

Mustard Grower Manual



*Mountain
States Oilseeds*

FARMING FOR THE 21ST CENTURY

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This manual has been compiled and revised by the Mustard Association and is for distribution to growers.

The Association is a group of mustard contracting companies, processors and research authorities. The objective of this Association is to provide a discussion forum for all aspects of the cropping of mustards, and relevant issues arising from the needs of the processors, and it provides financial support for crop improvement through breeding, variety testing and agronomic studies. At its annual meetings it is assisted by invited representatives of Agriculture and Agri Food Research, Canada and the Canadian Grain Commission. All bodies and the whole membership have contributed to the development of this manual as a comprehensive guide to profitable mustard seed production.

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TYPES OF MUSTARD AND THEIR USES

Mustard was one of the first crops domesticated by man. The seed's value as a spice soon resulted in its widespread dissemination along trade routes. The two species involved in condiment production in North America are: *Sinapis Alba* (White or Yellow mustard) and *Brassica juncea* (Brown and Oriental mustard).

Condiment mustard is used primarily in the production of dry (39%) and prepared mustards (61%). Dry mustard is used extensively as an ingredient in mayonnaise, salad dressings and sauces. Yellow mustard flour is also an excellent emulsifying agent and stabilizer and the ground product is widely used as an ingredient in prepared meats.

Oriental and Brown mustards are grown as oilseed crops in some parts of the world, and in Canada; this has been the fastest growing export sector for Canada. Since 1990, Bangladesh has imported up to two-thirds of their annual mustard oilseed requirements from Canada.

Brassica Juncea (brown & oriental)

Sinapis Alba (white or yellow mustard)



MUSTARD IN THE WORLD MARKET

Mustard has been a major special crop in North America since WWII disrupted supplies from Western Europe. It was initially produced in California and Montana until the early fifties when some production moved north into Alberta. Canadian production increased over the last twenty years and has continued its growth. In 1995, 660,000 acres were grown in Canada (550,000 acres in Saskatchewan).

For a number of years the Canadian dollar has been devalued against the U.S. dollar at times being worth only 70 cents U.S. The lower dollar value has allowed the Canadian grower to produce the crop at a relatively lower cost and has resulted in an almost total disappearance of mustard from the United States farms. Mustard is grown where acceptable quality can be economically produced at the least unit cost.

Condiment mustard is usually grown under contract so the grower and mustard manufacturer can have some feeling of market and price security. It is a product for human consumption and the mustard manufacturers spend a lot of time and money on quality control. They insure a close link to the grower by choosing to buy mustard seed from companies they know and trust. To ensure adequate supply, they contract with the mustard shipper to supply seed of a specific quality for a period of time ranging from six months to a year and a half. The mustard shipper contracts with growers in various areas where the crop is well adapted. The mustard shipper assumes some of the risk of supply as the grower is only obligated to deliver the actual quantity of crop he has harvested. If the crop is hailed out or otherwise destroyed by an "Act of God", the shipper may have to replace it to cover a sales commitment.

Many growers produce mustard without a contract, speculating that the market price will rise higher than the pre-harvest contract price. In a normal year, non-contract Yellow mustard seed is surplus to the market requirements and actually can have a depressing effect on prices in the following year. The major factor in the condiment mustard market is that consumption is steady and market increase is directly related to population growth. The market is limited to those ethnic groups that have used it over the centuries and there are only very limited alternative markets in time of surplus. Yellow mustard is a high protein oilseed but it is not popular in normal feed and vegetable oil markets because of the strong flavor. On the other hand, Oriental and Brown mustards contain a level of fixed oil that is only a few percentage points below Canola. As a result of changing world economies and trade relations, Canadian oilseed mustard has been competitive in the Bangladesh markets. Canadian exporters have been and should continue to be effective in marketing Oriental and Brown mustard to Bangladesh.

REGIONAL ADAPTATION

Mustard is a cool season crop well suited to a short growing season. Cultivars requiring 90-110 days to mature are available. Mustard will germinate at a soil temperature as low as 40 degrees F. and the seedlings are quite frost tolerant.

Mustards are also quite drought tolerant, especially the Brown and Oriental types. Although mustard will not tolerate extended periods of drought the plant's taproot, which penetrates deeply (5 ft) into the soil under dry conditions, allows efficient use of stored soil moisture.

Mustard is well adapted to the brown and dark brown soils of the prairies and Great Plains. Dry sand and dry sandy loam soils should be avoided. The crop should not be sown where flooding of the soil may occur. Mustard plants prefer well aerated soils that do not become water logged; poor aeration in the root zone will permanently stunt their growth. Mustard performs best in soils with a near neutral pH (pH 7), but will tolerate alkaline (above pH7) and slightly saline soils. Mustards tolerance to saline soils is similar to that of barley.

NORMAL YIELD RANGE

The normal yield range applicable to a specific growing area is available for either the local representative/county agent or from one of the contracting companies. It is strongly recommended that, for dependable performance, certified grade seed of pedigree varieties should be sown by farmers; indeed a number of processing companies specify that this should be done. Their choice will depend on the desired aspects of processing quality. For example, fixed and volatile oil content, flavor and mucilage content, seed size and uniformity and its suitability for particular manufacturing methods and products.

PERFORMANCE OF MUSTARD VARIETIES IN WESTERN CANADA
MEAN OF CO-OP TRIALS 1992-1994

TYPE & VARIETY	Yield Performance Compared TO CUTLASS	AVERAGE MATURITY (in days)
Oriental - Cutlass	100	92
Oriental - Forge	100	94
Oriental - Lethbridge 22A	80	93
Oriental - Valcan	104	95
Brown - Commercial	87	94

TYPE AND VARIETY	Yield Performance Compared TO OCHRE	AVERAGE MATURITY (in days)
Yellow - Ochre	100	93
Yellow - Gisilba	101	93
Yellow - AC Pennant	108	95
Yellow - Tilney	100	94
Yellow - Viscount	100	96

MUSTARD IN A ROTATION

Admixtures are a particularly severe problem in mustard. Cow cockle, cleavers, wild mustard, wild buckwheat and volunteer rapeseed/canola seed are almost impossible to remove from the harvested crop, and are a severe quality down grading factor. The land for sowing should be essentially free from these problem weeds before seeding a mustard crop.

Mustard can serve as a “clean up” crop for grassy weeds such as wild oats. Herbicides specific for grassy weeds may be used effectively without adverse effects on the mustard crop. Volunteer mustard can be easily controlled in cereals with the use of herbicides. Herbicides should be applied early, as volunteer mustard plants become more resistant in later growth stages. Mustard crop residues do not provide sufficient trash to protect the soil from erosion during a summer fallow year.

Mustard has several insect pests and diseases in common with flax, canola, sweet clover, soybeans, field peas, lentils and sunflowers so these crops should not be sown on the same field more than once in four years. Cereals are not susceptible to mustard pests and diseases although infestations of wire worm affect both cereals and mustard until the mustard has been grown multiple times which reduce the population to noneconomic levels.

SEEDBED PREPARATION

Surface soil structure has a marked effect on seedling emergence. Soils with very fine texture tend to form a crust; as a result, tender seedlings may have difficulty penetrating the soil surface. Conversely, very coarse textured soils are not suitable because of the difficulty in preparing a satisfactory seedbed.

Uniform shallow seeding to moisture promotes rapid germination, emergence, and growth. A properly prepared seedbed facilitates the mechanical planting of seeds and provides a suitable environment for germination. The seedbed should be firm, so that only a slight heel depression is produced by a person standing on the soil. It should be level, uniform, and free of plant growth, warm moist throughout its depth and have good granular structure with only enough large lumps to prevent wind erosion.

SEEDING RATES

Brown and Oriental mustards are usually seeded at 4 - 7 lbs. per acre, while the larger seeded yellow mustard is seeded at 7-12 lbs. per acre. Seeding rates can vary over a wide range without affecting yield. Moderate to high initial plant populations that are reduced in an early growth stage by frost, hail, disease, or insects can still produce seed yield similar to those of undamaged crops.

At very low plant populations individual plants may not fully utilize the light, moisture and soil nutrients available, thus reducing potential yield. Lower plant populations also provide less competition to weeds. High seeding rates may hasten maturity by a few days and result in a more uniform crop, but very high seeding rates can increase lodging.

SEEDING DEPTH

Seeds should be planted no deeper than is necessary to reach soil moisture. Seeding at a depth of ½ to 1 inch normally results in the most vigorous and uniform stands but it is sometimes necessary to sow up to 2 inches deep to place the seed in moist soil. A firm seedbed will help to keep moisture near the surface and around the seed long enough for germination, emergence and the development of a root system which can then reach into the soil to tap stored moisture.

SEEDING DATE

Seeding should take place as soon as a suitable seedbed can be prepared. Mustard plants are quite tolerant to frost in the seedling stage but a fall frost can cause a serious loss in yield and quality. Early seeding may allow the crop to benefit from spring moisture and escape the heat stress that can cause abortion of flowers or pods.

The timing of rains, summer heat and frosts can favor either early or late seeding. The mustard grower should weigh all the factors and choose a seeding date that will minimize risk and maximize production. Generally it is not economical to seed mustard after the first week in June.

FERTILIZER

Proper fertilization will increase both the yield and the quality of a mustard crop. However, fertilization alone will not increase either quantity or quality if other management practices are not up to par. Nor will fertilizer increase yields if the addition of nutrients is not required. Therefore a successful program must be based on knowledge of the soil's nutrient status and the fertilizer application tailored to that specific soil. In all cases it is advisable to have the soil tested for nutrient requirements. Mustard seedlings are sensitive to salt injury. Soluble nitrogen, phosphorus, potassium or other salts close to the seed may be harmful except at very low rates.

NITROGEN

Mustard is highly responsive to nitrogen (N) and its requirements are similar to that of wheat. Up to 10 lbs. / acre in any form except urea may be placed with the seed, up to 60 lbs./ acre of actual N or 40 lbs./ acre of urea can be side banded, while higher rates should be deep banded. High rates of N may

result in extended maturity of the mustard crop so consideration should be given to seeding date and moisture availability when deciding what rate to use.

PHOSPHOROUS

Mustard's phosphorous requirement is equal or greater than that of cereals. Due to mustard's extensive root system it is able to utilize phosphorous fertilizer more efficiently and absorb more total phosphorous. Under normal soil conditions up to 22 lbs./ acre may be placed with the seed. Higher rates may cause reduced germination. As much as 26 lbs/ acre may be placed with the seed under moist conditions or when applied with a discer or hoe drill. Deep banding, side banding or broadcasting should be used for higher rates.

POTASSIUM

Mustard's potassium requirement is similar to that of canola and barley. Rates higher than 18 lbs./ acre should not be placed with the seed. Potassium in excess of the recommended rates for seed replacement or side banding can be broadcast or deep banded in the fall or spring.

SULFUR

Mustard has a relatively large requirement for sulfur. In soils where sulfur is deficient, elemental sulfur (90-98%S) and agricultural gypsum (19%S) should be broadcast or deep banded at least one year before intended use by the crop, to allow time for the soil microbes to convert it to the available sulfate form. Ammonium thiosulfate (12-0-0-26) may be sprayed or banded in solution with other liquid fertilizers. Placement of sulfur fertilizers which also contain nitrogen and phosphorous, such as (16-20-0-14), (34-0-0-11) (21-0-0-24), should be based on the precautions already stated for the nitrogen and phosphorous compounds.

Prolonged deficiency results in general chlorosis or yellowing of new leaves, eventually progressing to all the leaves. Under certain conditions a pink coloring may appear on the underside of leaves and on the mid vein. If the sulfur deficiency is severe, plants may fail to set seed or have shrunken and shriveled seeds.

NITROGEN / SULFUR INTERACTIONS

Within a plants metabolic system both sulfur and nitrogen are incorporated into structural and enzymatic proteins. The amount of sulfur that will be incorporated into protein is limited by the amount of available nitrogen and vice versa. The use of nitrogen without sulfur on sulfur deficient soils results in little or no yield increase.

FLOWERING AND POLLINATION

Flowering begins with the lowermost buds on the main raceme. Side racemes flower later, with the highest branch starting to flower first. Under favorable conditions flowering will last for two to three weeks, its full plant height being achieved at the peak of flowering. Low temperatures decrease the rate of plant development, delaying the onset of the flowering period.

Flowers open in the early morning and pollen is dispersed by both the wind and insects. Oriental and Brown mustards are self fertile. Except where there are large numbers of pollinating insects, approximately 70% of the seed is produced by self pollination. Yellow mustard on the other hand is highly self incompatible; its seed development is a result of cross-pollination. The stigma is receptive to pollination for 3 days after the flower has opened. Fertilization occurs within 24 hours after pollination. Soon after fertilization has occurred the petals wilt and drop from the plant. Both the onset and duration of flowering are variable and depend on the weather.

About half of the flowers produced on a plant, develop productive pods, which are retained until harvest. Most productive pods are produced from flowers that open during the first 15 days of flowering on the main stem and the upper three branches.

If adverse conditions (disease, insects, and weather) damage buds, flowers or pods during early flowering, the mustard plant will compensate for these losses by development of normally non-productive bud and flowers. This will often include development of branches arising from the axils of lower leaves.

The earliest developed pods have a competitive advantage over the late pods. And nutrient or moisture stress on the developing flower clusters greatly affects flower and pod development. A decrease in nutrient supply, results in reduced flowers and pods and these pods will be smaller with fewer, lighter seeds. Conversely, with adequate moisture, an increase in nutrient supply results in production of more flowers and pods containing more and heavier seeds. Under commercial conditions, moisture stress, often brought about by hot dry conditions during flowering, frequently limits the potential yield.



Mustard Irrigation



Water requirement. The water requirement for mustard depends on growth stage, canopy density, climatic conditions, and irrigation and crop management. Mustard grown under optimal conditions (well fertilized, well-irrigated, well-drained soils, pest free stand, and uniform and optimum canopy) requires from 16 to 19 inches of water per growing season in southern Alberta. Average mustard water use ranges from 0.003 inches per day soon after emergence to nearly .275 inches per day during flowering and early pod development stages (Figure 10). Mustard roots grow to an ERZ depth of 39 inches in a well-developed soil. Root distribution is concentrated near the surface; hence, mustard obtains about 70 percent of its seasonal water from the upper 20 inches of the active root zone of 39 inches.

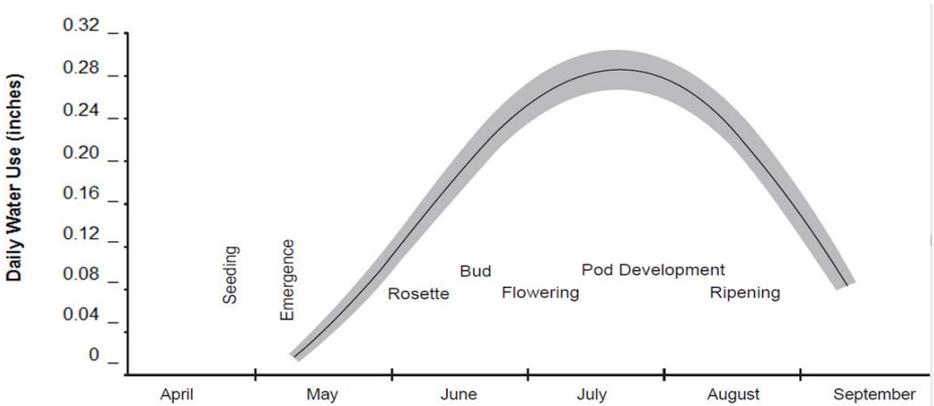
Irrigation scheduling. Adequate soil water is critical for mustard during the emergence, vegetative (pre-flowering: rosette, elongation, and bud), flowering, and pod-set (silique-set) growth stages. Ideally, soil water content in the 0 to 19 inch depth should be greater than 60 percent of available at planting. Mustard needs to have sufficient water for germination and root and leaf development during the early stages of growth. If seeded in a dry seedbed (less than 60 percent of available in the 0 to 19 inch depth) in late April before irrigation water is available, the first and subsequent irrigations (.60 inch per irrigation event) should be applied as soon as irrigation water is available in early May. These irrigations should be light and frequent to maintain soil water in the 0 to 19 inch depth at greater than 60 percent of available, to prevent crusting, and to encourage rapid emergence and early root and leaf development. Crusting should be avoided because it may lead to problems with crop emergence; hence, reduced plant populations and seed yield.

Water is essential for mustard growth during most of its growth stages, but more critical during the flowering period (about 30 days). To ensure that ample water is available to mustard during the vegetative (seedling, rosette, and elongation) growth stages, PAW should not be depleted to less than 60 percent in the upper 20-40 inch root zone.

Irrigation water applied during the vegetative growth stages should meet crop water requirements. Increasing the irrigation management root zone from 20 to 40 inch at the flowering growth stage requires less frequent and larger irrigation volumes and results in increased water availability to the mature mustard roots. This practice also increases the time between irrigations, keeping the mustard canopy dry and discouraging the growth of fungal diseases such as sclerotinia stem rot.

For effective control of sclerotinia, this irrigation strategy should be coupled with the appropriate application of registered fungicides, starting at 20 to 30 percent bloom. Terminate irrigation activities if sclerotinia growth is severe. Under a disease-free environment, the last irrigation to replenish the mustard root zone

water content to field capacity should occur when the earliest pods begin to ripen in August.



Daily water use during different growth stages of irrigated mustard. The shaded area indicates variation in mustard water use depending upon climatic conditions.

WEEDS

PREVENTION

Use weed free seed, preferably of certified stock.

CONTROL OF WEEDS IN THE CROP

**USE ONLY REGISTERED CROP PROTECTION CHEMICALS, SAFELY!
DO NOT USE UNREGISTERED CHEMICALS!**

Mixtures of pesticides or use of unregistered crop protection products may result in the requirement that the crop to be destroyed. If used, there could be serious legal repercussions; growers must ensure quality control over their product by using crop protection chemicals responsibly.

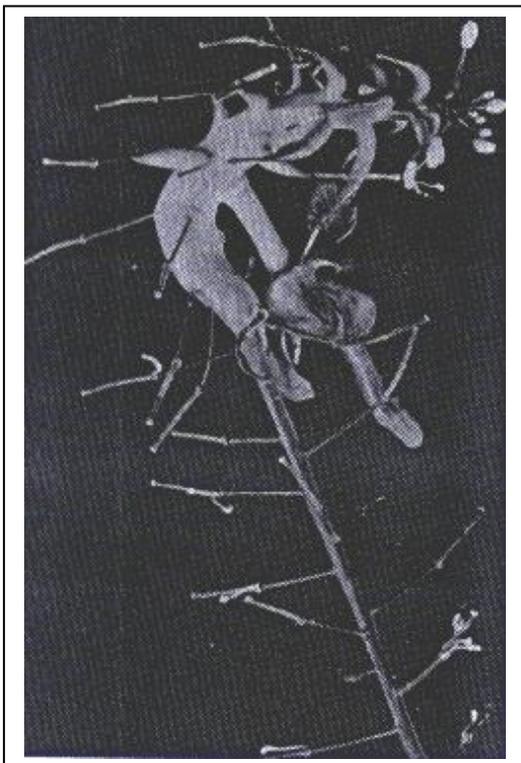
Good cultural practices and a suitable crop rotation will reduce weed problems in your mustard crop. Recommendations for chemical weed control must be combined with proper identification of the weed problem. The herbicide chosen depends on the type of weed and the crop tolerance to that chemical. Several herbicides are available for grassy and broadleaf weed control in mustard. Trifluralin is recommended for a wide spectrum of weed control. Annual publications put out by provincial / state governments are the best source of up to date information.

DISEASES OF MUSTARD

STAGHEAD OR WHITE RUST

White Rust or Staghead are the common names for a disease caused by the fungus *Albugo candida*. Crop losses caused by this disease are directly proportional to the number of stems with stagheads,

Symptoms appear in the seedling stage when creamy white pustules may occur on the underside of the leaves. The infection then spreads to the stems and pods, where green or white blisters form. A staghead may be produced on affected racemes. Stagheads are green at first but turn brown as they mature, becoming hard and dry.



SCLEROTINA Sp. STEM ROT

All mustards are susceptible to *Sclerotinia* but not to the same degree as canola. Severe infections are less frequent in mustard because the crop is usually grown in dryer, warmer climates. Yield losses on the number of infected plants and the stage of the plant at the time of the infection. Plants which are infected at early flowering will produce little, if any, seed, while those infected later suffer less yield loss. Additional losses may result from premature pod shattering.

The initial symptom of *Sclerotinia* stem rot is the appearance of soft rotted areas or of light brown lesions on the stem, branches, pods and leaves. Plants with stems that are girdled by rot wilt rapidly. Infected plants are easy to spot in the field due to premature ripening. The fungus forms hard black resting bodies called sclerotia within the stem. The stems of infected plants shred easily and will release these sclerotia into the soil and trash during harvesting. A 3-4 year rotation with non cruciferous crops will help control *sclerotinia*.

OTHER DISEASES

Alternaria Black Spot, White Leaf Spot and Seedling Disease Complex can infect mustards but these diseases seldom occur at economically significant levels.

CONTROL

In general, good cultural practices are the best disease control system. Keep good field records of disease occurrence, follow recommended rotational sequences, use seed treatments and be aware of potential host plants that could be removed or controlled in summer fallow, field margins and non-crop areas.

INSECT PESTS

GENERAL GUIDELINES

*USE ONLY REGISTERED CROP PROTECTION CHEMICALS, SAFELY!
DO NOT USE UNREGISTERED CHEMICALS!*

Mixtures of pesticides or use of unregistered crop protection products may result in the requirement of the crop to be destroyed. If used, there could be serious legal repercussions; growers must ensure quality control over their product by using crop protection chemicals responsibly.

Fields should be examined daily during the seedling stage and checked for signs of insect damage.

When damage is observed an attempt should be made to identify the insect responsible. If there is any doubt, this identification should be confirmed with the local agricultural representative. If necessary, examine the entire field and make counts to determine if the whole field needs treating; insect numbers are frequently higher on the edge of fields and mustard is quite resilient to minor damage.

Assess your individual situation and seek professional advice if necessary. Never apply an insecticide that isn't registered for use on mustard and don't exceed the recommended rate. Always make sure equipment is clean and free from previous chemical residues prior to use.

New chemicals are continually being developed and registered, offering more effective control of insect pests and greater safety for the user and the environment. Provincial and state governments publish new control recommendations each year; this information is available from your local agricultural representative.

Insect pests may attack the mustard crop over the entire growing season and can significantly reduce yields if present in large enough numbers.

TIME OF PLANT ATTACK						
PEST	APR	MAY	JUN	JUL	AUG	SEP
Flea Beetle						
Cutworm						
Red Turnip Beetle						
Diamondback Moth						
Berta Armyworm						

PESTS OF SEEDLINGS

FLEA BEETLES (*Phyllotreta cruciferae* and *striolata*)

Two flea beetle species, the crucifer flea beetle and the striped flea beetle are the most abundant and serious pests. Both are about 1/8 inch long and jump readily when disturbed.

The most serious damage from flea beetles results from spring feeding on mustard seedlings, which produces “shot holes” in the cotyledons and young leaves. Flea beetle damage can result in yield losses and, if severe, in destruction of seedlings. If the crop has advanced beyond the seedling stage, serious damage is unlikely to occur.

Seed treatment or in-furrow application of a recommended systemic insecticide should provide protection for the emerging mustard crop. No economic threshold level has been established for flea beetles on mustard but if 25% or more of total cotyledon area is destroyed, application of a foliar insecticide may be necessary.

RED TURNIP BEETLE

These are dark red beetles with three black stripes running down their backs. They are about the same size as the Colorado potato beetle, (1/2 inch). They overwinter in canola stubble fields in the form of reddish-brown oval eggs. The eggs hatch in early May and the larvae feed on volunteer plants.

The adult beetles migrate to nearby mustard fields. Plants attacked by red turnip beetles are often completely defoliated. The beetles are most abundant from mid June to early July. They move slowly on foot from the margins towards the center of the field and can be readily controlled by spraying.

Cultivation of canola and mustard stubble in the late fall and early spring may provide some control by burying the eggs and reducing the larval survival.

CUTWORMS (*Euxoa ochrogaster* and *Agrotis orthogonia*)

The pale western cutworm is found in the open southern portions of the prairies and the redbacked cutworm is found in the park belt and more northern areas. The larvae of both species cut off mustard plants just below ground level. The larvae feed mainly at night and most cutworm damage occurs from late May to mid June.

Cutworm damage is often seen in the form of patches where the crop started but disappeared. These patches gradually enlarge, sometimes destroying a whole field. Check the edges of bare areas for cut off plants and sample the top 2 inches of soil in the area for larvae.

The economic threshold level is reached when there are three or more cutworms in a 10 foot square area. It is best to apply the insecticide in the evening, when cutworms are feeding.

PESTS OF BLOOMING AND PODDING STAGES

DIAMONDBACK MOTH (*Plutella zylostella*)

In early June the moths are carried into the Northern prairies on winds from the southern U. S. the Diamondback is a small grey moth approximately ½ inch long with a diamond shaped marking on its back. Female moths lay eggs on volunteer mustard, canola and related weeds and the first generation mature on these plants.

It is the second generation that causes yield losses in mustard because the eggs are laid on the growing crop and the pale green larvae feed on buds and drop from the plant suspended on a silken thread. The larvae pupate in white open lacework cocoons that can be attached anywhere on the plant.

The economic threshold for Diamondback moth is 300 larvae for every 10 square feet. At this point foliar insecticide should be a consideration.

BERTHA ARMYWORM (*Mamestra configurata*)

The adult moths are grey with white markings. They are night flyers and lay their eggs from mid June to mid July. The young caterpillars are green and feed on the lower leaves of the plant while older larvae, which are a darker color, feed on the upper leaves and pods.

Bertha armyworm damage results primarily from feeding on green pods. Feeding on leaves does not appear to affect yield. The economic threshold for the Bertha armyworm is 20-30 larvae in 10 square feet, if they are feeding on the pods.

OTHER PESTS

Several other species may be encountered in mustard fields but these pests rarely become sufficiently numerous to warrant chemical control.

HARVESTING AND STORAGE

As a mustard producer, the care you take in the harvest, handling and storage of your crop will seriously affect quality. Quality, in many cases, is as important as yield when considering net return. Mustard processors and buyers have strict quality requirements for several factors, many of which you can control to some degree.

Mustard Quality

Canadian Grain Commission has established standards for mustard quality. In order to produce a high quality crop, mustard producers need to understand the factors that can lead to downgrading a mustard crop. The following tables outline these factors and their associated tolerance levels.

TABLE 1 Domestic YELLOW mustard seed: primary and export grade determinants

Grade Name	Standard of Quality		Damage (%)			
	Degree of Soundness		Other Classes %	Distinctly Green	Heated	Total
No. 1 Canada	Reasonably well-matured, sweet, good natural color		0.5	1.5	0.1	1.5
No. 2 Canada	Fairly well-matured, sweet, reasonably natural color		2.0	1.5	0.2	3.0
No. 3 Canada	May have the natural odor associated with low quality seed, not any odor that would indicate serious deterioration		5.0	3.5	0.5	5.0
No. 4 Canada	May have the natural odor associated with low quality seed, not any odor that would indicate serious deterioration		10.0	3.5	1.0	10.0

Grade Name	Conspicuous inseparable seeds					Other (%)			
	Distinctly detrimental (%)					Ergot	Excreta*	Soft earth pellets	Stones
	Cow Cockle	Sclerotinia	Wild Mustard Canola	Total distinctly detrimental	Total (%)				
No. 1 Canada	0.1	0.1	0.1	0.1	0.3	0.05	1K	0.01	0.05
No. 2 Canada	0.2	0.2	0.2	0.2	0.5	0.05	1K	0.2	0.05
No. 3 Canada	0.3	0.3	0.3	0.3	0.7	0.05	1K	0.3	0.05
No. 4 Canada	1.0	1.0	1.0	1.0	3.0	0.05	0.005	1.0	0.10

*Number of kernel-sized pieces in 500 grams
Source: Canadian Grain Commission

TABLE 2 Domestic **BROWN** mustard seed: primary and export grade determinants

Grade Name	Standard of Quality		Damage (%)			
	Degree of Soundness		Other Classes %	Distinctly Green	Heated	Total
No. 1 Canada	Reasonably well-matured, sweet, good natural color		0.5	1.5	0.1	1.5
No. 2 Canada	Fairly well-matured, sweet, reasonably natural color		2.0	1.5	0.2	3.0
No. 3 Canada	May have the natural odor associated with low quality seed, not any odor that would indicate serious deterioration		5.0	3.5	0.5	5.0
No. 4 Canada	May have the natural odor associated with low quality seed, not any odor that would indicate serious deterioration		10.0	3.5	1.0	10.0

Grade Name	Inconspicuous admixture (%)	Conspicuous inseparable seeds					Other (%)			
		Distinctly detrimental (%)					Ergot	Excreta*	Soft earth pellets	Stones
Cow Cockle	Sclerotinia	Wild Mustard Canola	Total distinctly detrimental	Total (%)						
No. 1 Canada	1.0	0.1	0.1	0.1	0.1	0.3	0.05	1K	0.01	0.05
No. 2 Canada	1.0	0.2	0.2	0.2	0.2	0.5	0.05	1K	0.2	0.05
No. 3 Canada	1.0	0.3	0.3	0.3	0.3	0.7	0.05	1K	0.3	0.05
No. 4 Canada	1.0	1.0	1.0	1.0	1.0	3.0	0.05	0.005	1.0	0.10

*Number of kernel-sized pieces in 500 grams
Source: Canadian Grain Commission

TABLE 3 Domestic **ORIENTAL** mustard seed: primary and export grade determinants

Grade Name	Standard of Quality		Damage (%)			
	Degree of Soundness		Other Classes %	Distinctly Green	Heated	Total
No. 1 Canada	Reasonably well-matured, sweet, good natural color		0.5	1.5	0.1	1.5
No. 2 Canada	Fairly well-matured, sweet, reasonably natural color		2.0	1.5	0.2	3.0
No. 3 Canada	May have the natural odor associated with low quality seed, not any odor that would indicate serious deterioration		5.0	3.5	0.5	5.0
No. 4 Canada	May have the natural odor associated with low quality seed, not any odor that would indicate serious deterioration		10.0	3.5	1.0	10.0

Grade Name	Inconspicuous admixture (%)	Conspicuous inseparable seeds					Other (%)			
		Distinctly detrimental (%)					Ergot	Excreta*	Soft earth pellets	Stones
Cow Cockle	Sclerotinia	Wild Mustard Canola	Total distinctly detrimental	Total (%)						
No. 1 Canada	0.5	0.1	0.1	0.1	0.1	0.3	0.05	1K	0.01	0.05
No. 2 Canada	1.0	0.2	0.2	0.2	0.2	0.5	0.05	1K	0.2	0.05
No. 3 Canada	1.0	0.3	0.3	0.3	0.3	0.7	0.05	1K	0.3	0.05
No. 4 Canada	1.0	1.0	1.0	1.0	1.0	3.0	0.05	0.005	1.0	0.10

*Number of kernel-sized pieces in 500 grams
Source: Canadian Grain Commission

Green Seed

All immature mustard seed contains the green pigment, chlorophyll, which can impart an off colour on finished products. With the right environmental conditions, chlorophyll will dissipate before harvest, but not after. Three enzymes remove chlorophyll from the seed as part of the natural maturing process. These enzymes are active only if the moisture level of the seed is above 20 percent (20%) and the ambient temperature is above 5°C. Frost prior to harvest or severe heat after swathing can both destroy the enzymes and result in the green color being “locked” in the seed. Green seed will not diminish in the bin; in order for it to reduce, seed must be in either the windrow or the standing plant.

Heated Seed

Excess moisture and/or high temperature in stored mustard seed may lead to heating. Mustard must be stored with lower moisture content than cereal grains because of mustard's high oil content. The high oil content means that any moisture in the seed is concentrated in the meal fraction. As an overall percentage, the moisture content can appear low but may cause problems because it is concentrated in only half of the seed. Mustard intended for long-term storage should be at less than nine percent moisture and less than 18°C. This moisture and temperature regimen inhibits mold growth, insect feeding and general seed deterioration. After binning, mustard will go through a sweating period caused by respiration. Mustard seed is alive and, like all living organisms, it respirees or takes in oxygen and releases carbon dioxide. This process generates heat and moisture, and generally elevates the moisture content of the newly binned mustard seed by one percent (1%).

Sclerotinia sclerotia

Sclerotinia is a disease of mustard, canola, sunflower, flax, pulse crops and many weed species. Severe infestations require high humidity and consequently, sclerotinia does not generally cause mustard producers significant yield loss. The disease produces hard black resting bodies, called sclerotia, in the stems of infected plants, which if threshed out during harvest, can end up in the seed sample. Even very low levels of infestation can lead to downgrading (classified as “foreign material”).

Ergot

Ergot is a cereal disease that does not infect mustard; however, the disease is similar to Sclerotinia in that the resting stage is sclerotia. Ergot contamination would most likely result from infected volunteer cereals or contaminated harvesting, transportation or storage facilities. Because ergot sclerotium contains a neurotoxin, the tolerance is very low.

Excreta

Excreta are the droppings of rodents and insects. Contamination is usually due to unclean harvest, storage or transportation equipment. As well, inadequate storage facilities that allow access to rodents may lead to problems. Good quality mustard seed has essentially no tolerance for excreta.

Rime

Mucilage is the substance that surrounds the seed coat of yellow mustard. It gives mustard many of its desirable qualities, namely its water binding properties. Repeated wetting and drying of the seed causes this mucilage to flake off and cover the seed in a white coating known as rime. The Canadian Grain Commission does not grade rime, but it is a downgrading factor at the buyer and processor level.

SWATHING vs. STRAIGHT COMBINING

For high quality mustard, straight combining is the preferred option; however, as some of the following factors indicate, swathing may still be necessary. When deciding to swath or straight combine, producers must consider the following: mustard type, the evenness and stage of maturity and crop height.

Yellow is the most shatter-resistant of all mustard types. Beyond that, the most shatter-resistant types are oriental mustard, brown mustard, Polish canola and Argentine canola (in declining order). Canola was added as a reference point: Argentine canola has very little shatter-resistance and is generally swathed.

Evenness refers to the range of relative maturity among plants. In many fields, some areas, especially high growth areas in low-lying spots, may mature earlier than others will. Producers can force these fields to ripen consistently by swathing. If producers have uneven maturity in their mustard crops and wait until all plants are mature enough to straight combine, they run the risk of increased shattering. At the same time, straight combining too early will increase green seed numbers and elevate moisture content.

The stage of maturity affects swathing. Producers are better off straight combining over-ripe mustard because swathing can cause shattering. Maturity can change very quickly in hot dry conditions and the crop needs to be closely monitored prior to swathing.

Crop height should also be taken into consideration when swathing. Ensure that the cut is made high enough to adequately anchor the windrow in the remaining stubble, but not so low that the pick-up reel gathers stones and soil.

If you have made the decision to swath, you must consider the stage of maturity, cutting height and anchoring the swath.

Time of Swathing

When to begin is the most important decision related to swathing mustard. Timing will affect yield, quality and net return. For all types of mustard, swathing should begin when the majority of seeds are at 25 percent moisture (25%). At this point, seeds will feel firm when pressed between the thumb and forefinger. Some pods will have developed a purple tinge; lower pods will have changed color but the upper pods will remain green. Break open several pods along the main stem of the plant. For oriental mustard, 75 percent (75%) of the seeds will have some yellow color; for brown mustard, 60 percent (60%) of the seeds will have some reddish-brown color. Be sure to crack the pods and look at the seed inside; do not decide when to swath solely based on pod color change. Varieties mature differently. In some, the pod will change color before the seeds; in others, the reverse occurs.

When swathing, mustard should be cut just below the level of the lowest pods. In most cases, this should leave ample stubble in which to anchor the windrow. Anchoring the windrow is crucial to prevent the swath from blowing. To ensure the windrow is properly anchored, roll and pack the windrow into the remaining stubble. Set the roller so that the windrow is firmly packed, but take care not to shatter overripe pods or pack the windrow so tightly that it cannot properly dry.

Swathing means the crop will need time in which to cure, the maturing process that reduces moisture content and green seed. If the green seed count is unacceptable (reduction to grade), the only thing that will lower it is time in the swath. In order to reduce green seed numbers the moisture content in the crop must be above 20 percent and the ambient temperature must be above 5°C (41°F). Extreme heat shortly after swathing, or a frost just before or after swathing, can destroy the enzymes required to remove the green color. *Green seed will not clear out in the bin.*

Straight Combining

Yellow mustard should be straight combined whenever possible. Brown and Oriental types are more resistant to shattering and may also be straight combined successfully.

Mustard that is uniformly mature and has a low green seed count can be straight combined. Straight combining is also recommended if there is a danger of the wind scattering the swaths. Straight combining could also be considered if the crop is too short to properly anchor the windrow. Set the reel speed

approximately the same as the ground speed: this will help prevent shattering. The cutter height should be just below the lowest pods in order to minimize the amount of stem that is processed through the combine.

Brown and Oriental mustards grow taller than yellow mustard, allowing for a higher cutting height. Taller plants provide a more compact swath that is less subject to wind damage. Cutting just below the level of the lowest pod enables the swath to settle into the stubble and reduces the danger of blowing in high winds; the swath should be laid in the direction of the prevailing winds if possible.

Remember that long-term safe storage requires a moisture content of less than nine percent (9%) and that the moisture level of mustard generally increases by one percent (1%) after binning (harvest less than 8% to allow for this increase). Addition, green seed will not cure out after harvest, but it will reduce in the plant if the moisture content is above 20 percent (20%) and the ambient temperature is above 5°C (41°F). Once the crop is harvested, the green seed content is fixed.

COMBINE ADJUSTMENT

To determine if there is a problem with cracked seed, run your hand into the threshed seed. If cracked mustard is present it will adhere to the hairs on the back of the hand and wrist. This indicates the need for further adjustment, probably lowering the cylinder speed. Combine cylinder and fan speeds should be lower than those used for wheat. A cylinder speed of 500-600 rpm, a front concave clearance of 3/16 - 7/16 inches and a rear concave clearance of 1/8 - 3/16 inch, with the chaffer set to 3/8 - 9/16 inch opening and the lower sieve at 1/8 - 3-16 inch should give good results. Pick up speed should match ground speed to prevent the loss of pods.

USE OF DESICCANTS

***USE ONLY REGISTERED CROP PROTECTION CHEMICALS, SAFELY!
DO NOT USE UNREGISTERED CHEMICALS!***

Mixtures of pesticides or use of unregistered crop protection products may result in the requirement of the crop to be destroyed. If used, there could be serious legal repercussions; growers must ensure quality control over their product by using crop protection chemicals responsibly.

Desiccant usage is not common but has been used in mustard under irrigation to accelerate plant drying and to obtain uniform maturity. Desiccants will not hasten maturity of seed. By killing the green growth of pods, stems and weed, the use of a desiccant should allow the crop to be straight combined. Aircraft applies desiccants when about 60% of the seed have changed color in the pods. The crop can be combined when the seed are fully mature and have undergone complete color change. If weather conditions are dry and warm, desiccation

should be complete within approximately 7 days; if weather conditions are damp and cool, desiccation may not be complete until 10 - 14 days after spraying.

DRYING SEED

Mustard seed is considered dry at the moisture content of 9.5% when using the Model 919 / 3.4 Moisture Meter and 1990 Canadian Grain Commission Mustard Charts. However, for long-term storage, a moisture content of less than 9%, accompanied by a temperature below 68 degrees F, is recommended.

The maximum drying temperature for a batch dryer is about 109 degrees F. Slightly higher temperatures may be used by experienced operators who are totally familiar with their dryer. The seed temperature must never exceed 120 degrees F. The temperature at which damage occurs is dependent on the seed's moisture content.

If mustard has a moisture content above 15%, drying should be done in two stages to avoid cooking and dryer burning. Mustard should be dried to approximately 13% moisture and thoroughly cooled. Expect the moisture content to rise, usually around 1%, when cooled as the seed reaches equilibrium with outside air. Then dry again down to approximately 9% moisture and cool.

Equipment designed for drying corn and wheat may require modification for the use with mustard. A fine screen will be needed to prevent the seed leaking or being blown from the drying bin.

Due to mustards small seed size there is an increased resistance to air flow in the dryer. This has the effect of prolonged drying time and raising temperatures in the drying layer. Less air is moving through the heating unit consequently less fuel will be required to warm the air. Faulty operation or poor temperature control could allow the air to be heated to excessively high temperatures which result in cooking the seed. It takes only a small amount of dryer burnt seed to downgrade #1 grade to sample grade. Always check the dryer for potential areas where the seed will not clean out or circulate properly.

QUALITY CONTROL

A producer of mustard must acknowledge and respect the fact that this commodity is destined for human consumption, failure to comply with global standards and tolerances for pesticide residues and related contaminants could have severe legal consequences for the source of the problem and the whole industry. Technological developments for the testing of impurities are and will continue to develop. These tests are motivated by the industry and consumer to aid in imposing compliance, identifying the source of contamination and ensuring the "global" consumer that the commodity is fit for human consumption.

It is strongly recommended by the members of the Mustard Association that growers be prepared to demonstrate an active and responsible quality control program. Land selected to produce the crop should have records available to show the history of previous crops, seed and crop protection products used. Documents of seed and all chemical purchases should be kept to support your records. As well, records and documents for chemicals used in storage bins should be noted.

The practice of sorting the production separately by quality and/or variety and marketing it as such can lead toward significant profits. For example, on occasion one area of a field may be of better quality than another. Binning and marketing the quantities separately may prevent a grade loss on the whole production. Sorting and marketing your production in terms of variety is very important to a buyer who has markets for a specific variety. For example, identifying a production of Oriental Mustard in terms of its variety, Forge Oriental Mustard may have better marketing opportunities to the right buyer/processor.

CONCLUSION

Any information you may have which in your experience has improved your mustard cropping would be valuable to include in future updates. Please mail your comments to:

“MUSTARD MANUAL”
c/o CANADIAN SPECIAL CROPS ASSOCIATION
AGRICULTURE AND AGRI-FOOD RESEARCH
CENTRE
107 SCIENCE PLACE
SASKATOON, SASKATCHEWAN S7N 0X2

Yellow Mustard Production Tips

SEEDING

- Yellow mustard is one of the easiest and earliest crops to grow and harvest. Plant this short season crop as early as possible so that the crop is "made" before the extremely high temperatures of mid-summer set in. Yellow mustard will usually mature in 80-85 days.
- Seeding rates should be 10-14 pounds/acre. Mustard germinates at 40°F and grows rapidly and competes well against weeds. It is also quite drought and frost tolerant. **EARLY SEEDING WILL RESULT IN SUBSTANTIAL INCREASES IN YIELDS.**
- Utilize a firm seedbed to assure ideal seed placement no more than 1/2" deep. Or mixing with fertilizer and broadcasting, harrowing, and watering up is certainly feasible.
- Row widths from 6-14 inches. Newer drills will seed mustard at recommended rates without attachments.

Fertilizer Recommendations for Mustard

- For specific recommendations on fertilizer rates, have your soil tested. Mustard is similar to canola in sensitivity to high rates of seed-placed fertilizer. Maximum rates should be no more than 10 units of N and P. All potassium and sulphur should be applied away from the seed. If soil analysis is not available, a general recommendation is as follows:
- Nitrogen_60 units Dryland Irrigation 150-175 unit Phosphate__25-45 units Dryland Irrigation 65-85 units Sulfur_40 units Dryland Irrigation 100-120 units
- Nitrogen and sulfur work together to provide the proteins for accelerated growth. Phosphate is very important in cold springs for adequate root development.

WEED CONTROL

- Treflan is the only broadleaf herbicide labeled for use. Select Max is labeled for grass and volunteer cereal control.

DIRECT COMBINING

- Combine directly when seed moisture content is below 8.0%. Ripe mustard should crack and not crush when bitten.
- **IT IS VERY IMPORTANT TO FIELD CHECK THE GREEN SEED COUNT; #1 MUSTARD IS ALLOWED ONLY 1.5% GREEN SEED.** Product containing more than 1.5% green seed may be refused at delivery.
- All makes of combines thresh mustard satisfactorily. Combine with slow cylinder speeds (400 - 600) to avoid cracking. Sieves, concave settings and wind adjustment is similar to the threshing of canola.

AGRONOMICS

- Mustard residue decomposes rapidly in the soil and shows fumigation properties that allows plant back of other crops. Cereal crops following mustard show excellent yield and quality, making it unnecessary to summer fallow mustard stubble under dry land conditions in 12-15 inch rainfall areas.
- Seed mustard on land free from wild mustard, rape seed, canola, buck wheat and cow cockle. These admixtures are black seed about the same size as mustard, are impossible to clean out, and will result in a "Sample Grade" product causing severe discounts in contract prices. **FIELDS PLANTED TO MUSTARD MUST HAVE 4 COMPLETE CROP ROTATIONS BETWEEN CANOLA AND MUSTARD.**



Contact [MSO](#) for details.

This bulletin serves as a guideline for production. Conditions may vary in individual fields. Good agronomic practices should always be followed by the grower to ensure the maximum potential.





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YELLOW MUSTARD COMBINE SETTINGS

- Yellow mustard is the most shatter resistant of all the mustards. When one considers starting harvest of yellow mustard, one must attain **8-9% SEED MOISTURE and GREEN SEED count less than 1.5%**. If these conditions cannot be met, consider waiting to harvest or the possibility of swathing. Straight combining usually leads to higher quality mustard but if uneven maturity or weed pressure are concerns, swathing should be considered.

PREHARVEST SWATHING

- The most important decision for swathing is when to start. Mustard seeds that are green in the pod will not change color when swathed, especially if temperatures are in the 90's right after swathing. Generally, swathing should begin when the majority of the seeds are at 25% moisture. The lower pods on the mustard plant will have changed color while the upper pods will be green. One should not rely solely on pod color; checking seed color is important too. Generally if a mustard seed is green without a slight color change, it will stay green. When swathing, cut just low enough to capture all the pods. Laying the wind row on long mustard stems will reduce a chance of the wind blowing the swath away. Swathing should only be considered if conditions are not satisfactory to straight combine.

STRAIGHT COMBINING

- Straight combining mustard should start when the mustard has low green count and moisture between 8 & 9%. Set the cutting platform just below the lowest pod to minimize the amount of product to be separated leading to clean samples. The following are the suggested combine settings.

COMBINE SETTINGS

- REEL SPEED.** – set the speed approximately the same as the ground speed.
- CYLINDER SPEED** should be 1/2 to 2/3 rpm that is used on wheat. Cylinder speeds between 400 and 800 can be acceptable if the amount of cracked seed is low. Cylinder speed is usually the cause of cracked seed.
- CONCAVE CLEARANCE** should be wider at the front than the back. General setting would be 1 inch in the front and 1/8-1/2 inch in the back.
- Compared to cereals, **CLEANING ACTION** for mustard depends more on the shaking of the sieves than the air pushing through them. **AIR SETTING** should be 3/4 the volume that is used for wheat.
- TOP CHAFFER** should be 1/4 to 1/3 inch and the bottom sieve setting at 1/8 to 1/4 inch open. Make small adjustments to the chaffer, bottom sieve and air if the sample is either too clean or not clean enough.



This bulletin serves as a guideline for production. Conditions may vary in individual fields. Good agronomic practices should always be followed by the grower to ensure the maximum potential.



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Please see our website for additional grower manuals and information.
www.msoilseeds.com