

# Winter Camelina Growers Guide for Minnesota

(Relay- and Double-Cropping with Soybean)



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## Overview

Winter camelina is a mustard-type plant closely related to canola that produces high concentrations of oil in its seeds. The seeds can be sown in autumn, they germinate and emerge relatively quickly after sowing given adequate soil moisture. Seedlings typically produce “rosettes” before the deepfreeze arrives in November. Rosettes are circular bundles of seedling leaves that may be 1” to 6” in diameter by late autumn. However, even with very late plantings, say mid-October, with seedlings only in the cotyledon stage of growth by early November, the young camelina plants still 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. Pale 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, and these visits facilitate cross-pollination of the flowers.

Small pear-shaped fruits develop from the flowers. The fruits technically are called silicles, which are basically capsules, and each capsule contains about a dozen small seeds. The capsules tend to be mature and are ready to harvest before the end of June. At that time the plants are about 30” tall, with most of the seed capsules in the upper half of the plant. Combining is relatively simple, and standard machinery typically is used to harvest the crop’s small seeds directly. Swathing is not necessary.



Oil from seeds of winter camelina 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 because these fatty acids promote heart health. Most cooking oils do not contain ALA or other omega-3 fatty acids because of their propensity to oxidize. Fatty acid oxidation means rapid rancidity and short shelf lives for cooking oils. Fortunately, camelina oil also contains a natural anti-oxidant called tocopherol (also known as vitamin E).

Tocopherol confers a very long shelf life for camelina oil, unlike any other oil with a high ALA content. This combination of traits (natural flavor, nutritional benefits, and long shelf life) means that winter camelina has good market potential.



## Variety selection

Five winter-hardy varieties have been tested in Minnesota and in some surrounding states. These are 'Bison', 'BSX-WG1', 'Joelle', 'WG1-35', and 'WG4-1'. The vast majority of research in Minnesota has been performed with 'Joelle'. It has superior cold and freezing tolerance. In the approximately 10 years of research on this variety in Minnesota, it has never failed to survive the winter. Winter camelina is, however, susceptible to extended periods of water-logging. When sown in depressions that collect water in spring, death of rosettes has been noted.

Curiously, when these same varieties have been sown in the Great Plains of western Kansas and eastern Wyoming, winterkill has been a significant issue, with survival in only one of three years. Ironically, winter temperatures in these areas are much higher than those in Minnesota; thus, the ultimate cause of winterkill is not clear.

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 in the future for Minnesota. In the meantime, however, our recommendation for Minnesota growers is to plant 'Joelle'.

## Field Selection

Winter camelina is drought-hardy and grows well on many soil types. However, it does not tolerate water-logging, so clay soils and fields with poor drainage should be avoided.

Winter camelina also is highly sensitive to some persistent herbicides, such as the triazines, sulfonyleureas, and imidazolinones. If atrazine was applied in spring in a preceding corn crop, the herbicide would not have had enough time to deactivate by September when the winter camelina is sown. Winter camelina is especially sensitive to residues of sulfonyleurea herbicides, as well as to those of the imidazolinones. Toxic levels of residues of these herbicides can remain in soil for more than two years.

Do not plant winter camelina in fields where in the two previous crop years the field might have received any one of the following herbicides.

Corn	Potato	Small grains	Soybean	Sugar beet
Aatrex	Matrix	Ally	Classic	Upbeet
Accent		Amber	Harmony	
Basis		Express	Pursuit	
Beacon		Maverick	Python	
Matrix		Peak	Raptor	
Option			Scepter	
Permit			Valor	
Python				
Valor				

The trade names of the above herbicides are associated with the following common chemical names: Aatrex (atrazine), Accent (nicosulfuron), Ally (metsulfuron), Amber (triasulfuron), Basis (thifensulfuron), Beacon (primisulfuron), Classic (chlorimuron), Express (tribenuron), Harmony (thifensulfuron), Matrix (rimsulfuron), Maverick (sulfosulfuron), Option (foramsulfuron), Peak (prosulfuron), Permit (halosulfuron), Pursuit (imazethapyr), Python (flumetsulam), Raptor (imazamox), Scepter (imazaquin), Upbeet (triflusulfuron), and Valor (flumioxazin)

The table at right gives trade names of herbicides whose residues may affect winter camelina. These are herbicides labeled for use in crops

planted in Minnesota. Many of these herbicides have multiple trade names that are not listed in the table. Thus, pay attention to the common chemical names on herbicide labels. The common chemical names associated with trade names are listed in the table's footnote.

### **Planting time and seedbed preparation**

In Minnesota successful plantings occur anytime from early September to mid-October. Seed yields and oil concentrations of seeds tend to be higher with late September and early October plantings. However, if relay-cropping soybean, it is recommended to plant camelina by mid-September. Most research plots were sown into stubble of spring wheat. This was done initially to insure overwinter survival by trapping an insulating layer of snow amongst the six-inch tall wheat stems. However, winter survival was equally high even in years without much snowpack. Moreover, autumn growth of seedlings is greater in the absence of residues from previous crops, and survival is equally good. In brief, winter camelina can be sown with or without residues from previous crops. However, high amounts of residue such as that left behind after grain corn harvest, can hinder seedling establishment.

Recent research has emphasized broadcasting (with a specialized "Hi-Boy" seeder or aerial seeding) winter camelina seeds into corn crops at tasseling and up to the R6 stage of corn development. Seedling establishment was quite high, but during the following spring the high levels of corn residue severely depressed growth and development of camelina. However, if the corn residue was baled and removed, and only 12" stalks remained in autumn, camelina seedling growth was vigorous in spring. Drill-seeding can also be used for successful establishment of camelina after removing corn for silage.

Accordingly, our recommendations are that winter camelina seeds be sown in mid-September in tilled and harrowed soil or no-tilled into residues of crops such as wheat, soybean, dry bean, sunflower, silage corn, etc. If sown into growing (tassel-stage and beyond) field corn, then corn stalks must be baled after corn grain harvest and removed leaving not more than 12" tall stubble.

### **Seeding depth**

Winter camelina has very small seeds, each about 1 mm wide and 2 mm long. About 400,000 to 500,000 seeds weigh one pound. Such small seeds require shallow planting. Best results occur with a planting depth of 0.5", but seedlings still can emerge with a planting depth as deep as 1.5" as the seeds are quite vigorous for their size.

As mentioned above, broadcasting also can lead to good establishment, but only if the germinating seeds are protected from desiccation by living crops or crop residues. High crop residue levels must be lowered before resumption of camelina rosette growth in spring. If seeds are broadcasted onto bare soil, a harrow or roller-packer should follow to insure good soil-seed contact.

Our recommendation, however, is to drill camelina seeds at 0.5" deep in soil and gently use the drill's press wheels to pack soil above the seed rows.

### **Seeding rate and row spacing**

Winter camelina seeds typically have germination rates greater than 65%. 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. Indeed, stands of only 4 plants/sq ft sometimes can yield as much or more than those at the target density. However, research has shown

that higher densities near the targeted amount do an excellent job of suppressing fall and early summer weeds. Therefore, a seeding rate of 6 to 8 lbs/A of seeds typically is recommended for drill-seeding, while for broadcast seeding, a higher rate of 10 lbs/A is recommended to assure sufficient stands.

Row-spacings between 6" and 12" can be successful. However, higher seed yields tend to occur with the narrower spacings of 6", 8", or 10". Our recommendations are to use a seeding rate of 5 to 6 lbs/A and drill the seeds in rows spaced at 6". However, if winter camelina is going to be double-cropped with soybean, then every fifth row should be a "skip-row," and this empty row will be drilled to soybean the following spring (see section on "Drilling soybean," below).

### Weed control

Autumn sowings of winter camelina typically do not require pre-plant herbicide applications. However, special situations easily can be imagined where treatments may be necessary. For example, when no-till drilling into wheat stubble, if numerous wheat volunteers are present, then preplant glyphosate (e.g., Roundup), glufosinate (e.g., Liberty), or some other burndown herbicide should be applied. Otherwise, tillage may be beneficial.

Although the need is unlikely, if high densities of summer-growing grassy and broadleaf weeds are expected to be a problem after autumn sowing of winter camelina, the herbicides listed in the adjacent 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).

Trade name	Common name	Product rate	Application time
Command	clomazone	3 oz/A	PRE
Dual Magnum	s-metolachlor	1.3 pt/A	PRE
Outlook	dimethenamid	17 oz/A	PRE
Prowl	pendimethalin	1.5 pt/A	PPI or PRE
Quinclorac	quinclorac	1.5 pt/A	PRE
Sonalan	ethalfluralin	2 pt/A	PPI
Treflan	trifluralin	1.5 pt/A	PPI
Zidua	pyroxasulfone	2.5 oz/A	PRE
Roundup	glyphosate	1 qt/A	Burndown PRE

If camelina seeds already germinated and 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, as well as quackgrass or other grassy weeds, such as foxtails. Camelina seedlings are tiny and do not compete well with other plants.

Once camelina seedlings are well established by mid to late October, they form a carpet of rosettes that is quite competitive with weeds, not only in autumn, but also the following spring when summer-growing weeds begin to emerge. However, some weeds, like dandelion, which likely germinated the previous autumn, can thrive in camelina stands in spring. Postemergence applications of bromoxynil (Buctril at 1 pt/A) and fluroxypyr (Starane at 0.4 pt/A) in spring can suppress dandelion selectively in winter camelina, as well as provide good control of several other broadleaf weeds. No other POST herbicides are known to be tolerated by winter camelina.

Because winter camelina is such a new crop in Minnesota, some of the herbicides listed above are not labeled yet for use in the state on this crop. Special-use permits from the Minnesota Agriculture will be required for use of these herbicides in commercial plantings of winter camelina. In the table above for herbicides, the ones colored green are labelled for use with camelina.

### **Fertility**

One of the values of growing winter camelina is that it sequesters excess soil nitrate in the autumn, thereby preventing water-borne movement of this nutrient into groundwater or surface water. However, if the soil has little nitrate in early autumn, growth of camelina seedlings may be diminished. For highest seed yields camelina requires approximately 80 lb/A of total N (i.e., residual soil N plus fertilizer N) in the top 2 feet of soil. Thus, fertilizer rates applied to winter camelina are about 50 lb/A of N and 25 lb/A each of P and K if seed yields of 1000 lb/A are expected. The requirement for sulfur is not well-established for winter camelina, as it is for some other oilseed crops, and many reports suggest extra sulfur is unnecessary.

The best time to apply fertilizers are in early spring before the winter camelina bolts. In west central Minnesota, this is typically around mid-April or the earliest one can get machinery into the field. Winter camelina seedlings grow fast and more luxuriantly when fertilizers are applied at or near the time of bolting, and doing so, does not hamper winter camelina's ability to sequester residual nitrates in soil and from soil water in autumn 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 autumn/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 autumn. Studies comparing the effects on plants and the environment of broadcasting versus incorporating fertilizers have not been conducted yet.

### **Drilling soybean (and other crops) into camelina**

Camelina is an economically viable crop in Minnesota when it is double-cropped with soybean or some other summer-growing crop. Soybean can be no-till drilled into the skip-rows of camelina (see photo) when the camelina is beginning to bolt. ("Bolting is the initiation of fast-growing flower stalks.) Bolting typically occurs in late April to early May in west central Minnesota and mid to late April in southern Minnesota. By planting the soybean seeds in the skip-rows, the intensity of competition between soybean and rapidly growing camelina is diminished. A full-season soybean can be chosen for such a double-crop system, which is known as "relay-cropping."

Alternatively, drilling soybean can be delayed until after camelina harvest in late June. However, a very short-season soybean variety will be needed in such a



sequential double-crop system. This type of double-crop system is called “sequential cropping.”

In either relay or sequential systems, soybean should be drilled at a standard rate (180,000 to 200,000 seeds/A) and depth (1” to 2”).

A wide variety of summer crops other than soybean also can be sown as relay or sequential crops with camelina. Other crops that have been shown to be successful following winter camelina sequentially or in a relay system include sunflower, proso millet, buckwheat, calendula, cuphea, dry bean, sweet corn, and teff.

### **Combine harvesting**

Camelina seeds should be harvested when 80-90% of pods are mature, that is yellow to grayish-brown in color, when seeds rattle when capsules are shaken, and when mature seeds have a reddish brown color. The dates for this operation vary, but tend to be in late June to early July. 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 typically is less than 18%. Post-harvest drying is required until seed moisture decreases to 8% to 9%, after which it can be stored for a long time



Standard combines can be used to harvest winter camelina seeds despite the small size of the seeds.

If the camelina is being relay-cropped with soybean, 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 need to be taken out so that the header is rigid.

Additional adjustments to combine settings may be needed. For instance, the reel speed must be low to prevent shattering of camelina seed capsules, cylinder speed should be medium, sieves and concaves set tightly, fan speed should be medium, and a small to medium screen is recommended.

### **Seed storage**

Because seeds are so small, care must be taken to prevent losses by sealing openings in grain carts and beds of trucks. Seeds must be dried to 8% to 9% seed moisture to maintain seed quality.

### **Ecosystem services**

Winter camelina flowers earlier (late April) than other crops, and even earlier than most spring-flowering wild plants. Consequently, its flowers are prized by many native pollinators as well as honey bees. Transient honey bees typically are returning to Minnesota from the Gulf and West Coasts in April, and camelina flowers provide abundant and natural pollen and nectar for them.

