A GUIDE TO BUCKWHEAT PRODUCTION IN MANITOBA

2nd edition

Information about growing, marketing and consumption of Manitoba-grown buckwheat

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Updated from 1997 version edited by Joe Tsukamoto

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INTRODUCTION

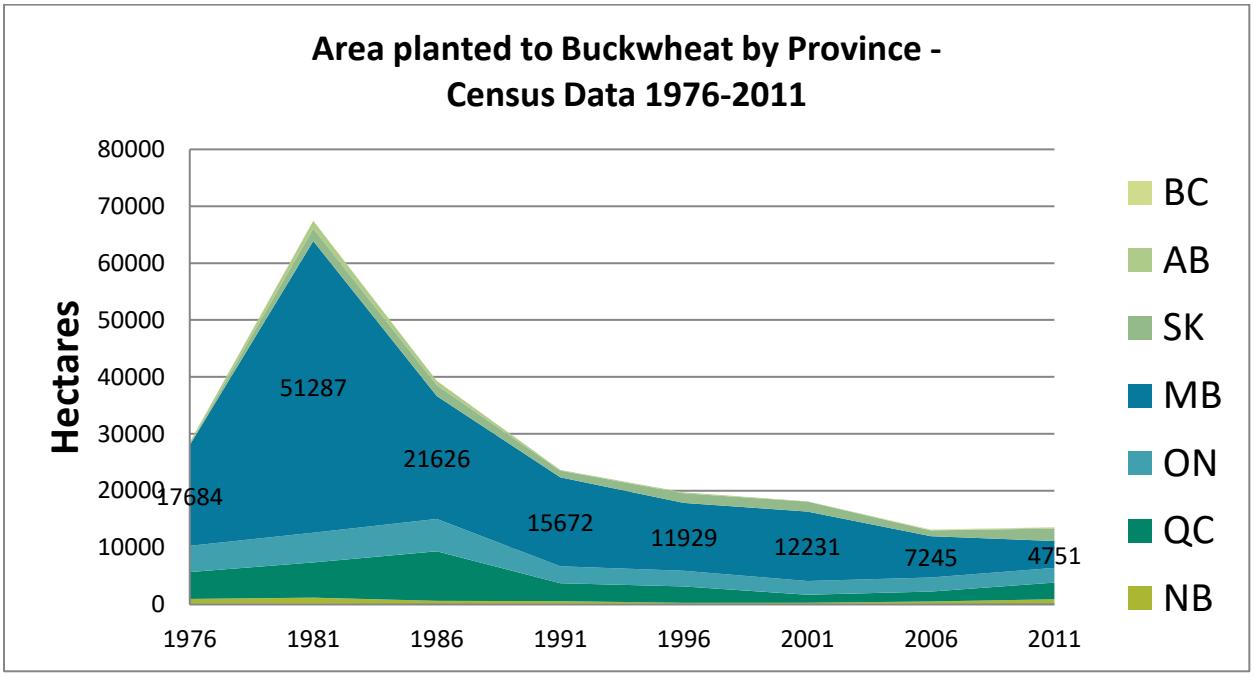
Buckwheat, which is thought to have originated in the mountainous regions of China, is grown in many parts of the world and has long been consumed as human food and as livestock feed. Early settlers from Ukraine brought buckwheat to Manitoba where it was cultivated and used in traditional dishes, with any surplus buckwheat being fed to chickens.

The buckwheat which is produced commercially in Manitoba is common buckwheat, *Fagopyrum esculentum* Moech. Tartary buckwheat, *F. tataricum* (L.) L. J. Gaertin, is a related species. It is considered a noxious weed in western Canada although it has been grown for feed in eastern Canada. More distantly related is wild buckwheat, *Polygonum convolvulus* L., which is a common weed. These related species and common buckwheat do not cross.

Buckwheat is not a true cereal because it does not belong to the grass family, but because it is handled in the same way as a cereal, it is usually classed with cereals. When the market for traditional cereal crops is poor and Manitoba producers need alternative crops, buckwheat is one alternative. Buckwheat, however, can be a profitable crop to grow at any time, providing its production is well managed.

HISTORICAL PRODUCTION

In the 1960s and early 1970s, the export of buckwheat to Japan was an attractive business venture, but the returns for producers were small. Japanese millers' interest was captured by the development of large-seeded buckwheat. The first large-seeded variety, Mancan, was released in 1974 by Agriculture Canada from the Morden Research Center in Manitoba. Today, traditional small-seeded buckwheat is no longer recommended for production in Manitoba.



Source: Statistics Canada

In 1979 buckwheat acreage peaked in Manitoba at 135,000 acres (54,635 ha), but because weather was unfavourable for buckwheat production that year, the average yield was only 7.4. bushels per acre (400 kg/ha). In 1981, with attractive prices for buckwheat, Manitoba growers produced 45,700 tonnes. Since then, the production of buckwheat has decreased in Manitoba, dwindling to as little as 2,600 acres (1,050 ha) in 2014.

Table 1 Buckwheat production and pricing

YEAR	Seeded (Ha)	Harvested (Ha)	Yield (kg per ha)	Production (tonnes)	Price per tonne	Value ($000)
2006	6,900	6,900	1,100	7,400	331	2,449
2007	2,000	2,000	1,200	2,300	355	817
2008	2,300	2,300	1,075	2,473	444	1,098
2009	2,000	2,000	921	1,851	480	888
2010	2,100	2,100	1,036	2,176	422	919
2011	1,700	1,700	903	1,535	658	1,011

Table 2 Seeded Acreage and Production of Buckwheat in Manitoba (MASC)

YEAR	Seeded Acres	Yield (bus per acre)	Production (bus)	Number of growers	Average acreage per grower
2012	11,139	10	111,390	85	131
2013	5,002	14	70,028	43	116
2014	2,579	8	20,632	20	129
2015	8,674	22	190,828	57	152
2016	11,083	14	155,162	62	179

MASC = Manitoba Agricultural Services Corporation

ADAPTATION

Buckwheat thrives in cool, moist climates and is widely adapted but not frost tolerant. Buckwheat, therefore, is grown in almost all parts of the world where the season is adequate for the crop to mature. Buckwheat requires a growing season of approximately 10 to 12 weeks. It is sensitive to cold and is killed quickly when temperatures fall much below freezing. Buckwheat is regarded as a warm temperature-loving, short-day crop. High temperatures, however, and hot and dry wind cause flower blasting, especially if the crop is under drought stress.

It can be grown on soil that is relatively low in fertility, and it can be grown in various types of soil, at various altitudes, and under various climatic conditions. Buckwheat is best suited to light and medium-textured soils, such as sandy loam, loam and silt loam. Clay soils and highly fertile soils are more

challenging to grow buckwheat on due to possible moisture stress and excessive vegetative growth that can cause luxuriant vegetative growth and lead to lodging.

High fertility, particularly high nitrogen, is not required, but balanced fertility is necessary. Buckwheat is as acid tolerant as oat and potato. Liming soils above a pH of five should not be necessary. Studies in Western Canada have shown an early growth-stage tolerance to saline soils, however, as the crop matured, this tolerance lessened. Buckwheat is susceptible to lodging because of its hollow stem and is easily flattened by high wind and heavy rain. Buckwheat was often grown as a catch crop, and little consideration was given to the conditions which are best for its production.

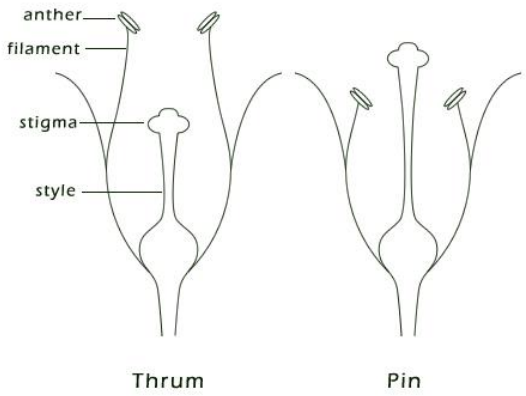
BOTANICAL DESCRIPTION

Common buckwheat is a broad-leaved annual plant characterized by large heart-shaped leaves. Plants are 2 to 5 feet (0.6 to 1.5 m) or more in height with an erect stem which is succulent. The stem is grooved, but smooth and usually hollow, and it has several branches. Stem colour ranges from green to red, and, as they approach maturity, plants turn brown. Often fields appear purplish-red when buckwheat is swathed. Leaf blades are green, triangle to heart shaped, and approximately 2 to 4 inches (5 to 10 cm) long.

The plant has a shallow tap root system with several branched lateral root systems extending to 3 to 4 feet (0.9 to 1.2 m) in depth. It comprises about 3 per cent of the weight of the plant. Buckwheat has far less root system than cereal grain which has 6 to 14 per cent of the weight of the plant in the root system. Its fine roots penetrate the soil quickly, but do not tolerate compaction, flooding or drought.

Common buckwheat has an indeterminate inflorescent (flowering) habit. Flowering begins 5 to 6 weeks after the buckwheat is seeded and continues for at least a month, often until frost. Flowers are formed in dense clusters occurring at the end of branches or arising from the axils of the leaves. The flowers are usually white, but occasionally pink or pinkish-red flowers may occur. A flower consists of five petal-like sepals. Common buckwheat plants bear one of two floral types. Pin type has flowers with a long pistil, a three-parted style with knoblike stigmas, and short stamens. Thrum type has flowers with a short pistil, a three-parted style, and long stamens.

Figure 1 Buckwheat floral parts

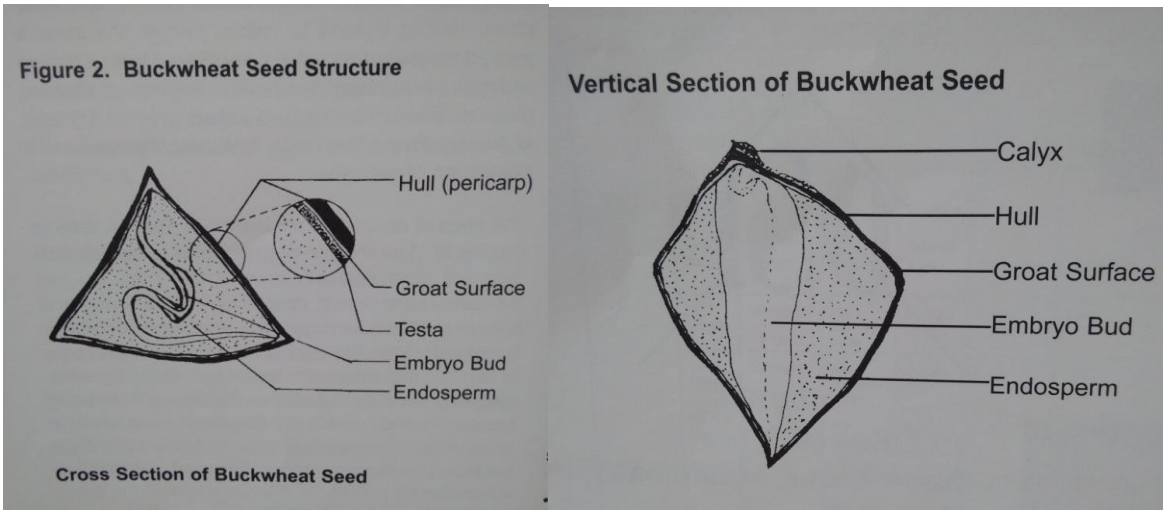


Common buckwheat plants usually do not set seed with pollen from the same flower type. Cross-pollination, pollination between plants of different flower types, must occur. Pollination is normally done by bees and other insects. The insects are attracted to the nectar which appears at the base of the style. When visiting flowers to collect nectar, the insects transport sticky pollen which has adhered to their bodies and pollinate the buckwheat. With legitimate pollination (i.e., cross pollination), plants will set seed. A 1:1 ratio of plants with the two flower types usually occurs in a population of buckwheat. Honeybees and leaf cutter bees are effective pollinators. Manitoba research recommends one honeybee colony per acre for effective fertilization and seed set. Most buckwheat production is done with only natural pollinators but is sometimes aided with beehives set up later season when other flowering crops, like canola, are finished flowering.

Buckwheat plants flower abundantly, however, flower abortion is quite high. As much as 88% of flowers do not produce seed. This is a significant amount of resources spent by the plant on flowering with relatively little seed production resulting. Plant breeding efforts have been made to improve the seed set but existing varieties still have high abortion rates.

The seed of common buckwheat is a fruit (a seed-bearing structure that develops from the female organ of a flowering plant), an achene (Figure 2). The triangle-shaped seeds are green until they are physiologically mature, and then the hull (pericarp) turns brown, grey brown or grey in either a solid or mottled pattern, or black. As the seed matures, a peduncle connected to the seed dries and becomes brittle. It, therefore, can be broken easily by wind. Also, when frost damage occurs, the peduncle dries and becomes brittle. Inside the pericarp is testa which is green when the seed is first harvested, but this layer becomes reddish brown as the seed ages. With the disappearance of the green colour, a loss of flavour and aroma is indicated. A similar colour change can occur if seeds are exposed to high temperatures, or such a change can occur more quickly if seeds are subjected to both high humidity and high temperatures.

Figure 2 Dehulled buckwheat seed: freshly harvested with green testa (left) and oxidized with reddish testa (right)



Buckwheat hulls

Buckwheat hulls are a by product of the whole seed being dehulled and separated by its components; groats and hulls. Hulls are fibrous material with little feed value. They are used in Japan for stuffing pillows and some of it is used for that purpose in North America. Hulls are also used as a fuel source to produce heat in the processing facility where it is generated. Processing plants are the primary source of supply for buckwheat hulls.

ADVANTAGES

There are many advantages in growing buckwheat.

- Buckwheat matures in 80 to 90 days. As one of the special crops, it requires the least number of days to mature (Figure 3). Because it requires a relatively short period in which to achieve maturity, buckwheat may be an alternative crop for late seeding.

Table 2 Days to maturity for selected special crops

Crop	Days to Mature
Buckwheat	80- 90
Yellow mustard	80- 90
Brown or oriental mustard	85- 95
Corn (grain)	110-120
Field peas	90 -100
Canola (late)	92 -102
Canola (early)	73 – 83
Lentils	85 -100
Canary grass seed	95 -105

Wheat	90 -100
Navy beans	90 -100
Sunflowers	120-130
Coriander	90 -100
Fababeans	105-115
Black beans	95 -105

** The number of days varies from season to season, depending on the weather.*

- Equipment used in the production of traditional cereal crops is used in buckwheat production; no additional equipment is required.
- Buckwheat is troubled by fewer pests than are many crops that are grown in Manitoba.
- Buckwheat is adapted to a wide range of soil types.
- Input costs are low if crop rotation is planned wisely.
- Buckwheat can be grown in a zero tillage system.
- Buckwheat is a very competitive crop that can smother weeds without the need for a herbicide
- Buckwheat can be grown organically because a short growing season is required and the quick establishment of the crop can suppress the late development of weeds.
- Buckwheat can be grown as a cover crop to prevent soil drift in the winter months.
- Buckwheat can provide a good crop of rich dark honey.
- Buckwheat can be used in many ways, including in food (groat, flour, noodles, fillings, and so forth), beverages (tea and liquor), pharmaceuticals and health related products, such as pillows.
- Buckwheat can benefit leaf cutter bees, which pollinate buckwheat, by enabling them to multiply at a high rate. The bees prefer to use buckwheat leaves in making the cocoons in which they lay their eggs.

RISKS

There are some risks in growing buckwheat.

- Buckwheat is weather sensitive. Late spring and early fall frosts are detrimental to the crop.
- Flower blasting results from high temperatures and hot, dry winds. The affected flowers thus fail to set seed.
- Succulent stems and luxuriant plant growth are prone to wind damage.
- The nature of the root system makes luxuriant plant growth susceptible to lodging.
- A very limited number of herbicides are available to use in buckwheat production.
- Buckwheat tends to volunteer in the subsequent crop because seeds easily shatter.
- Yield can be quite variable from year to year depending on the growing conditions.

PROPERTIES AND USES

In Canada buckwheat has been grown primarily for grain for export and domestic purposes. Throughout history, this crop has had a number of uses: human consumption, livestock feed, a honey producing crop, smother and green manure crop.

Buckwheat is also harvested green for rutin extraction. Rutin is a flavonol glycoside compound, found in plants that is known for their effectiveness in reducing blood cholesterol, keeping capillaries and arteries strong and flexible and assisting in prevention of high blood pressure. Rutin is the main buckwheat flavanoid. Other flavanoids include quercitin, quercetrin, orientin, vitexin and more. The flowers and the leaves of buckwheat contain the highest level of rutin. Some is accumulated in the seed but at lower concentrations. Tartary buckwheat (*Fagopyrum tataricum*) also has a higher concentration of rutin than common buckwheat (*Fagopyrum esculentum*). Tartary buckwheat is not commercially produced in Manitoba given its status as a noxious weed on the Manitoba Noxious Weeds Act.

North American processors use buckwheat in pancake mixes, breakfast cereals, breads and poultry stuffing. Europeans use whole groats in porridges, soups and breakfast cereals. Japanese millers buy buckwheat whole where it is dehulled and the groat milled into flour to combine it with wheat flour to produce "Soba" or buckwheat noodles. They use the hulls from the seed for stuffing pillows. Japanese buyers are very particular about the quality of Soba noodles and only new crop buckwheat has the desired color and flavour. The European market is not as particular as the Japanese market for new crop buckwheat and will purchase buckwheat that may have lost its green testa color that is characteristic of new crop buckwheat.

Buckwheat produces a dark, strong-flavoured honey, which is usually sold for a premium. Beekeepers in southern Manitoba are concerned about shrinking buckwheat production and how that may affect their honey yields and prices.

The crops rapid germination and growth and broad-shaped leaves, which shade early in the crop's development, smother most weeds. Buckwheat is therefore not a good choice for a cover or companion crop. It has also been used as a green manure crop because of decent yields of dry matter in a short time.

Nutrient value of straw

Buckwheat when the plant is actively growing and developing is very soft and fleshy making it very palatable so that livestock will graze it quite readily. When harvested to maturity, the straw can be harvested for livestock feed and bedding although this is not an important use of the plant material. Buckwheat straw is usually returned to the field. It is chopped and spreaded on the field during the harvest operation and subsequently incorporated with tillage.

Analysis of buckwheat straw was conducted in 2015 using three samples from Manitoba growers. Results indicate that the feed value is comparable to cereal straws having relatively low energy and protein values.

Table 3 Nutrient value of buckwheat straw collected post harvest (dry matter basis).

Protein %	4.4
Total Digestible Nutrients (TDN) %	44.6

Calcium (Ca) %	.6
Phosphorus (P) %	.2
Magnesium (Mg) %	.5
Potassium (K) %	1.8

GROWING THE CROP

PRE-PLANT PLAN

In order to achieve the best returns, buckwheat production must be carefully planned as part of an integrated farm operation. Suitable fields must be selected according to soil type, the least hazard of weeds, the absence of harmful chemical residue from the previous crops, and the presence of residual soil fertility which will reduce the cost of production. All production activities from seeding to harvesting must be timely in order to obtain good yields of high quality buckwheat. Also, arrangements to market the crop must be made to maximize returns.

FIELD SELECTION

SOIL

Well drained sand or silt loams are preferred. Buckwheat is known to tolerate acid soils and appears to tolerate saline soils. However, in saline soils, when plants pass the seedling stage, normal plant development often will cease. Seedbed preparation should aim to create drainage around the seed otherwise the seed will rot if water collects or ponds around it.

SOIL HERBICIDE RESIDUES

From the herbicides used in the production of previous crops, various levels of residual chemicals may be present in soil and be harmful to buckwheat. Chemicals with just such a harmful residual effect include the following: Ally, Assert, Atrazine, Banvel, Bladex L, Glean, Lontrel, Muster, Princep Nine-T, Simadex 80W, Simazine 80W, Tordon 202C, and Trifluralin. (See illustration.) It is best for buckwheat growers to consult the current Guide to Crop Protection when chemical residue is a concern.

WEEDS

In buckwheat production, field selection is critical. Weeds, including perennial weeds, should be controlled in the crop year previous to the year in which buckwheat is grown so that no weeds are inherited. An integrated approach to crop production with carefully planned crop rotation can reduce the occurrence of volunteer crops, both in buckwheat and in the subsequent crop when buckwheat itself is likely to volunteer. Herbicide options are available to control weeds prior to seeding, consult the Crop Protection Guide for the most current information.

CROP ROTATION

Well planned crop rotation is essential because weeds must be controlled in buckwheat production. Furthermore, buckwheat tends to volunteer in subsequent crops. Crops that follow buckwheat should be such that effective control of volunteer buckwheat is possible. The correct sequence of crops in rotation is important when buckwheat is being produced. Crop rotation with buckwheat, however, can be flexible enough to accommodate emergency re-cropping or late planting, providing reasonable returns will be realized from including buckwheat in the rotation.

Although insects and diseases are not now problems in buckwheat production, crop rotation can prevent a problem from developing.

IRRIGATION

Elsewhere in the world, irrigation has been used successfully in the production of buckwheat. Under good management, yield increases and good physical qualities are obtained. As well, consistent production is possible. Perhaps in Manitoba, too, buckwheat may be included in crop rotation on irrigated land, and similar results may be obtained. Preliminary trials have been conducted on irrigated potato land in Manitoba, but because results were inconclusive, further trials are needed before reliable recommendations can be made for the commercial production of buckwheat under irrigation in Manitoba.

VARIETIES

Historically, buckwheat has been grown as a cash crop in Manitoba and is intended for the export market. Currently large seeded varieties are recommended; small seeded varieties are no longer recommended for production. Eight recommended varieties are currently available. All are large seed varieties. These varieties are Mancan, Manor, AC Springfield, AC Manisoba, Koban, Koto, Koma, Horizon and KenMar.

Mancan is the first large seeded variety registered in Canada in 1974. It is about 20 percent larger than the small seeded variety Tokyo. About 12 to 15 percent of the seed has a wing extension of the hull.

Manor is the second large seeded variety registered in Canada in 1980. About 3 to 5 percent of the seed has a winged extension of the hull.

AC Springfield is a larger seed than Mancan with a high seed weight. It has a higher percentage of large, whole groat after dehulling. About 2 percent of the seed has a winged extension of the hull.

AC Manisoba is intermediate in size between Mancan and AC Springfield. Seed is light brown to dark brown which is the same colour range as Mancan, Manor and AC Springfield.

Koban has greater seed density and contains higher protein than AC Manisoba. Seed is dark brown to black.

Koto is earlier maturing and higher seed weight than AC Manisoba. The seed is very dark brown to black.

Koma

Horizon is a large seed variety licensed in 2011.

KenMar is large seed variety licensed in 2016.

Table 4 Description of recommended varieties (2016)

	Mancan	Manor	AC Springfield	AC Manisoba	Koban	Koto	Koma	Horizon	KenMar
Yield as % of Koma	108	111	115	115		120	100	126	
1000 seed weight in g.	29.2	28.7	35.7	33.7	31.5	36.9	37.3		
Seed density in kg/m3	557	570	523	556	560	621	622		
Plant height in cm	102	101	100	110	102	123	122		
Protein in %	13.6	13.6	13.6	13.9	14.0	13.8	13.5		
Days to 100% bloom	Mid-season	M	M	M	M	M	M		
Flower color	White	W	W	W	W	W	W		
Seed colour									

Average yield of Koma over 21 site-years is 1608 lbs/acre of 33.5 bushels per acre.

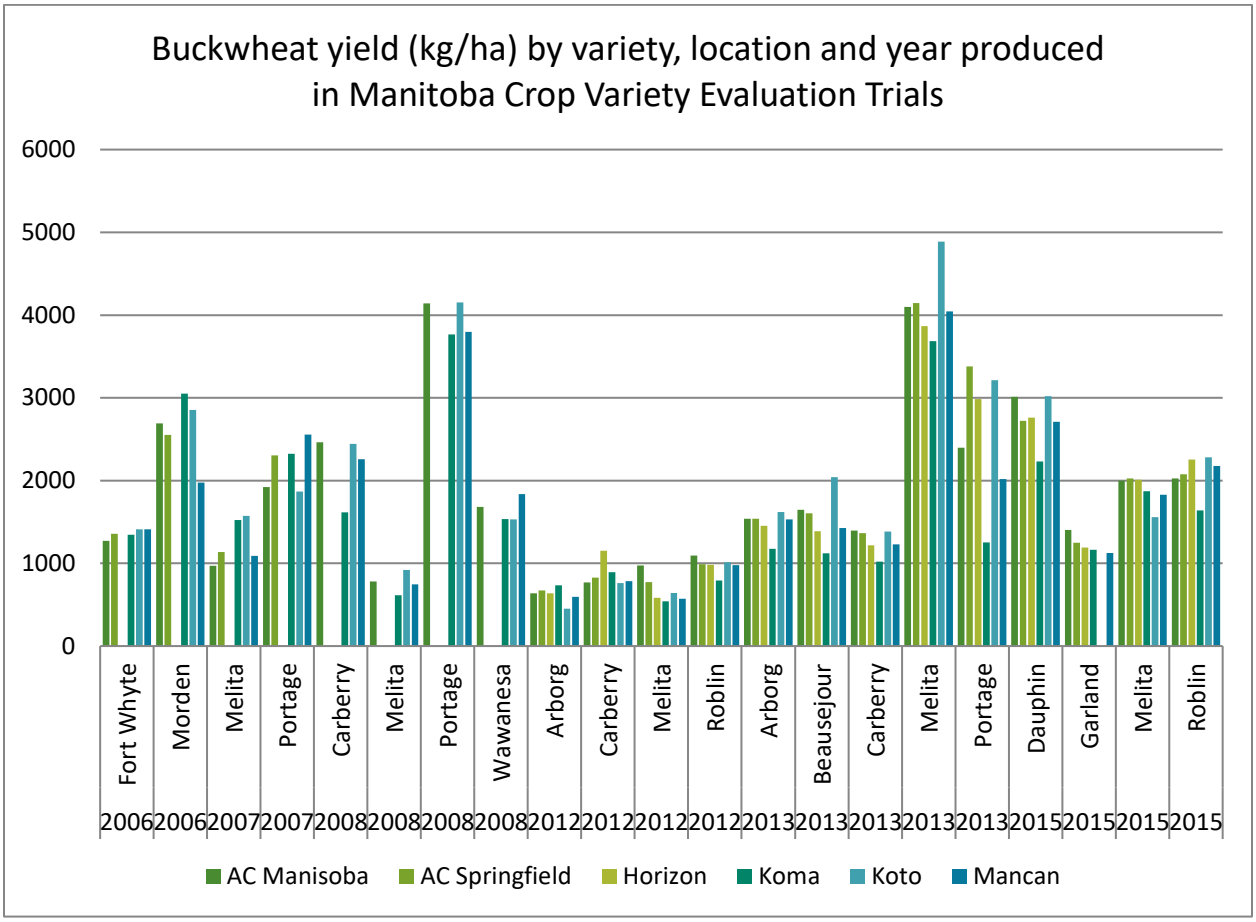


Figure 3 Buckwheat yield (kg/ha) by variety, location and year produced in Manitoba Crop Variety Evaluation Trials

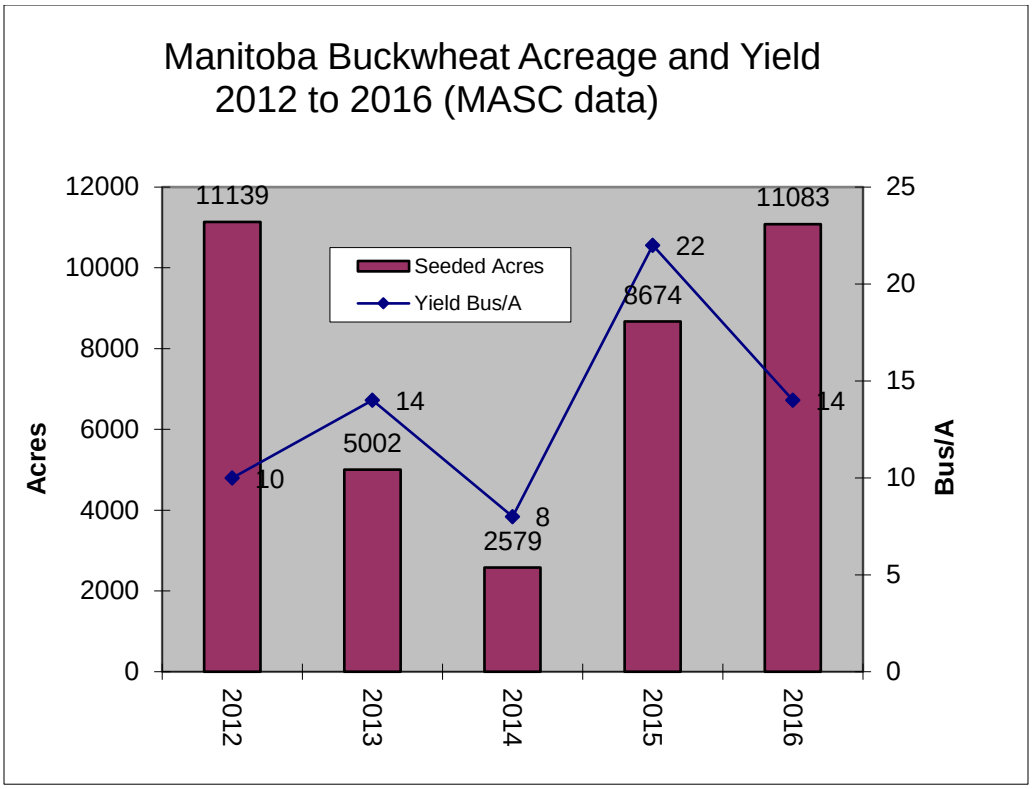


Figure 4 Average acreage and yield of buckwheat in Manitoba.

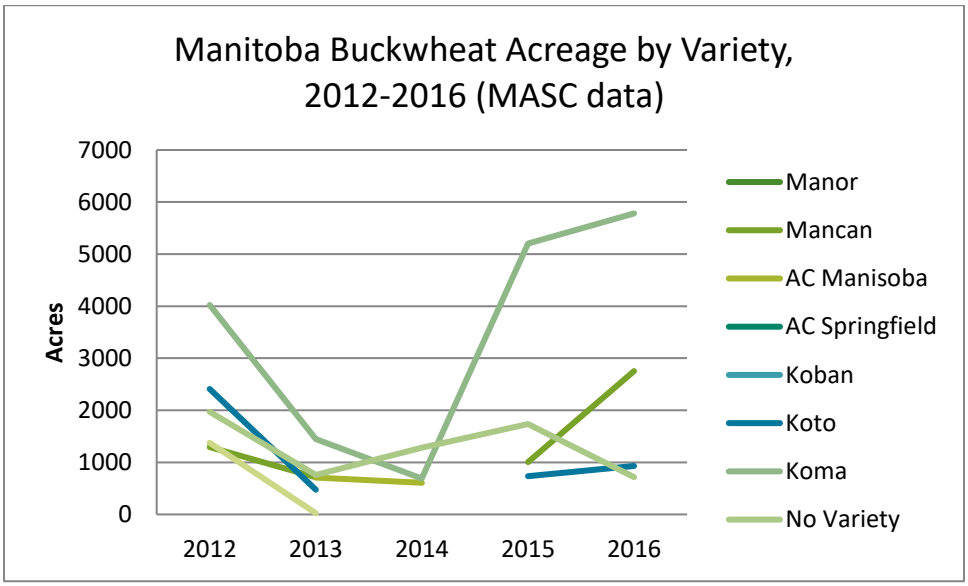


Figure 5 Manitoba buckwheat average by variety, 2012-2016 (MASC data)

SEED YIELDS

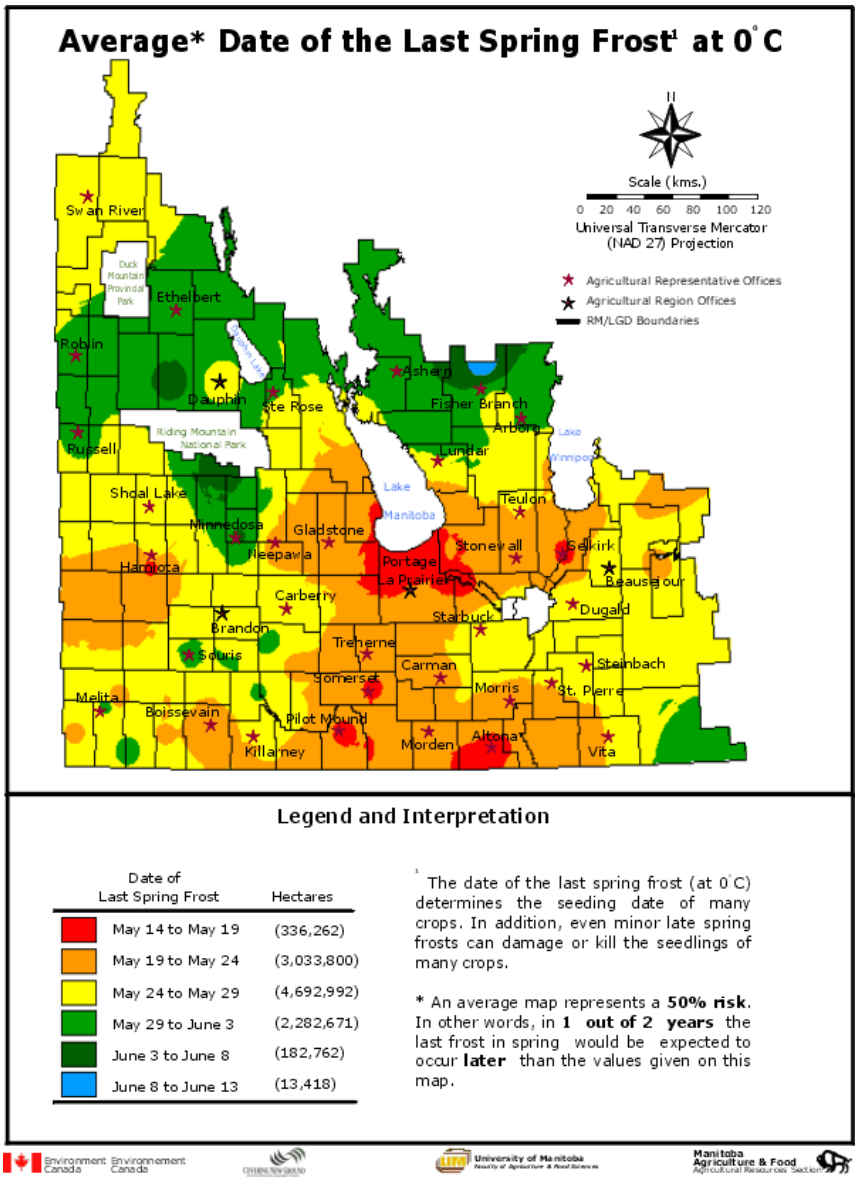
With good management and with improved varieties, a seed yield of 30 bu/ac (1633 kg/ha) is a realistic aim in buckwheat production. In the past, very low yields have been reported, but, in some seasons, successful growers have obtained from 40 bu/ac (2200 kg/ha) to 50 bu/ac (2700 kg/ha). Yields vary from season to season because buckwheat is sensitive to weather. Furthermore, buckwheat often has been grown as a catch crop, and ideal conditions have not prevailed for its production.

Figure 4 shows the acreage and yields achieved in Manitoba from 2012 to 2016. Acreage varied from a high of over 11,000 acres to a low of less than 3,000 acres. In 2014, acreage reached a 5-year low due to a very wet spring in the core growing area of the province resulting in few acres planted.

During the same 5 year period, yields varied from a low of 8 bushels per acre in 2014 to a high of 22 bushels per acre in 2015. The Long Term Average Yield (LTAY), which is a 10 year average, for buckwheat in Manitoba is 17 bushels per acre (MASC).

SEEDING

In order to obtain high yields of buckwheat, timely seeding is essential. Buckwheat is susceptible to frost, both late spring and early fall. Therefore in Manitoba's growing areas, early June is the ideal time for seeding. Research conducted in Manitoba indicates that early June seeding results in high yields and yields rapidly decline as seeding extends past mid June.



A firm seedbed is necessary, and seed must be placed 1.0 to 2.5 inches (2.5 to 6 cm) deep in moist soil. A general seeding rate of ¾ to one bu/acre (40 to 55 kg/ha) is recommended. The higher rate is suggested for fields where weeds may be a problem. Some growers seed as high as 1½ bu/acre (82 kg/ha) to deal with the problem.

A preferred method to determine optimum seeding rates is to consider final plant stands or plant populations. This method takes into account the desired plant stand, the variety seed size (thousand kernel weight or TKW) and the expected seed survival.

Seeding Rate = $\frac{\text{desired plants/ft2 X TKW (g)}}{\text{\% expected seed survival * X 10}}$ =

*Expected seedling survival used in decimal form (90 % = 0.9)

The desired plant population varies depending on the crop. For buckwheat a plant stand of 13-17 plants/ft2 is recommended.
The thousand kernel weight (TKW) is measured simply by counting out 1,000 seeds and weighing them in grams (g). Seed weights vary between varieties, fields, crop types and from year to year.

Expected seed survival is the germination less a small amount for seeding mortality. For example, under normal conditions expect approximately 95 percent survival of the germinating seeds. However, if planting in unfavourable conditions, i.e. cold, wet soils, expect approximately 90-93 percent survival.

Example A, high TKW and high plant population targeted:
Desired plant stand = 16
Thousand kernel weight = 37
Germination = 90 percent
Expected seed survival (good conditions) = .95 X .90 = .86

Seeding rate $\frac{16 \text{ X } 37}{.86 \text{ X } 10}$ = 69 lbs per acre or 1.4 bushels

Once the desired seeding rate is calculated, the next step is to calibrate the drill so that it delivers the right amount of seed.

Seeding at a higher rate allows faster ground coverage which smothers weeds. Conventional, minimum, or zero tillage practices result in equally good yields of buckwheat.
Buckwheat does exhibit a high degree of plasticity, branching profusely to compensate for lower plant populations.

Figure 6. Buckwheat seedlings emerging at the cotyledon stage (left) and with one true leaf (right).

FERTILIZATION

Soil should be tested to determine specific fertilizer requirements. Buckwheat does not require high fertility, but an adequate balance of nutrients is essential in obtaining good yields. The general recommendation for fertilizer when a soil analysis is not available is as follows:

Table 5. General fertility recommendation for buckwheat.

Buckwheat to be grown on:	**Nitrogen** (N) Lb/a kg/a	**Phosphate** (P2O5) Lb/ac kg/ha	**Potash** (K2O) Lb/ac kg/ha	**Sulphur** (S) Lb/ac kg/ha
Following legume breaking	0-20 0-20	Maximum 20 lbs/a (22 kg/ha) P2O5 should be placed with the seed. 30-40 lbs/a (34-45 kg/ha) if placed away from the seed.	Sands, sandy loams and organic soils are frequently low in available potassium. On these soils apply 30-60 lbs/a (34 to 67 kg/ha) of potash K2O	Sulphur deficiency may occur in many soils in any area of the province. Apply sulphate sulphur at 15 lbs/a (17 kg/ha) when required.
Following grass and grass-legume breaking	20-40 22-45	As above	As above	As above
Following stubble	40-60 45-67	As above	As above	As above

- Any nitrogen in excess of 6 lbs/a (7 kg/ha), phosphate in excess of 18 lbs/a (20 kg/ha) P2O5 and all potash and sulphur should be placed away from the seed to avoid injury.

In tillage trials in Manitoba, a total of 75 lb/acre (83 kg/ha) of nitrogen (available soil nitrogen and nitrogen fertilizer) and 25 lb/acre (28 kg/ha) of P2O5 were provided. Buckwheat was seeded at a row spacing of 10 inches (25 cm), and fertilizer was banded 5 inches (12.5 cm) between rows. With this method, good yields were obtained.

Under conditions of high nitrogen, buckwheat plants produce luxuriant vegetative growth. The succulent stems can break easily with wind or rain, and the plants are prone to lodging. (See illustrations.) When urea is used as a source of nitrogen, particular attention must be given to placing the fertilizer with the seed. An excessive amount of urea placed with seed can reduce seedlings. Under

dry conditions, this consequence can be serious. Side-banding at one inch aside and one inch below seed can achieve good results, but urea side-banded at 80 lb/ac (90 kg/ha) or higher adversely affects seedlings.

A non-replicated buckwheat N-ramp was established at Carberry in 2008 with plots measuring 2 m by 5 m. fertilized with 0. 20, 40, 60, 80 and 100 lbs/ac o' N, to assess yield increases as well as any agronomic issues that may occur, such as lodging. There were slight visual differences in the treatments over the growing season. In general, all treatments grew well, based on good residual soil fertility and timely rains. The highest yielding treatments were the application of 20 and 40 pounds of actual N/acre (Figure 7). This confirms many studies that indicate that buckwheat does not require a lot of fertilizer to maximize yields.

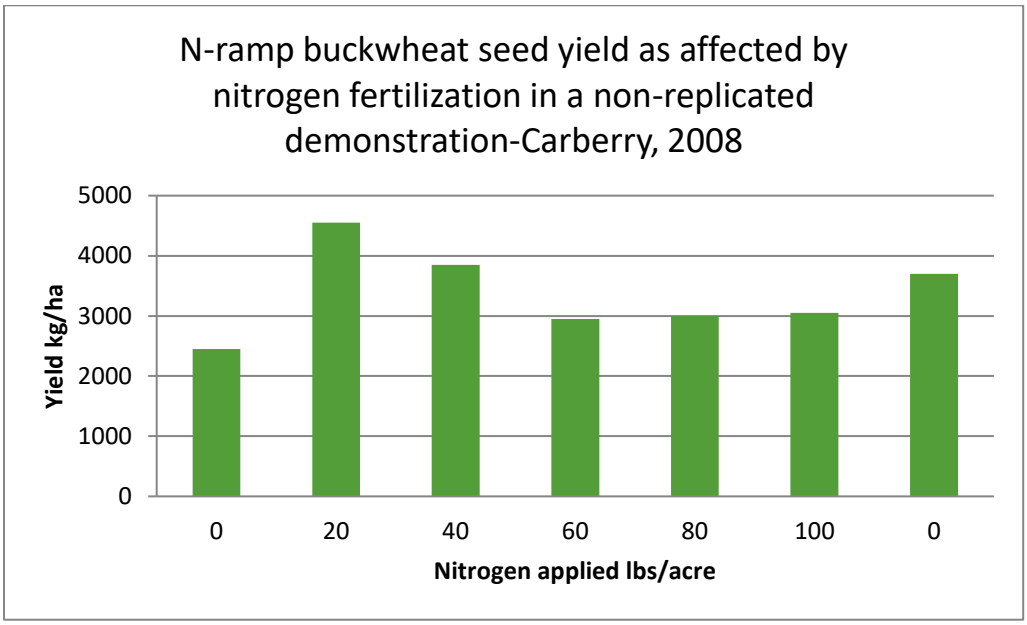


Figure 7. Buckwheat seed yield as affected by nitrogen fertilizer.

Buckwheat responds well to a phosphorus application when phosphorus in the soil is low; however, plants are efficient at removing phosphorus from the soil and making it available to subsequent crops through straw and stubble decay.

WEED CONTROL

In Manitoba no herbicide is currently licensed for in-crop use to control grassy or broadleaf weeds. Care must be taken to avoid problems with weeds and volunteers from the previous crop.

Since buckwheat is sown late, there is ample opportunity to control problem weeds with herbicides or cultivation before seeding. Avoid using herbicide that may leave a residue before seeding. Weeds can reduce both yield and quality of buckwheat.

In good stands of buckwheat, the seedlings compete strongly and smother weeds. In thin stands, further controls may be needed if a severe weed problem is anticipated. While living buckwheat may have an allelopathic weed-suppressing effect, its primary impact on weeds is through shading and competition.

The most common broadleaf weeds found to impact buckwheat in Manitoba are common lamb's quarters, redroot pigweed and wild mustard. A variety of herbicides have been tested for their effectiveness in controlling broadleaf weeds but often the injury to the crop is considered too great to have a product registered. There is ongoing research to identify and register an herbicide that would be effective to control those weeds.

Weeds like green foxtail (*Setaria viridis*), left, and red root pigweed (*Amaranthus retroflexus*), middle, are warm season plants that can compete with buckwheat and often require control. Lambsquarter (*Chenopodium album*), right, is a cool season plant and prolific seed producer.

Grassy weeds like wild oats and green foxtail can also be an issue and may be controlled with some herbicides. Few herbicide control options are currently registered for use in buckwheat. Work is ongoing to have more herbicide options registered for weed control in buckwheat.

Clean stubble in a well managed buckwheat stand.

INSECTS

Currently, insects are not a cause for serious concern in the province. Few chemicals are registered to control either insects or diseases in the production of buckwheat in Manitoba. To continue avoiding these hazards, it is important to use good quality seed which will result in the quick establishment of

vigorous stands of seedlings. Good seed, combined with balanced fertility, ensures good plant growth and development, leading to healthy plants. Diseases and insects can be kept to a minimum, too, if sound crop rotation is practised. Certain beneficial and detrimental insects and certain diseases are relevant in Manitoba buckwheat production.

Beneficial Insects

Honeybees. Some insects are beneficial in buckwheat production. Buckwheat requires cross-pollination, and pollination is done by insects. Although many insects serve as pollinators, honeybees can perform the service. The unique dark buckwheat honey that bees produce is collected, and it is often valued by consumers, particularly those who are health conscious. Honeybees, therefore, mutually benefit buckwheat producers and beekeepers, provided arrangements are made well in advance of the season. Although less than one hive per acre is common, two hives per acre or more in the field are suggested to provide bees to pollinate buckwheat, which produces nectar only in the morning.

Leaf Cutter Bees. Leaf cutter bees pollinate buckwheat well. In the early days when leaf cutter bees were not readily available, the bees were multiplied in well-sheltered fields of buckwheat. For the bees, buckwheat leaves are ideal to use in making the cocoons in which they lay their eggs. Under favourable conditions, leaf cutter bees multiplied eightfold. When leaf cutter bees are removed from alfalfa seed fields in late summer, they can be moved into buckwheat fields to obtain the benefit of their late season activities. The bees will further pollinate buckwheat.

Destructive Insects

Potential problems with destructive insects exist in buckwheat production.
Damage by **flea beetles** has been noticed on buckwheat seedlings, but it appears not to be cause for economic concern. (See illustration.)

Cutworms and **grasshoppers** are potential problems. Thresholds of ½ /ft2 (3-4/m2) and 1/1 ft2 (7-12/m2), respectively, are recorded. Consult the current edition of the Field Guide Guide to Crop Protection for the most current available information to control these insects.

Research done in 2002-2003 by lead investigator Dr Neil Holliday from the University of Manitoba, verified that **Lygus bugs** can have an effect on yield of buckwheat. They found that the early application of an insecticide (Matador) reduced populations of Lygus bugs in the buckwheat crop in early August, but this effect did not persist until the time of the second application. As a results of its control effects, the insecticide application resulted in an average 12% yield increase compared to the untreated check. The insecticide application depressed the population of adults which colonize the buckwheat crop early in the growing season, and thus, prevent their reproduction of a new generation of nymphs compared to the untreated check.

Lygus bugs have piercing and sucking mouthparts, with which they puncture plant tissues and suck the juices. The plants may react to the saliva that the insects inject when they feed.

Plant bugs in the genus *Lygus* feed on many plants; crops, weeds and wildflowers. Some of the crops that they potentially can be of greatest economical concern in Manitoba include alfalfa seed, canola, sunflowers, beans, **buckwheat**, and strawberries. Lygus bugs will also feed on flax and wheat, but feeding in these crops does not appear to be economical. Some weed hosts of lygus bugs include chickweed, dandelion, red clover, red root pigweed, lamb's quarters, plantain, goldenrod, and asters.

Wireworms

Wireworms are larvae of a family of beetles known as click beetles (Elateridae). There are many species that can feed on crops, and in Canada there are about 30 economically important species of wireworms. Larvae of wireworms feed underground on seeds, roots and other below-ground plant parts. They are attracted to germinating seeds by the CO_2 given off during germination/respiration. They may shred the emerging tissue when it is still underground.

Wireworms are slender, have hard bodies, and have 3 pairs of legs behind the head. The last abdominal segment is flattened with a keyhole-shaped notch. Size of fully-grown larvae varies between species. Larvae of the prairie grain wireworm are the larger of the 2 main species in the Canadian Prairie Provinces, and can reach a length of about 20 mm.

How long larvae spend in the soil before pupating also varies between species of wireworms. The prairie grain wireworm normally remains in the larval stage for 3 to 4 years.

CROP ROTATION

Well planned crop rotation is essential because weeds must be controlled in buckwheat production. Furthermore, buckwheat tends to volunteer in subsequent crops. Crops that follow buckwheat should be such that effective control of volunteer buckwheat is possible. The correct sequence of crops in rotation is important when buckwheat is being produced.

Buckwheat is a later maturing crop that produces well with later season moisture at the time seed fill is taking place. Buckwheat would be considered a cool season crop which will tend to produce well in cooler environments.

Crop rotation with buckwheat, however, can be flexible enough to accommodate emergency re-cropping or late planting, providing reasonable returns will be realized from including buckwheat in the rotation.

Although insects and diseases are not problems in buckwheat production, crop rotation can prevent a problem from developing.

IRRIGATION

Elsewhere in the world, irrigation has been used successfully in the production of buckwheat. Under good management, yield increases and good physical qualities are obtained. As well, consistent production is possible. Perhaps in Manitoba, too, buckwheat may be included in crop rotation on irrigated land, and similar results may be obtained. Preliminary trials have been conducted on irrigated potato land in Manitoba, but because results were inconclusive, further trials are needed before reliable recommendations can be made for the commercial production of buckwheat under irrigation in Manitoba.

DISEASES

Downy Mildew (*Pernaspora ducometic* Siemet Jank). It is the most prevalent disease in buckwheat fields in Manitoba. (See illustration.) All varieties are susceptible to downy mildew. The disease can be seed borne, and it can over winter in the dead parts of infected buckwheat plants. Oospores cause the primary infection, the secondary infection being caused by conidia. So far, no assessment of economic damage caused by the disease has been reported in Manitoba.

Rhizoctonia Root Rot (*Rhizoctonia* spp). The disease can affect seedlings during a prolonged cool, wet period. At the base of the stem, a reddish brown sunken lesion occurs. When the lesion encircles the stem, the plant will wilt and die, or the damage to the root is severe. (See illustration.)

Botrytis Leaf and Stem Rot (*Botrytis cinerea* Pers.). It can cause severe damage to buckwheat when warm and moist conditions prevail. The disease may result in seedlings damping-off or in leaves and stems developing water soaked lesions which cause them to become necrotic and dry out. Fungus remains in the soil in the form of sclerotia and spreads under humid conditions.

White Mold (*Sclerotinia sclerotiorum* (Lib.) d By). The disease is widespread in Manitoba where cool, moist conditions favour its development. It is common in canola, sunflower, and pulse crop fields. Buckwheat, therefore, should not follow these crops. Severely infected buckwheat fields have not been reported. But sclerotia bodies may find their way into buckwheat exported to Japan, causing the seed to

be rejected and creating severe economic losses for exporters. This situation has occurred in the past, and it should be prevented from occurring again.

Aster Yellows. It is a virus-like disease transmitted by vectors. The disease often occurs on the periphery of the field. Infected plants are chlorotic, prolific, malformed, and possibly stunted or abnormally elongated. Often flower clusters are extreme, resembling "witches broom" in appearance. The economic consequences of this disease have not been reported.

There are a number of seed treatment options available to producers for the control of seedling diseases including *Pythium* root rot and *Fusarium* spp. However most growers do not use seed treatments for producing buckwheat.

HARVESTING

Buckwheat can be safely stored at 16 per cent moisture. Combining the crop at slightly higher moisture will results in less shattering. Grain drying or aerating may be necessary.

In Manitoba, buckwheat generally is swathed for a good reason. Buckwheat shatters easily upon maturity, and if it is left standing for direct combining, wind can cause serious losses. Buckwheat does not always mature uniformly under Manitoba conditions, but desiccation is not recommended. Consequently, when 75 per cent of the buckwheat reaches physiological maturity, with seed changing to brown or black, the crop is swathed. Swathing should be done when the crop is damp. Reel and ground speed should match, again to reduce the danger of shattering. Buckwheat with 16 per cent moisture can be stored safely. Combining should be timely. Unnecessary weathering of buckwheat in the swath can cause seed ends to split, lowering the grade. Such splitting often is mistaken for sprouting. (Large plump seed with a thin hull is prone to end splitting.) During combining, to avoid shattering, the pickup and ground speeds should be monitored to ensure they match, and the cylinder speed should be adjusted to avoid dehulling seed. When making adjustments, the combine manual should be consulted so that damage and loss are minimized.

Buckwheat continues to flower in cool and moist conditions and generally flowers until a killing frost occurs. Often the first killing frost is not severe and destroys only the top canopy. If this is the case, it is advisable to let the remaining green seed fill by delaying swathing. By waiting, yields can be improved, but when 75 per cent seed maturity occurs, the buckwheat should be swathed. The yield gained from green seed filling after 75 per cent maturity has been attained is counteracted by losses from shattering. Thus, no gain is obtained by delaying. Once a severe killing frost occurs (top _ to ½ of canopy frozen), buckwheat should be swathed when the crop is damp. Dried, frozen buckwheat with rigid peduncles is prone to shattering, which results in a serious loss in yield.

STORAGE

As buckwheat ages while in storage, the testa turns reddish brown and flavour and aroma disappear. With the loss of quality, the value of buckwheat declines. Ideally, the current buckwheat crop should be sold when its quality ensures a good price. The current buckwheat crop should not be mixed with older buckwheat, regardless of whether they are the same grade. Crops must be kept separate because the testa under the hull changes from green to reddish brown as seed ages. The current buckwheat with green testa possesses a good flavour and aroma which the Japanese refer to together as "fu-u-mi." As seed becomes older, fu-u-mi is lost. Thus it is important to have testa in stored buckwheat retain its green colour for as long as possible.

Under Manitoba conditions, in sun-cured buckwheat, green testa is always present. When buckwheat needs to be artificially dried, care must be taken so that the temperature is not raised too quickly and too high. The temperature should not exceed 43°C. High temperatures destroy the colour of the green testa. Japanese buyers prefer sun-cured buckwheat. For fresh buckwheat noodle makers and their customers, fu-u-mi is the most valued quality of buckwheat. Good Manitoba buckwheat has this elusive quality. To maintain the quality of buckwheat, it should be stored at low temperatures and low humidity. Buckwheat can be safely stored at 16 per cent moisture.

The stored buckwheat should be monitored regularly to ensure that it remains in good condition.

MARKETS AND MARKETING

Buckwheat continues to be an export crop. It was built on export to Japan for decades up until the early 2000’s but has shifted more to the United States as the primary export market while Japan as well as to European countries remain important destinations. Because buckwheat production is market-oriented, efforts are ongoing in Manitoba to develop suitable varieties for foreign markets. The task of improving large seeded buckwheat has been undertaken privately now that Agriculture and Agri-Food Canada has ended its buckwheat breeding programme.

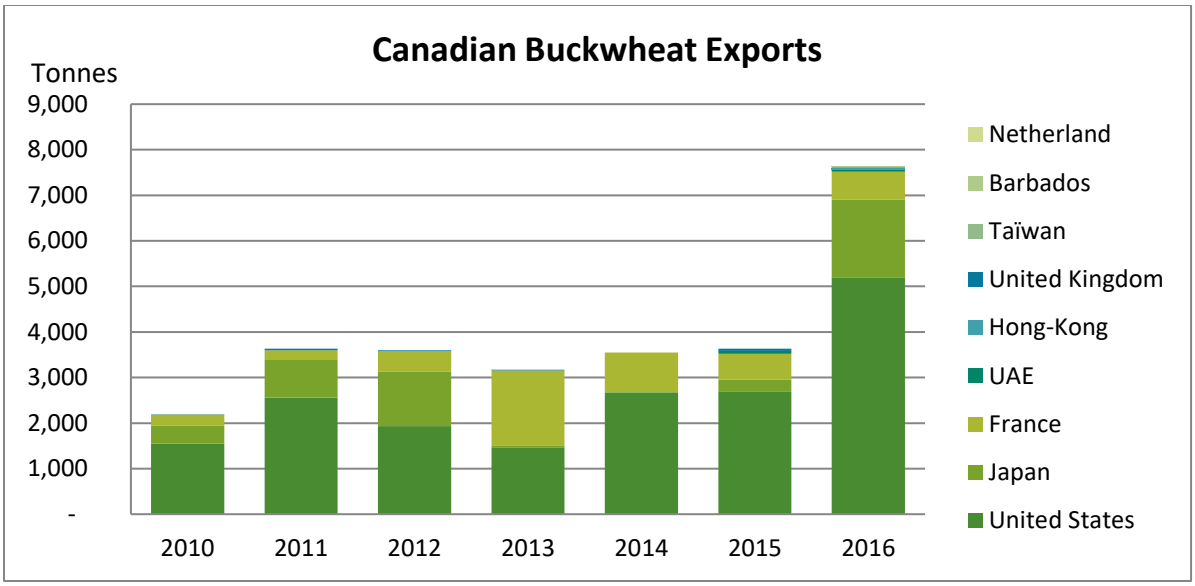


Figure 8. Canadian buckwheat exports (tonnes).

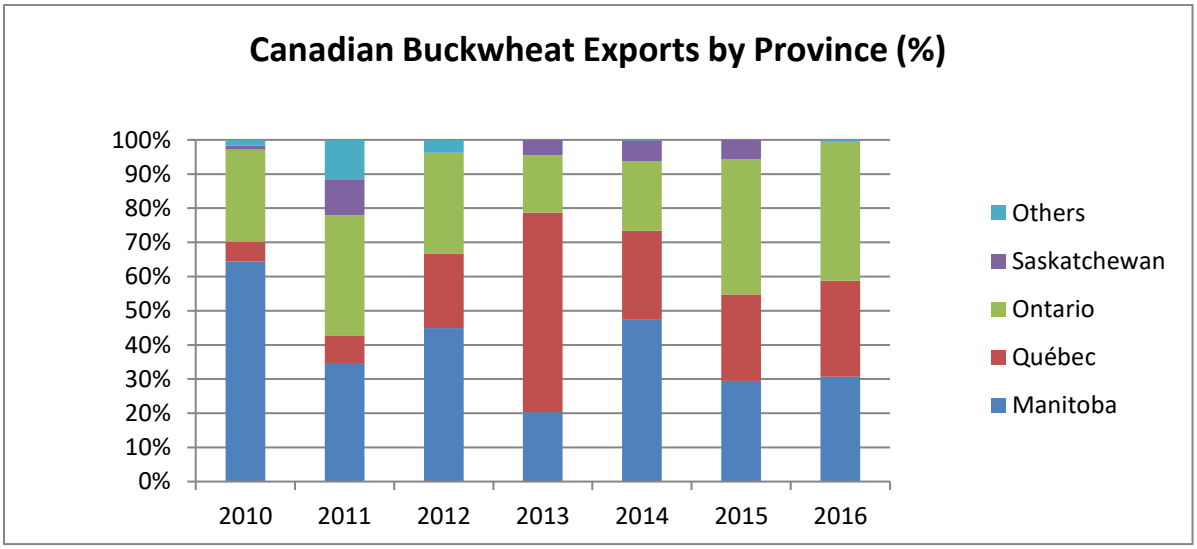


Figure 9. Canadian buckwheat exports by province.

So that quality standards for Canadian buckwheat are maintained, statutory grades are established under the Canada Grain Act (Table 6 and 7). As varieties are introduced for commercial production, changes may occur in grade specifications; therefore, when information is needed, the most recent grade specifications should be consulted. To maintain markets, as well as to expand them, constant communication and cooperation are required among those involved with buckwheat: researchers, extension staff, producers, processors, merchants, and consumers.

Buckwheat, Canada (CAN)

Grade name	Minimum test weight kg/hL (g/0.5 L)	Degree of soundness	Damage			Foreign material						
			Dehulled %	Immature %	Total %	Cereal grains %	Ergot %	Excreta %	Matter other than cereal grains %	Sclerotinia %	Stones %	Total %
No. 1 Canada	58 (285)	Cool and sweet	1	1.5	4	1	Nil	0.010	0.2	Nil	0.03	1
No. 2 Canada	55 (270)	Cool and sweet	2	1.5	8	2.5	0.05	0.010	1	0.05	0.03	3
No. 3 Canada	No minimum	May have a ground or grassy odour, not musty or sour	5	5	20	5	0.25	0.010	2	0.25	0.03	5
Grade, if No. 3 specs not met			*Buckwheat, Sample Canada (size) Account Damage*			*Buckwheat, Sample Canada (size) Account Admixture*	*Buckwheat, Sample Canada (size) Account Ergot*	*Buckwheat, Sample Canada (size) Account Excreta*	*Buckwheat, Sample Canada (size) Account Admixture*	*Buckwheat, Sample Canada (size) Account Admixture*	2.5% or less—*Buckwheat, Rejected (grade) (size) Account Stones*, or *Buckwheat, Sample Canada (size) Account Stones* Over 2.5%—*Buckwheat, Sample Salvage*	*Buckwheat, Sample Canada (size) Account Admixture*

Note: The size may be added to the grade name

Table 6. Export grade determinants of buckwheat (Canadian Grain Commission)

Buckwheat, Canada (CAN)

Grade name	Total removable material %	Damage			Foreign material						
		Dehulled %	Immature %	Total %	Cereal grains %	Ergot %	Excreta %	Matter other than cereal grains %	Sclerotinia %	Stones %	Total %
No. 1 Canada	2.5	1	1.5	4	1	Nil	0.010	0.2	Nil	0.03	1
No. 2 Canada	2.5	2	1.5	8	2.5	0.05	0.010	1	0.05	0.03	3
No. 3 Canada	2.5	5	5	20	5	0.25	0.010	2	0.25	0.03	5

Table 7. Contaminants of buckwheat allowed for each grade (Canadian Grain Commission).

The Japanese market requires new crop buckwheat for Soba noodles. Because of this need, growers are not allowed the luxury of long periods of storage before marketing. New crop groats are white with a greenish tinge, whereas old crop buckwheat groats is reddish-brown to grey.

NUTRITIONAL INFORMATION[1]

Buckwheat products may provide health benefits that common cereals do not, therefore it may be beneficial to include them in the diet as well.

Buckwheat is a good source of complex carbohydrates, fibre and protein, and also contains a variety of minerals, vitamins and antioxidants. It is also low in fat and is essentially gluten-free. Although the

[1] Canadian Centre for Agri-Food Research in Health and Medicine (CCARM), St Boniface Hospital

buckwheat seed is actually a fruit, it is usually classified with the cereals grains (wheat, oats, barley, rye) due to its grain-like characteristics.

Buckwheat and other whole-grains are good sources of carbohydrates because they contain a number of constituents (dietary fibre, resistant starch, protein, tannins and phytic acid) that slow the digestion and subsequent absorption of carbohydrates from the gut into the bloodstream. Low-glycemic index foods like buckwheat cause a gradual rise in blood glucose and insulin levels after they are eaten and have been associated with numerous beneficial health effects.

Dietary fibre is a general term referring to plant cell wall polysaccharides that cannot be digested by human digestive enzymes. Dietary fibre is normally classified according to its solubility in water; soluble or insoluble. Soluble fibres are viscous fibres that generally increase transit time, delay emptying of the stomach, slow the absorption of glucose into the bloodstream and reduce blood cholesterol levels. Insoluble fibres on the other hand, increase stool bulk, decrease intestinal transit time and generally do not slow glucose absorption or reduce cholesterol levels. Buckwheat is a good source of fibre, containing amounts comparable to those in cereal grains like wheat, oats and barley.

Buckwheat is a good source of protein, containing approximately 13 g per 100 g of grain (13 %). Buckwheat protein is poorly digested but it is of very high biological value containing all nine essential amino acids in good proportions. Essential amino acids are those that cannot be produced by the body and must therefore be acquired by the diet. Unlike the cereal grains, buckwheat contains no gluten, a protein mixture that is important for bread making (adds elasticity to the bread).

Buckwheat is a good source of a number of minerals and vitamins including magnesium, phosphorus, potassium, zinc, selenium, vitamin E and some B vitamins. It also contains a small amount of a number of other minerals and vitamins.

On average, buckwheat and other grains exhibit very high antioxidant activity, even higher than most fruits and vegetables. Antioxidants are compounds that are capable of neutralizing highly reactive molecules in the body, thereby reducing oxidative stress. Buckwheat seeds have been shown to exhibit greater antioxidant activity than oats, barley, wheat and rye.

Other health benefits related to buckwheat consumption include cholesterol reduction, management of diabetes, reduced risk of cancer, reduced risk of kidney failure and even promote weight loss.

Although buckwheat is generally considered safe for those with gluten-sensitivity disorders, it may cause other allergic reactions in some people. Food allergies to buckwheat are most common but airway exposure may also trigger allergic reaction. Possible symptoms of buckwheat include itching, gastrointestinal upset, asthma attack and anaphylactic shock. Other than allergies, no serious side effects are associated with buckwheat consumption. In susceptible individuals, buckwheat consumption may result in skin rash after exposure to sunlight.