

Canola Production

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Canola is Popular Oilseed Crop for N.D.

North Dakota leads the U.S. in canola production, with approximately 85 percent of the domestic production in 2014.

Canola is a specific, edible type of rapeseed that contains about 40 percent oil. It was developed in the 1970s. The term “**canola**” is a name registered by the Western Canadian Oilseed Crushers Association.

Canola varieties must have an erucic acid content of less than 2 percent and less than 30 micromoles of glucosinolates per gram of seed. Canadian and U.S. farmers primarily grow low-erucic acid and low-glucosinolate hybrids. High-erucic acid oil rapeseed is grown and used for industrial lubricants. This type of rapeseed mostly is grown in Europe, although some production occurs in Canada and the U.S.

In January 1985, the U.S. Food and Drug Administration granted canola oil GRAS (Generally Recognized as Safe) status for use in human foods. This has led to greatly increased sales and demand in the U.S., with only part of the demand being met by U.S. production. Canola oil has achieved worldwide commodity status and is used extensively in Japan, Canada and Europe.

Adaptation

Canola (*Brassica napus* L.) varieties have been developed as spring and winter annuals. The spring type is best adapted to North Dakota conditions. The winter types have not survived consistently in trials in North Dakota, northwestern Minnesota or in the Prairie Provinces of Canada. Canola can be grown on most soil types. It is best suited to clay-loam soils that do not crust.

If grown on soil with poor internal drainage, good surface drainage and/or subsurface (tile) drainage is essential because the canola plant cannot tolerate standing water or waterlogged soils. Canola is less tolerant to drought than small-grain crops. It could be considered as a crop to plant on fallow if moisture recharge on recrop land is limited.

Rotations

Canola best follows cereal grains or fallow in rotation. A preferred crop rotation would have canola planted at least two cropping years between plantings. However, if planting canola after one cropping year, we recommend growing a variety that is resistant to blackleg. Canola is susceptible to sclerotinia stem rot.

White mold (sclerotinia) infection risk increases if canola is planted closely in rotation with other highly susceptible crops, such as sunflowers or dry edible beans. If planting canola within three years of susceptible crops, a fungicide application may be needed.

Less susceptible crops that could be planted successfully in a close rotation with canola are rowed soybeans,

Canola Growth Stages

The growth stages of canola can be determined using a scale developed in Canada. This scale uses five principal stages and subdivides these into secondary stages. Many crop management recommendations are based on these specific growth stages of canola.

Table 1. Growth Stages of Canola.

Stage	Description of Canola Growth Stage
0	Pre-emergence
1	Seedling – cotyledons showing
2	Rosette 2.1 First true leaf expanded 2.2 Second true leaf expanded 2.3 Etc. for each additional leaf
3	Bud (Bolting) 3.1 Flower cluster visible at center of rosette 3.2 Flower cluster raised above level of rosette 3.3 Lower buds yellowing
4	Flower 4.1 First flower open 4.2 Many flowers opened, lower pods elongating 4.3 Lower pods starting to fill 4.4 Flowering complete, seed enlarging in lower pods
5	Ripening 5.1 Seeds in lower pods full size, translucent 5.2 Seeds in lower pods green 5.3 Seeds in lower pods green-brown or green-yellow, mottled yellow 5.4 Seeds in lower pods yellow or brown 5.5 Seeds in all pods brown, plant is dead

flax, semileafless field peas or lentils. In years when ideal environmental conditions favor air-borne spore movement, all canola plantings without fungicide applied, regardless of rotation intervals, may have economic losses due to sclerotinia.

Canola is certain to shatter seeds, and volunteer plants are a probability the next season. Cereals should follow canola to allow the use of certain broadleaf phenoxy herbicides for volunteer canola control. Avoid the production of canola and tame mustard on the same farm. A mixture of the two crops reduces the market value of both. In addition, conventional canola should not be planted on fields with heavy infestations of wild mustard. Roundup Ready, Liberty Resistant or Clearfield canola can be planted to manage wild mustard in canola fields.

The persistence of herbicide residue remaining from application to prior growing crops and weeds can injure new canola seedlings. These include sulfonyleurea, imidazolinone and triazine classes of herbicides. Always refer to the herbicide label information pertaining to crop rotation restrictions following their use.

The "North Dakota Weed Control Guide," publication W253 (www.ag.ndsu.edu/weeds/weed-control-guides/nd-weed-control-guide-1), includes information on rotation restrictions for certain crops, including canola following herbicide applications.

Varieties

Canola varieties are of two types: the Argentine type of the species, *Brassica napus*, and the Polish type of the species, *Brassica rapa*. Argentine varieties have a higher yield potential and also are taller and have a higher oil content than Polish varieties. Argentine varieties require about 95 days to reach maturity, while Polish varieties need approximately 80 days to reach maturity. Variety trial results are available from NDSU. See NDSU Extension Service publication A1124 (www.ag.ndsu.edu/varietytrials) for the most recent variety yield results.

Seed Preparation and Planting

Canola is very susceptible to soil crusting. The seedbed must be firm to seed canola. Seed and soil moisture contact is critical for rapid emergence, so seeding canola into dry soil is not recommended. The seedbed should be prepared in a manner that minimizes wind erosion so seedlings are not damaged by drifting soil. Harrowing canola seedlings is not recommended.

Canola can be planted with a variety of seeding equipment. The optimum depth to seed canola is ½ to 1 inch. Seeding depth should not exceed 1 inch. Canola typically is seeded in 6- or 7-inch rows with a grain drill or air seeder if uniform depth control can be obtained.

Planting and Seeding

Dates

NDSU researchers have evaluated the effect of planting date on canola yield at different locations. Growing conditions differ within the state. Data collected for Minot from 1998, 2010 and 2011 studies, and for Langdon from 1989-1994 and 1992-1995 averages, 2010 and 2011 were used to construct response curves for the different locations (**Figures 1 and 2**). Yields were expressed as the percent of the highest yield obtained from each separate experiment.

The graphs indicate that the yield potential decreased as the canola planting date went later into the season. At the most northern location, Langdon, the yields stayed relatively stable from the earliest plant date though the third week of May. At Minot, yields tended to decrease more rapidly after the optimum seeding date (first part of May).

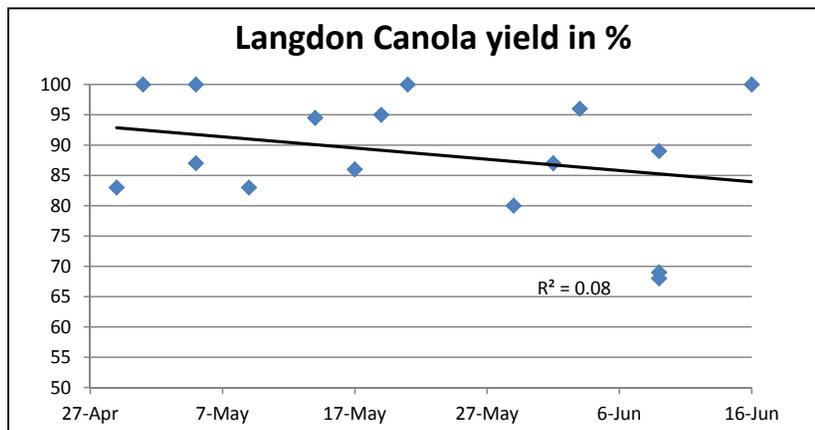


Fig. 1. Percent of yield for averaged 1989-94, 1992-95, 2010 and 2011 planting date studies at Langdon, N.D.

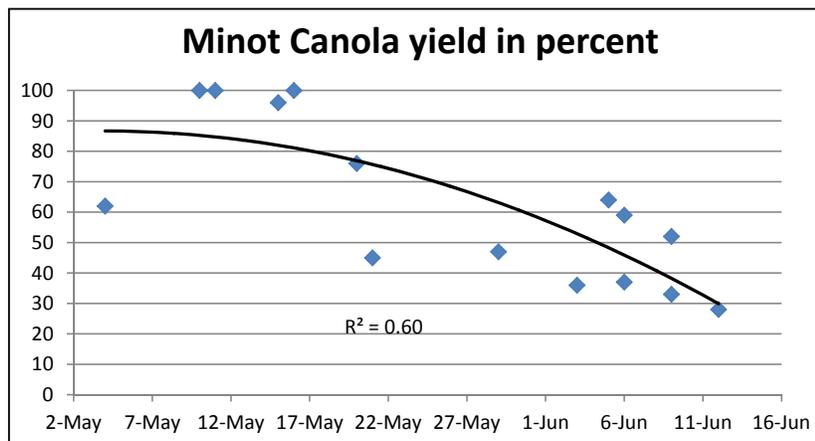


Fig. 2. Percent of yield for 1998, 2010 and 2011 planting date studies at Minot, N.D.

Canola should be planted in late April to early May to achieve the highest yields. Planting dates delayed beyond May 15 may result in yield reductions. Significant yield reduction can be expected if seeding is delayed into June. Canola is very susceptible to heat and drought stress during flowering. Planting in early May will reduce the risk of heat and drought stress on the crop. Canola seedlings are frost tolerant and can tolerate temperatures as low as 24 F.

Dormant seeding of canola can be defined as seeding it in cold, nearly frozen soil, which will inhibit germination that fall. The objective is that the seed remains dormant after planting until early spring. As conditions become favorable in the spring, the canola germinates and emerges. Determining when to dormant seed is difficult because growers can't go by a specific calendar date. The soil needs to be cold, if not frozen (below or near 32 F in the top 2 inches). If soil temperatures warm to 38 F or higher, the seed will germinate and will be killed once the soil freezes.

Seeding Rates

Rates of 5 to 8 pounds per acre for Argentine varieties and 5 to 7 pounds per acre for Polish varieties are recommended. A common rule of thumb for seeding canola is 5 pounds per acre. A major difference can be found between seeds per pound among canola varieties. Adjusting for these differences is very important to avoid a stand being established that is too thick or too thin.

Knowing the number of seeds per pound of the variety and establishing a seeding rate by plant population are very important for a grower. As a general rule for the Argentine canola, hybrids will contain approximately 75,000 to 85,000 seeds per pound, whereas open-pollinated varieties

will contain a range of 135,000 to 160,000 seeds per pound. For the Polish varieties, the seed count usually will be greater than 200,000 seeds per pound.

An optimum plant population is 16 plants per square foot, or 600,000 plants per acre. A good stand is 10 to 12 plants per square foot and a minimum stand is four plants per square foot. However, with herbicide-tolerant canola, stands can be as low as two plants per square foot, providing they all are uniformly spaced.

Fertilizer

Canola is similar to small grains in its response to fertilizer and levels of soil fertility. Nitrogen and sulfur are the key elements for high canola yields. Nitrogen and potash materials should not be placed in direct contact with the seeds but should be broadcast or applied in a band at least 2 inches away from the seed. A soil test is recommended for proper assessment of nutrient need. See NDSU Extension publication SF1122, "Fertilizing Canola and Mustard," (www.ag.ndsu.edu/pubs/plantsci/soilfert/sf1122.pdf) for additional information.

Canola is a high user of sulfur (S). A 2,000 pounds per acre (lb/A) canola crop contains about 12 lb/A of sulfur in the straw and 15 lb/A of sulfur in the seed. A 40 bu/A wheat crop, on the other hand, contains only 7 lb/A of sulfur in the straw and 5 lb/A in the seed.

The consequences of low soil S levels are very serious in canola production. Low sulfur can make the difference between having a crop and not having a crop. Responses to sulfur fertilization have been demonstrated in North Dakota. A composite soil test for sulfur may not represent sulfur fertility variation across the field. The current S soil test tends to overestimate available sulfate-S and field variability is large. Therefore, at medium to low sulfur soil test levels, 20 to 30 lb/A of S is recommended. At high soil sulfur levels, 10 to 15 lb/A still is recommended.

Canola takes up sulfate-S. The form of sulfur fertilizer may be ammonium sulfate (21-0-0-24S) or a blend of ammonium sulfate and degradable elemental sulfur (0-0-0-90S). A blend is recommended because in sandy soils, sulfate may leach during early season rains, while the elemental sulfur may degrade during a moist season to supply needed S later during the growing season.

Providing adequate sulfur before or at planting is best. However, if deficiencies are identified early in the season before significant flowering, yield responses are still possible by applying a rescue treatment of ammonium thiosulfate (12-0-0-26S) or ammonium sulfate. The earlier a treatment is made, the greater the yield response. Little sulfur is absorbed by leaves. A rescue treatment needs rainfall to move the soluble sulfate to the roots.

Weed Control

Young canola seedlings are very sensitive to early weed competition. An effective weed control program should include cultural, mechanical and chemical methods. Once established, canola is a good competitor with most weeds.

Wild mustard is a serious seed contaminant in canola and can cause price discounts or rejection in the market. Give special attention to preplant control or avoiding this weed in canola fields.

Follow cultural practices to assure a dense, vigorous developing crop that will compete well with weeds. Pay attention to seeding dates, rates and depth of seed placement. Perennial weeds should be controlled the year prior to seeding canola.

Because canola is a shallow-seeded crop, the use of a rotary hoe or springtooth harrow for weed control is discouraged. These tillage tools can injure and destroy the canola seedlings, greatly reducing stands. Trifluralin (several brands)

and Sonalan (ethalfluralin) are the only preplant soil-incorporated herbicides labeled for control of weeds in canola. Use the lower rates of these two herbicides on sandy, coarse-textured, low-organic matter soils.

Trifluralin and Sonalan always must be preplant-incorporated in the soil prior to planting. Both will control annual grasses and some broadleaf weeds, such as pigweed, common lambsquarters and kochia. Wild mustard will not be controlled.

Clopyralid is labeled for postemergence control of small broadleaf weeds. This herbicide also can be used to control Canada thistle and perennial sowthistle in canola. Apply clopyralid when the canola is in the two- to six-leaf stage and prior to bolting.

Sethoxydim (Poast), quizalofop (Assure II or Targa) and clethodim or (Select Max 1EC, Select 2EC, Shadow 3EC) all are labeled for postemergence grass control in canola. See the label for rates according to grass weed species and size. For best control, grasses should be growing actively and crop oil adjuvants must be added.

Tank-mixing these grass-controlling herbicides with broadleaf herbicides can be done in some cases, but follow all label restrictions because reduced grass weed control may result if you don't follow directions.

Thoroughly clean and rinse any herbicide residue that may be harmful to canola prior to filling the spray tank. Sulfonylurea herbicide residue on phenoxy herbicide in trace amounts can be very injurious to canola.

Canola is extremely sensitive to drift from most broadleaf herbicides, such as 2,4-D, MCPA, dicamba, glyphosate (nonglyphosate-tolerant hybrids) and certain sulfonylurea herbicides. Take precautions to keep these herbicides from drifting to canola fields.

Herbicide-resistant Canolas

Clearfield (Imidazolinone) Resistant Canola

Beyond (imazamox) is registered for use in Clearfield canola. Beyond at 4 fluid ounces per acre (fl oz/A) applied post to Imi-tolerant canola from emergence until prior to bloom controls most annual grass and broadleaf weeds. Apply with a nonionic surfactant (NIS) at 0.25 percent volume for volume (v/v) alone or with UAN liquid fertilizer at 1 to 2 quarts per acre (qt/A). Beyond will not control ALS-resistant weeds. See the label or information on Beyond for use, weed control, crop rotation restrictions and other information.

Liberty (Glufosinate) Resistant Canola

Liberty 280 (glufosinate) at 22 fl oz/A applied post to Liberty-tolerant canola from cotyledon to bolting stage controls most annual broadleaf weeds, controls or suppresses grasses and may suppress perennial weeds. Always apply with AMS fertilizer at 2 to 4 lb/A.

Liberty is a nonselective, nonresidual, contact-type herbicide with limited translocation and should be applied to small weeds. Refer to the label for weeds controlled, application information and timing, tank-mix options and other restrictions. Liberty has a unique mode of action and may be used as another tool in weed-resistance management.

Roundup (Glyphosate) Resistant Canola

Glyphosate applied at a rate maximum single application of 0.56 pound of acid equivalent (lb ae) and maximum in crop of 0.75 lb ae/A, with no more than two applications to glyphosate-resistant canola from emergence and prior to bolting (five- to six-leaf stage) controls most annual and perennial weeds. Apply with an AMS fertilizer. Application timing may not be appropriate for effective perennial weed control. Glyphosate is a nonselective, nonresidual, systemic herbicide. Full labeled rates are required for broadleaf weed control. Do not apply after the six-leaf stage of canola or once bolting has begun because canola injury can occur. Refer to the label for weeds controlled, application information and timing, tank-mix options and other restrictions.

Sulfonylurea (SU) Resistant Canola

Draft herbicide can be applied at a rate maximum of 0.3 oz/A at the two- to five-leaf stage of development but prior to the beginning of bolting for control of weeds listed on the label. It is for use only on canola that contains the Cibus sulfonylurea herbicide-tolerant trait (SU Canola Trait). Draft herbicide is a dry, flowable granule that is used for selective postemergence weed control in SU-tolerant canola, a nontransgenic canola. The best control is obtained when this product is applied to young, actively growing weeds. The use rate will depend on weed spectrum and size at the time of application. Refer to the label for weeds controlled, application information and timing, tank-mix options and other restrictions.

Influences of High Temperatures and Drought in Canola

Heat injury to seedlings occasionally occurs on hot, sunny days with air temperatures in the range of 85 to 95 F and soil temperatures of 100 F. Heat injury commonly is associated with drought injury, but excessive heat also will injure or kill plants, even if moisture is plentiful.

When in the blooming stages, heat blasting and/or flower abortion is a strong possibility. This can vary from field to field and is very dependent on the time of flowering, soil moisture and humidity during the hot periods. Usually in this situation, you would see no or limited pod growth and, thus, no seed. It usually will be in distinct regions on the main stem and branches as related to the time of flowers and the heat stress. With good soil moisture, canola flower abortion usually will be minimized to some extent.

Low and high temperatures can affect development adversely prior to and during flowering. Low but nonfreezing temperatures just prior to flowering slow the rate of plant development. The start of flowering is delayed or, if begun, the rate of flower opening is slowed and the amount of pollen shed is reduced.

High temperatures at flowering will hasten the plant's development, reducing the time from flowering to maturity. High temperatures during flowering shorten the time the flower is receptive to pollen, as well as the duration of pollen release and its viability. Both can decrease the number of pods that develop and the number of seeds per pod, resulting in lower yields.

Once pods are formed, canola is more tolerant to high temperatures than at flowering. Cool night temperatures at this time also help the plant recover from extreme heat or dry weather. However during this stage, a combination of heat and extreme drought will affect the pod and seed development severely, including the formation of seeds, seed size and oil content. The seed oil content is highest when seeds mature under lower temperatures (50 to 70 F).

High temperatures during seed maturation result in reduced oil content. High temperatures, drought and long days hasten maturity and, in combination, can reduce yield through fewer pods, with fewer and lighter seeds per pod.

Diseases

Plant diseases can be a serious problem in canola production. Rotations must be planned carefully to keep disease incidence and levels low. The two diseases of major importance are sclerotinia wilt and blackleg. Diseases of canola less often reported are white rust or staghead, downy mildew, alternaria blackspot, aster yellows and clubroot.

The blackleg disease occurs in two strains: a mild strain and a virulent (severe) strain. The virulent strain produces deep-stem girdling cankers near the soil line. These cankers reduce plant vigor and may cause lodging. The virulent strain of blackleg first was found in North Dakota during the 1991 growing season.

The blackleg fungus is spread by rain-splashed or wind-borne spores and infected seed. Hybrids that have good tolerance or resistance to this disease are available. As new varieties and hybrids are introduced, more will be resistant to this disease. Generally, the Argentine varieties are more tolerant, while the Polish varieties are more susceptible to blackleg.

In areas where the virulent strain of blackleg is present, crop rotation and selection of resistant varieties is important to blackleg management. Several fungicides are labeled for control of blackleg and should be applied at the two- to four-leaf stage of canola. For detailed information, see publication PP622, "North Dakota Field Crop Plant Disease Management Guide."

Blackleg is not a problem in mustards (yellow, brown and oriental), which are highly resistant. See NDSU Extension Service publication PP1367, "Blackleg of Canola," for more information.

Sclerotinia stem rot or white mold is a canola disease that can be very destructive during periods of wet weather. The sclerotinia fungus survives up to five or six years in the soil in the form of hard, black fungus bodies called sclerotia. Whenever wet weather occurs for a week or two, with moist soil, the sclerotia germinate to produce tiny mushroomlike bodies called apothecia. These apothecia are only 1/8 to 3/16 inch across, yet they produce millions of air-borne spores. Canola primarily is susceptible during all bloom stages and shortly thereafter. The spores infect the dead canola blossom tissue during periods of wet weather.

Infections that start on the dead blossoms spread to adjacent tissues, resulting in dead branches or plants, causing the plants to lodge. The rotted stems usually have a bleached appearance. Sclerotinia infections can be serious on canola if cool, wet weather occurs in the last two weeks of June and continues into early July, when blossoming occurs.

A minimum of a three-year rotation is recommended for fields that have a history of heavy sclerotinia or white mold infestations. During this rotation, avoid planting highly susceptible crops, including sunflowers and dry beans.

Various fungicides are registered for use in the suppression and control of sclerotinia in canola. Information on fungicides registered is available in the NDSU Extension Service publication PP622, "North Dakota Field Crop Plant Disease Management Guide."

The decision to spray should be made only when: 1) yield potential is above normal (at least 40 bushels or 2,000 lb/A), 2) weather leading to early bloom has been wet (at least 1 to 2 inches of rain in the two weeks prior to early bloom), 3) more rain or high humidity is expected and 4) sclerotinia has been a problem in recent years in fields currently planted to canola or in other fields nearby. A fungicide is more likely to be needed if canola is planted on tight rotations (three years or less). The NDSU canola pathology program provides a sclerotinia risk map (www.ag.ndsu.edu/sclerotinia) for North Dakota during the growing season.

See the following NDSU Extension Service publication on the control of sclerotinia in canola: PP1410, "Sclerotinia of Canola." (www.ag.ndsu.edu/pubs/plantsci/crops/pp1410.pdf).

Insects

Severe damage to canola plants can be caused by overwintering populations of flea beetles feeding on newly emerged seedlings from May through June. Adult beetles start to emerge when temperatures are above 60 F and feed on the cotyledons and first true leaves, causing the typical shot-holed appearance. Severely damaged seedlings may die, and less seriously damaged plants may suffer a reduction in growth and vigor.

Hot, sunny weather is conducive to feeding activity, while cool, damp weather slows feeding and favors crop growth. Hot and dry weather may cause seedlings to wilt and die, resulting in partial to complete crop loss.

In some instances, the infestation of a field can occur as a creeping movement from plant to plant across a field; in other instances, the entire field may become infested quickly and evenly. Severe damage usually does not occur once the crop advances beyond the four- to six true-leaf stage because vigorously growing canola plants can outgrow the beetle defoliation.

No major effects on plant vigor have been noted from the larval feeding on the plant roots. Occasionally in August, large numbers of newly emerged adults will move onto semimature canola plants and devour the epidermis of the stems, leaves and pods, and may cause pod shattering and small seeds. In most years, the crop will be sufficiently advanced to escape economic damage. Research in Canada found that very high numbers of 100 to 350 flea beetles per plant are needed to cause significant yield losses during pod development.

Cultural methods can help reduce plant losses caused by flea beetles. A firm seedbed that is fertilized adequately will help plants outgrow beetle damage during the susceptible seedling stage in the spring. Zero-tillage has been shown to reduce flea beetle damage per plant, and planting *B. napus* rather than *B. rapus* resulted in less crop damage.

Other effective strategies from previous research include increasing seeding rates, planting large rather than small seeds at wide row spacings, and using later planting dates (late May or early June). Integrating cultural strategies can help minimize the use of insecticides for control of flea beetles in canola production.

A few flea beetles or scattered shot-holing in leaves of a seedling crop are not necessarily cause for alarm. However, if the flea beetles are numerous and feeding holes cause approximately 25 percent defoliation (economic threshold), immediate control is recommended. The key to flea beetle control is frequent monitoring during the susceptible seedling stage.

Various insecticides are registered as seed treatments and labeled for control of early season flea beetles feeding damage in canola. These include the active ingredients thiamethoxam, imidacloprid, clothianidin and cyantraniliprole. All seed treatments must be applied by commercial seed treaters and are not for use in hopper-box, slurry-box or other seed treatment applications at or immediately before planting.

Foliar insecticides also are registered under state label for control of flea beetle, diamondback moth, Bertha armyworm and other insect pests. When the residue of insecticide seed treatment declines during cool, wet growing seasons (usually 25 days after planting), rescue foliar insecticides often are needed for flea beetle control during the seedling through the six-true-leaf stage.

Any foliar application of insecticides during flowering should be applied during the early morning or late evening to minimize any toxicity to bees foraging in canola. For more complete information on insect control in canola, see NDSU Extension Service publication E1143, "North Dakota Field Crop Insect Management Guide" (current year).

Swathing and Harvest Management

Swathing canola at the optimum stage of ripening reduces green seed problems and seed shatter losses and ensures the quality required for top grades and prices. Inspect fields every two to three days when some color change occurs in the first formed pods on the bottom of the main stem.

To determine when a field of canola is ready to swath, examine plants from different parts of the field. The stage of maturity in an evenly maturing field will vary from plant to plant and from area to area within the field. When examining the plants, take into account varying soil types, low-lying areas, available soil moisture and exposed early ripening areas.

Examine only pods on the main stem. Seeds in pods on the bottom third of the main stem were formed earlier and will turn color much sooner than seeds in the pods on the top third of the plant. When the overall moisture content of seed from the total plant averages 30 to 35 percent, about 30 to 40 percent of the seeds in pods on the main stem will have changed color or started to change color. Seeds with only small patches of color should be counted as color-changed. Remember, the color of the seed is more important than the overall color of the field in determining the stage of maturity.

Most of the seeds that have changed color will be from the bottom third of the main stem. When seeds in the bottom pods slightly turn color, seeds in the top, last-formed pods are filled or nearly filled.

Seeds in all pods on a plant complete filling (physiological maturity) at about 40 percent moisture and then slowly turn from green to light yellow, or reddish brown, brown or black, depending on the variety. In hot (90 F), dry weather, canola seed can go from 10 to 50 percent seed color change in just three to five days or less. Once filled, the seeds rapidly lose moisture at about 2 to 3 percentage points or more each day, depending on the weather.

Swathing early can be beneficial if a hard fall frost is expected. Frost fixes the chlorophyll, or green color, in immature seed, making it difficult to remove during processing. Fall frosts rarely freeze to ground level. A swathed crop will not only lie below the coldest night temperatures, but much of the seed will benefit from the insulating properties of the swath and residual soil heat, preventing or reducing frost-fixed chlorophyll.

Another sign of canola being very near the swathing stage is the natural yellowing and senescence of leaves and leaf drop. When canola plants consist only of stems, stem branches and pods, the crop is probably very near the optimum time for swathing.

Swathing can begin in Argentine canola at 15 percent seed color change. Polish canola should be left until 20 to 25 percent seed color change.

Cutting Height

The swather should be run just low enough to get all the seed pods, leaving the maximum amount of stubble to anchor the windrow and ensure adequate air circulation through the windrow. Most stubble height varies from 10 to 12 inches in canola fields after swathing.

Swather Table and Throat

The windrow must flow smoothly through the swather without bunching. Bunching leads to uneven drying and combine plugging. Therefore, a good swather must have enough depth of table (40 inches) to handle the crop material. It also should have a large throat opening – at least as wide (40 to 54 inches) as the distance between the two swather canvases on center-delivery swathers. It should have a vertical clearance for the windrow of at least 30 to 40 inches.

The table canvas should be strong enough to carry the heavy load of material cut and should be run just fast enough to keep the table clean. If possible, the canvas speed should be varied depending on the maturity of the

crop cut. A fast canvas tends to produce a hollow, twisted windrow; a slower canvas produces a more compact windrow, but it may bunch and sit high on the stubble. Increase the canvas speed until the windrow is pressed into the stubble.

The reel should be set as high and far forward as possible. Reel speed should be set to correspond with the forward speed of the swather. Finger reels work best in canola to help bring the material back onto the table and gently handle the ripened canola. For a lodged or leaning canola crop, finger reels are highly recommended for ease of swathing.

Ordinary end dividers that are long and gently sloping are generally less prone to plugging than short, abrupt types. When the crop is tall, tangled and lodged or laid across the seeded rows, divider plugging is almost inevitable unless special vertical cutter bars or power blades are fitted on the swather. These can cause minor loss of pods and whole seed tops, but they prevent stops and bunching. In badly lodged crops, swathing parallel to the direction in which the crop is leaning may be advantageous.

In areas where windrows could be lifted and blown by the wind, a light roller pulled behind the swather will help anchor the windrow in the stubble. The roller should be set so that it just anchors the windrow into the stubble without shelling any ripe pods. Excessive roller pressure will produce a windrow that is too compact to dry quickly and difficult to pick up without shelling the canola. NDSU research has shown that swath pack density and seeding rates had little effect on green seed of canola.

Swathing Overly Ripe Fields

Swathing late, when seed moisture content is much lower (around 80 percent seed color change), will result in fluffy windrows susceptible to blowing and increased shattering. To reduce shattering losses, overripe fields should be swathed when humidity is high, such as after a rain, after a heavy dew or at night.

Swathing Unevenly Maturing Crops

Determining when to swath unevenly maturing fields is difficult. When checking uneven stands, producers should do an early count on the ratio of early emerged canola that is bolting or starting to flower to the late-emerged flush of young, more immature plants.

Knowing the ratio of early to late-emerged canola plants allows making a better decision as to how soon to swath or whether to wait until the later crop catches up. If the stand is 20 to 25 percent early and 75 to 80 percent late, then waiting to cut later may be the best strategy to reduce the amount of green seed.

Curing in the Swath

Canola should be allowed to cure and ripen from 10 to 14 days in the swath before combining. If combined too early, the chance of increased green seed in the harvested crop is much greater.

While starting on the early side for swathing is better, the same doesn't necessarily hold true for combining. Hot or windy weather at or after swathing can cause canola seed to be at the appropriate moisture content for combining before it has cured and cleared the green chlorophyll. This occurs because the plant dries up before sufficient moisture can move into the seed to finish curing it.

Canola requires at least 20 percent moisture in the seed for the maturing process to take place and eliminate the green seed color. Checking the moisture content and green seed count before starting to combine is important. Delayed combining can help clear the green color, particularly if the swath sits through several heavy dews or light rain showers. The canola swath should be allowed to cure and ripen for a minimum of 10 to 14 days before harvesting.

Combining Canola in Swaths

All combines work fairly well to harvest canola. Combines should be checked thoroughly before starting on canola. Cover any holes or worn spots in the table/platform or within a combine with duct tape or caulking compound. Leakage can occur easily in the stone trap or top feeder housing, or through lower inspection doors.

The travel speed of the combine should be equal to that of the pickup so a gentle lifting of the swath occurs without tearing or pushing. Set the pickup to rub just under the swath.

Cylinder speeds will depend on canola crop conditions. Speeds of one-half to two-thirds of that used for small grains often are used for canola. The speed should be just fast enough to break open the pods. Speed reduction is important to prevent over-threshing of pods and stems and overloading the sieves. Cracked canola is caused by impact when the cylinder speed is too high. Examine the threshed seed for cracked canola. Push your arm into the seeds and observe if cracked canola seed pieces stick to your skin or hair on your arm. Reduce cylinder speeds if excessive cracking does occur.

Fan speed should be set low to avoid blowing canola seed out with the chaff. This will allow large amounts of pods in the return. Start with a low fan speed and increase gradually until separation of chaff and seed occurs with no canola being blown over the chaffer sieve. See NDSU Extension publication A1171, "Swathing and Harvesting Canola," for more detail.

Direct Combining Canola

Small- and field-scale studies were conducted by NDSU Research Extension Center agronomists comparing direct combining canola with traditional methods of swathing and harvesting. The results of this research indicate that canola can be direct combined successfully. All combine headers – rigid, flex and draper – performed well with direct combining canola and did not cause any harvest loss, compared with the pickup head. When harvested at the optimum time, direct combining canola can be successful, with equal to higher yield than traditional harvest methods of swathing and combining.

Straight combining also results in less green seed and generally higher oil content and test weight than swathing and combining. One important consideration with direct combining is that canola is more vulnerable to seed and shatter loss when harvest is delayed past the optimum. When direct combining canola, harvesting at the optimum time is very important.

The optimum harvest time is identified as the first time the harvest moisture falls below 10 percent. Research trials indicate that seed loss due to shattering increases significantly with direct combining approximately 10 days after the optimum harvest time is reached.

Desiccation

Diquat is labeled for use as a preharvest desiccant in canola. Growers can maintain excellent canola yield and quality if the diquat application is timed properly and the crop harvested in a timely manner. Apply the desiccant when seed in the middle pods (or 60 to 75 percent) have started to turn color. Research has shown that when the desiccant is timed properly, crop quality parameters, including canola yield, test weight, oil content, seed loss, green count and grade, generally were similar for desiccated canola, compared with swathing.

However, diquat applied too early could result in lower yield and seed quality, with a trend toward higher green content. Diquat requires a seven-day preharvest interval. Research has shown that canola harvested 14 days after application will have lower green content than canola harvested seven days after application. Fields with excessively lodged canola may be difficult to desiccate because the spray droplets may not be able to penetrate the canopy. Therefore, swathing may be the better choice for lodged canola.

Sharpen + Glyphosate also can be applied as a canola desiccant, but it may require 10 to 14 days to achieve adequate desiccation. If you absolutely need to harvest seven days after desiccating, then diquat is the better choice because it will provide faster desiccation. If you are desiccating for control of annual weeds, Sharpen + Glyphosate may provide as good or better weed control than diquat. However, if the goal is long-term control of perennial weeds such as Canada thistle, then don't use Sharpen because reduced perennial weed control will result. Long-term perennial weed control is best with Glyphosate applied in September or October.

Practices to Reduce Green Seed

Problems have occurred with green seed in North Dakota. Cool, wet and overcast weather during the growing season promotes green seed problems in all canola varieties, and these problems can be made worse by sulfur deficiency in some cases.

Temperature at maturity is an important factor in chlorophyll breakdown. Cool temperatures and light frosts in August and September slow the enzyme activity that breaks down chlorophyll. Frost from 32 to 33 F disrupts that system; more specifically, this frost can reverse the enzyme activity and restart the synthesis process. This is very sensitive in the seed development stage, and the window is very narrow. This can cause differences between adjacent fields that are only days apart in maturity or differ in uniformity of maturity.

Even canola swathed four to six days before a frost will retain relatively high levels of chlorophyll. Two or more germination flushes and growth stages result in immature seed at swathing and green seed at harvest. Thin stand counts can result in plants with more branching and more variability in seed maturity, and crops are more likely to have immature seed at swathing. Late-seeded canola may be impacted by all these situations.

Management Decisions Growers Can Make to Reduce Green Seed Problems:

- Choose fields with better surface and/or subsurface drainage (tile) and fertility.
- Seed as early as possible in the spring to allow for the maximum ripening time.
- Provide a firm seedbed to achieve the correct depth of planting and good seed-to-soil contact for quick and even emergence.
- Swath or desiccate at the recommended color stage for the weather conditions.
- Maintain adequate fertility levels for canola growth and ripening. Canola stressed from nutrient deficiency will not mature evenly.
- Take soil samples for a general indication of nitrogen, phosphorus, potassium and micronutrient levels.
- Sample plant tissue early during the rosette stage to allow time for corrective micronutrient applications if needed.
- Know that fields with high fertility levels can be expected to delay maturity in years with below-normal growing degree days' accumulation or heat units (cool years).

Storage and Drying

Canola storage and handling problems are similar to those of flax. The seed is round, small and heavy, and runs freely. Very tight truck boxes and storage bins are required. The seed can sweat for up to six weeks after harvest, so heating and spoilage can occur, even at 9 to 10 percent moisture levels. Canola as low as 8.5 percent moisture should be examined for heating at regular intervals.

If harvested at high moisture, natural air or artificial drying can be used. To maintain seed quality, a drying temperature of 110 F or less is maximum for commercial production. If a significant amount of foreign material (straw) is included with the seed, running it over a scalper may be advantageous before drying and binning.

Canola Products

Canola varieties produce meals having about 38 percent protein. The amino acid distribution is very complementary to soybean oil meal, and the two meals often are included in the same ration. Feeding trials have shown that animals perform better when fed a mixture of the two meals than when fed either alone.

In Canada, canola meals are recommended for up to 10 to 20 percent of the ration for chickens, turkeys, ducks, geese, pigs, and dairy and beef animals. Edible rapeseed oil or canola oil has been used in some countries for decades and was approved for human consumption in the U.S. by the Food and Drug Administration in 1985.

Canola oil usually is blended with other vegetable oils for the production of various solid and liquid cooking oils and salad dressings. Canola oil is high in oleic acid relative to other vegetable oils and has been competitive in price with other cooking oils.

Marketing

Most canola is not grown under contract. U.S. grain standards for grading canola and rapeseed were established Feb. 28, 1992, by the U.S. Grain Inspection Service. (See Table 2.)

Factors of most importance in the determination of grades are admixtures and soundness. Grading admixtures include such factors as foreign material, common wild mustard seed, tame brown and yellow mustard seed, earth pellets, sclerotinia, ergot and stones. Soundness refers to broken seed not assessed to dockage, seeds distinctly green after cracking, heat damage and odor.

Table 2. USDA grade and grade requirements for canola.

Grading factors maximum percent limits of:	U.S. Grades		
	1	2	3
	Percent		
Damaged Kernels			
Heat damages	0.1	0.5	2
Distinctly green	2	6	20
Total	3	10	20
Conspicuous Admixture¹			
Ergot	0.05	0.05	0.05
Sclerotinia	0.05	0.10	0.15
Stones	0.05	0.05	0.05
Total	1	1.5	2
Inconspicuous Admixture²			
	5	5	5
Grading Factors maximum count limits of:			
Other material			
Animal filth	3	3	3
Glass	0	0	0
Unknown foreign substance	1	1	1

U.S. sample grade – canola that:

- does not meet the requirements for U.S. Nos. 1, 2 or 3 or
- has a musty, sour or commercially objectionable foreign odor or
- is heating or otherwise of distinctly low quality

¹ **Conspicuous admixture** is all matter other than canola that is readily distinguishable from canola and that remains in the sample after the removal of machine-separated dockage. It is not limited to ergot, sclerotinia and stones.

² **Inconspicuous admixture.** Any seed that is difficult to distinguish from canola. This includes common wild mustard (*Brassica kaber* and *Brassica juncea*), domestic brown mustard (*Brassica juncea*), yellow mustard (*Brassica hirta*) and seed other than the mustard group.

Grower Considerations

- Know where to deliver canola to a market before planting the crop.
- Plant recommended hybrids of good quality and good yield potential.
- Plant early for profitable yields.
- Select weed-free fields and control weeds prior to planting.
- Take time to prepare a firm seedbed.
- Mangle canola to avoid green seed.
- Monitor fields for flea beetles and other insect pests.
- Swath or desiccate at the proper maturity. Swathing or desiccating early reduces yield; delays allow excessive shattering.
- Monitor seed in storage for heating and spoilage because canola requires more attention than cereal grains.
- Leave a three-year rotation between canola and other sclerotinia (white-mold)-susceptible crops.
- Promote the use of canola oil to consumers.
- Consider joining the Northern Canola Growers Association.

Canola Information Resources

North Dakota State University

Broadleaf crops, canola

www.ag.ndsu.edu/broadleaf/canola

North Dakota State University Extension, canola

www.ag.ndsu.edu/crops/canola

Sclerotinia Risk in Canola Forecast Program

www.ag.ndsu.edu/sclerotinia/

Canola Insects Information

www.ag.ndsu.edu/extensionentomology/field-crops-insect-pests/canola

Northern Canola Growers Association

2718 Gateway Drive, 301

Bismarck, ND 58503

Telephone: (701) 223-4124 or toll-free (877) 585-1671

Web address: www.northerncanola.com

U.S. Canola Association

600 Pennsylvania Ave. S.E., Suite 320

Washington, DC 20003

Telephone: (202) 969-8113

Email: info@uscanola.com

Web address: www.uscanola.com

Canola Council of Canada

400 167 Lombard Ave.

Winnipeg, MB R3B 0T6

Telephone: (204) 982-2109 or toll-free (866) 834-4378

Web address: www.canola-council.org/

Publications

NDSU Extension Service – Canola Production

www.ag.ndsu.edu/crops/canola

Canola Council of Canada Crop Production Resources

www.canolacouncil.org/publication-resources/print-resources/crop-production-resources/

NDSU Extension Service Publications

The following publications can be found at

www.ag.ndsu.edu/crops/canola

- A1280 Canola Production Field Guide
- A1124 Canola Variety Trials
www.ag.ndsu.edu/varietytrials/canola
- SF1122 Fertilizing Canola and Mustard
- W253 North Dakota Weed Control Guide
- PP1024 Blackleg of Canola
- PP1201 Sclerotinia Stem Rot of Canola
- A1208 Canola: Flowering and Fungicide Application Timing
- A1171 Swathing and Harvesting Canola
- E1143 North Dakota Field Crop Insect Management Guide
- PP622 North Dakota Field Crop Plant Disease Management Guide

Cover photo courtesy of the Canola Council of Canada

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