase by 50% when modest soy yield reductions (10–15%) are coupled with strong camelina yields. In essence there are two harvestable crops in one season under this system. Soybean yields are stronger in the relay-system vs. the double-crop system.

To set-up a viable relay-system, skip rows need to be left in the field to allow soybeans to emerge and rapidly grow under the camelina canopy. By planting the soybean seeds in the skip-rows, the intensity of competition between soybean and rapidly growing camelina is diminished. The ideal spacing for these skip rows is detailed (see right):

A full-season soybean is recommended for the relay-system; in fact some growers who have trialed this system at-scale have used slightly later maturing soybeans than maturities recommended for their area to keep the soybeans vegetative for longer. Research has shown that using a slightly longer (up to 0.5RM) maturing soybean than normal for a given region helps improve soybean yield in this system.

Soybean can be no-till drilled into the skip-rows of camelina when the camelina is beginning to bolt in late April to early May in west central Minnesota and mid to late April in southern Minnesota. Camelina can be driven over with minimal yield impact up to flowering. Camelina plants are very resilient to physical stress from soybean planting equipment.

For harvesting camelina in the relay system, the cutting bar of the combine needs to be set at about 6” to 8” or just above the height of the soybean to prevent damaging the soybean. If using a flex head on the combine, the flex needs to be taken out or locked so that the header is rigid. Utilizing a harvest shield (ex. from Flexxifinger: https://flexxifinger.com/FlexxiSelect_Harvest_System) or another method to push the developing soybeans out of the way of the cutter bar is recommended to avoid damaging the soybeans. Some producers have used plastic tile pipe to cover the cutter bar (e.g. a 6” piece of tile pipe every 30”).



Schematic of relay cropping treatments.
A) 3 rows of camelina on 7.5” centers with a skip (not planted) at 30” for interseeding the relay crop.
B) 2 rows of camelina on 7.5” centers with 2 skips and the relay crop interseeded on 30” centers.
C) alternating rows of camelina and the relay crop on 15” centers. Image courtesy of USDA-ARS.

Camelina field prepped for relay planted soybeans. St. Peter, MN; March 2024.

A low-cost solution for relay-cropping. Covering cutter bar with tile pipe; Rutland, ND.

Alternatively, planting or drilling soybean can be delayed until after camelina harvest in late June/early July. However, a very short-season soybean variety will be needed in this double-crop system, leading to lower soybean yield potential.

In either relay or double-crop systems, soybean should be planted at a standard rate (140,000–180,000 seeds/acre) and depth (1" to 2"). If planning to desiccate the stand of camelina with chemicals, choose an herbicide resistant variety that matches your planned desiccation chemistry.

A wide variety of summer annual crops other than soybean have also been researched by relay- or double-cropping with camelina. Other crops that have been shown to be successful when double-cropped following winter camelina include sunflower, proso millet, buckwheat, dry bean, sweet corn, snap beans or other canning crops and annual forages.

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