

# Winter Squash

## VEGETABLE CROPS PRODUCTION GUIDE FOR NOVA SCOTIA



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## 1.0 INTRODUCTION

Winter squash (*Cucurbita pepo*, *C. moschata*, *C. maxima*, *C. argyrosperma* – formally *C. mixta*) is a member of the Cucurbitaceae or gourd family. It originated in the Americas and was cultivated by the ancient civilizations of Central and South America over 7000 years ago. Winter squash is the edible fruit of any species of *Cucurbita* utilized when ripe as a table vegetable or in pies. The flesh is fine grained, mild flavoured and is suitable for baking. The fruits have hard rinds and store well into late fall and winter months.

Winter squash can be divided into the following groups:

1. *C. pepo*: Acorn, Delicata/Sweet potato, spaghetti. These varieties have hard, woody stems with long grooves.
2. *C. maxima*: Buttercup, Kabocha, Hubbard. These varieties have hard short, corky round stems.
3. *C. moschata*: Butternut. This variety has stems that are deeply ridged, pentagonal and smooth.
4. *C. argyrosperma*: Green striped Cushaw and other processing squash have an enlarged corky stem.

Winter squash is a warm season crop that is both cold weather and frost sensitive. The minimum temperature for seed germination is 16°C, with a maximum of 38°C and an optimum range of 20 to 32°C. Best crop growth occurs at 18 to 25°C, with a minimum of 10°C and a maximum of 32°C. An hour or more of temperatures at 0°C will usually kill squash plants. Cultivars requiring a long growing season should be planted in the regions with more than 2200 crop heat units. Generally this is along the south shore and in the Annapolis Valley. Plastic tunnels, row covers and/or plastic ground mulches benefit winter squash.

Well drained loams, supplied with organic matter are optimal for early production. Heavier soils may be used, if they are of good structure, for late season and storage production. These fields will usually be rotated from a perennial forage crop the previous growing season.

The market season varies for each type and cultivar of squash. Generally winter squash (mainly buttercup) can be harvested and marketed from mid August to March of the next year. Yields vary depending on weather and cultivars grown. Most Nova Scotia winter squash is grown for the fresh market.

## 2.0 CROP ESTABLISHMENT

### 2.1 SEEDING/PLANTING

Winter squash can be direct seeded or grown from transplants, however in Nova Scotia it is usually grown from transplants. Regardless of the method used to establish plants, it should not be planted until the soil temperature is at least 16°C. For direct seeding, some types of vegetable seeders and translators can be adapted to accommodate the size of squash seed. The seeding rate depends on the seed size, whether it is running or bush type and on the actual spacing.

About two to four weeks are required to produce squash transplants, therefore it is recommended to start in early May. Plants may be grown in plastic plant cells or peat pots/blocks/pellets. Slight hardening is beneficial, but severe hardening may stunt growth. Hardening is the process whereby, one week before planting, transplants are gradually acclimatized to the outdoor environment. When placing transplants into the ground, the roots must not be disturbed, otherwise, it will result in slow establishment of the crop. Do not place transplants outside until the danger of frost is low and soil temperature is over 16°C.

Transplants and seed spacing requirements are different for each type of squash plant. For standard sized plants, space rows 1.5 – 3m apart and plants 60-150 cm apart. For semi-bush type plants, space rows 1.2-1.5 m apart and plants 45-90 cm apart. For small bush type plants, space rows 0.9 – 1.2 m apart and plants 45-90 cm apart. In all cases, seeds should be planted 2.5 – 3.5 cm deep. In Nova Scotia, the practice of using plastic mulch, to grow squash is becoming the norm. When using this method, double rows of plants can be spaced on one row of plastic. The spacing's between the double rows vary, but generally a 120-180 cm centre row to centre row spacing is used.

## **3.0 CROP MANAGEMENT**

### **3.1 SEASON EXTENSION**

For direct seeded or transplanted winter squash, black or clear plastic mulch, floating row covers, and tunnel houses can be used effectively to extend the growing season in the spring and the fall. Economics dictate what is feasible for each type of cultivar for specific markets.

Black plastic mulch controls weeds, increases soil temperature, conserves moisture and protects fruits from ground rots. Clear plastic mulch is good at transferring heat to the soil, but does not control weeds. It is best to apply plastic mulch to the soil with the aid of a machine that can effectively lay mulch close to the soil.

Floating row covers can be used for four to eight weeks after seeding or placing transplants to increase the heat accumulated by the plant. It is imperative that the cover be removed as the plants begin to flower, to allow for pollination.

Tunnel houses are temporary structures placed over the crop to increase heat and protect from wind and rain.

### **3.2 POLLINATION**

For the most part, winter squash plants are monoecious (separate male and female flowers on the same plant), but a few parthenocarpic (does not require pollination) cultivars exist in the market place. Male flowers appear first, produce pollen and drop off. Fruit is only formed on female flowers and bees are needed to transfer pollen from male flowers to female flowers. Unpollinated female flowers result in poorly shaped fruit as well as excessive blossom drop. Between 3 to 5 colonies of honey bees per hectare are suggested. Hives can be placed within the field in two ways, one, located within the field or two, located close to the edges of the field. Bees must visit squash flowers several times to get successful pollination. This may be difficult because cucurbit flowers are only open for one day and squash flowers are usually only open in the morning. It is best to place hives 3-5 days after the first blossoms appear, when 10-15% of plants have blossoms. This will create a more attractive field for the bees to stay and forage at. Most insecticides will poison bees so take precautions and spray when bees are least active (late afternoon and evening).

On winter squash, fruit set takes place over a 2 to 3 week period so that is how long the hives will have to remain in the field.

### **3.3 IRRIGATION**

Under moisture stress, winter squash is generally responsive to irrigation. Squash is a deeply rooted crop and can tolerate dry conditions; however the critical moisture requirement periods are between fruit set and harvest. If moisture is not available at these times it will result in poor fruit set and poor fruit development. On an average 25 mm of water every 7-10 days during flowering and fruit development is required. Overhead and drip irrigation systems are used in winter squash production.

### **3.4 SOIL FERTILITY**

Recommendations for supplemental organic matter, fertilizer, lime or manure should be based on a soil test and a Nutrient management plan. In Nova Scotia, soil tests are performed by the provincial agriculture labs in Truro. To find out more about how to take a soil test, where to send the sample and fees for the tests, visit <http://www.gov.ns.ca/agri/qe/labserv/index.shtml#analytical> or phone (902) 893-7444. Nutrient management plans balance the crop requirements and nutrient availability, with the aim to optimize crop yield and minimize ground water contamination, while improving soil productivity.

#### ***Manure***

Winter squash responds well to applications of manure. The best is to use composted manure.

#### ***Lime***

Lime should be applied to maintain the soil pH between 6.0 and 7.0.

#### ***Nitrogen***

Up to 110 kg/ha of actual nitrogen is required for winter squash production. If manure is applied then there is a need for a reduction in the amount of total nitrogen applied to the field. Apply two thirds of the required nitrogen before planting by broadcasting and working into the soil. Apply the remaining nitrogen as a side dress, just before the vines begin to run. A second side dress may be needed on sandy soils. Nitrogen deficiency symptoms include yellowing of older leaves, slow growth and stunted plants.

#### ***Phosphorous***

A soil test will determine the level of phosphorous requirements. Banded fertilizer would be effective in reducing the needed phosphorous. It is recommended to use a plant starter with high phosphorus content when transplanting early crops. Phosphorous is important for root development and cool, wet soil conditions hinder its uptake. Deficiency symptoms include dull, emerald green young leaves, delayed maturity, stunted growth and poor fruit set.

#### ***Potassium***

A soil test will determine potassium requirements. The requirement for this nutrient is not high especially if good quality manure is applied. If potassium is banded, it is not recommended to exceed 100 kg of nitrogen plus potassium per hectare. Deficiency symptoms include tip and marginal burn on older leaves and slow growth.

#### ***Sulphur***

On sandy soils low in organic matter that has been intensively cropped, soil sulphate levels may be low. Deficiency symptoms include yellowing of young leaves and small weak plants. Application of gypsum should be considered on these soils.

#### ***Magnesium***

Magnesium deficiency symptoms include yellowing between older leaf veins and leaves curling upwards along the margins. Deficiency symptoms are fairly common especially on light acid soils where dolomitic limestone has not been applied. If soil magnesium levels are low, soil apply or foliar apply magnesium. Refer to the table below for fertilizer sources and application rates of magnesium.

### Magnesium Application Rates

Nutrient	Source	% Composition	Foliar Applied		Soil Applied	
			Nutrient kg/ 1, 000 L	Product kg/1,000L	Nutrient kg/ha	Product kg/ha
Magnesium (Mg)	sulphate of potash magnesia	11% Mg	-	-	30	270
	Epsom salts	10.5% Mg	1.9	18	30	285
	dolomitic limestone	6-13% Mg	-	-	120 - 260	2 t/ha

### Micronutrients

#### **Boron**

Boron deficiency causes distorted young leaves and cracks in petioles and fruit. Leaf symptoms are similar to Cucumber mosaic virus. Boron should never be banded, however it can be foliar applied. Refer to the micronutrient application table below for a list of fertilizer sources and application rates.

#### **Manganese**

Deficiencies may occur on sandy, over limed soils. Manganese deficiency causes yellowing between veins of young leaves. Leaves gradually turn pale-green with darker green next to the veins, petioles and stems. Foliar sprays of manganese sulphate may be necessary to correct a deficiency. Refer to the micronutrient application table below for a list of fertilizer sources and application rates.

### Micronutrient Application Rates

Nutrient	Source	% Composition	Foliar Applied		Soil Applied	
			Nutrient kg/ 1, 000 L	Product kg/1,000L	Nutrient kg/ha	Product kg/ha
Boron (B)	sodium borate	12-21% B	0.1-0.3	-	1.0-3.0	-
Manganese (Mn) <sup>3</sup>	manganese chelates	5-12 % Mn	0.5 – 1.0	-	-	-
	manganese sulphate	28 % Mn	0.5 – 1.0	1.8 – 3.6	-	-

### 3.5 CROP ROTATION

A general guideline to follow concerning crop rotation is that a crop should never follow itself. Continuous cropping of any crop will result in an increase of disease and insect pressure and possibly a reduction in yields.

A proper rotation will include growing different botanical families on the same piece of land, in sequential seasons. The table below outlines some of the common botanical families vegetables belong to.

<b>Botanical Family</b>	<b>Vegetable Crops</b>
Asteraceae	Lettuce, Endive, Artichoke, Radicchio
Alliaceae	Leeks, Garlic, Onion
Chenopodiaceae	Spinach, Swiss Chard, Beets
Brassicaceae	Broccoli, Cauliflower, Brussels Sprouts, Cabbage, Kale, Turnip, Kohl Rabi, Radish
Cucurbitaceae	Winter Squash, Summer Squash, Watermelons, Muskmelons, Cucumbers, Pumpkins
Poaceae	Sweet Corn
Fabaceae	Beans, Peas, Peanuts
Solanaceae	Tomato, Eggplant, Peppers, Potatoes
Apiaceae	Carrots, Parsley, Parsnip, Fennel

By rotating crops that leave a high amount of residue in the soil, soil fertility can be enhanced naturally. Crop rotation can also improve soil structure by alternating deep-rooted and shallow-rooted plants.

Crop rotation plays a key role in an IPM program by aiding in the suppression of diseases, insects and weeds. Crops within the same plant family tend to be susceptible to the same pests therefore rotation of non susceptible crops for several years allows all plant material to decompose and pest cycles to become broken. Without the presence of susceptible plant material, the number of disease and insect organisms will begin to diminish.

Crop rotation aids in weed control because the growth habit of each crop differs, which causes a decrease in a weeds ability to compete for space. Tillage practices and timings are different for each crop group resulting in a decrease in a weeds ability to permanently establish.

Due to disease and insect pressures (refer to the pest management section of this guide) it is best not to plant winter squash more often than once every three to five years. This crop has deep roots that will help improve soil structure and aeration. Winter squash has large seeds that do not require a finely manicured seed bed, therefore previous crop residues would be tolerated, however too much debris will delay the soil from heating up in the spring.

## **4.0 PESTS AND PEST MANAGEMENT**

Effective management of any pest requires the use of multiple pest control techniques. Integrated Pest management (IPM) is a system that integrates Managerial, Cultural, Physical, Biological and Chemical control techniques to manage pests. A key to IPM is understanding what pests are in your crop, through scouting and adjusting production practices to discourage pests from becoming problems. IPM is a proactive approach to pest management, rather than just a reaction to pests as they occur.

### **4.1 WEEDS**

Herbicides are available to use in a winter squash crop. Rates and methods of application can be found on the product label. A number of shallow cultivations are an essential part of a weed control program. Good weed control requires integration of cultural and chemical methods. Winter squash should be planted to land free of perennial weeds, where the annual weed seed population has been reduced by cultural practices such as crop rotation, stale seedbed or hoeing.

Crop rotation is discussed in great detail in the section above, but essentially involves growing different groups of crops on the same piece of land in successive years. Stale seedbed is a technique whereby the planting bed is made early, under dry conditions, water may be applied, and weeds are allowed to germinate and grow. After the first flush of weeds germinates, they are controlled with a total herbicide (glyphosate) or by a flame weeder. For weeds that escape and

grow close to the crop, hoeing can be used as a control option. Between row cultivation is an important method of cultivation. This can be done on a regular basis. Weeds can be controlled in winter squash by planting seed or transplants in black plastic mulch

Care must be taken to avoid fields where residual herbicides from previous years persist in the soil as crop injury may occur. Refer to the AgraPoint Guide to Pest Management for winter squash for a listing of herbicides and their application methods.

## 4.2 DISEASES

### ***Bacterial Wilt***

This disease is caused by the bacteria *Erwinia tracheiphila* and is vectored by the striped cucumber beetle. Symptoms first appear on leaves as dull green patches that quickly increase in size. The leaf lobe wilts, followed by the rest of the leaf, the branch and entire plant. The wilting is a result of the vascular system being clogged by a lot of bacteria. The pathogen overwinters in the gut of the adult striped cucumber beetle and is transmitted to the plant when the insect feeds on plant tissue. If beetle populations are high, the severity of this disease is greatly increased.

#### Control:

Once bacteria have entered the vascular system of the plant, control of this disease is impossible. Prevention lies in controlling populations of the cucumber beetle. Be sure to remove wild or volunteer cucurbit plants from nearby areas, and choose varieties that flower later in the season. See the section on striped cucumber beetles for control options.

### ***Alternaria and Septoria Leaf Spot***

*Alternaria* fungus causes small circular spots which enlarge to 1 to 2 cm in diameter with dark concentric rings within the spots. Spots may coalesce to affect larger areas of the leaf. Black sunken lesions may occur on the fruit. *Septoria* fungus causes numerous small leaf lesions with white centers which may lead to defoliation. It also causes raised, pimple-like lesions on fruit. These fungi will overwinter in soil for one season or possibly up to two years. This disease is common during unseasonably cool summers or during late fall.

#### Control:

Treat seed and rotate with non-cucurbit crops for at least two years. If using pesticides, scout plants frequently and apply appropriate fungicides at first sign of the leaf spots and at 7 to 10 day intervals. Refer to the AgraPoint Guide to Pest Management for winter squash for a listing of fungicides and their application methods.

### ***Black Rot and Gummy Stem Blight***

Black rot and Gummy stem blight are caused by the same fungus, *Didymella bryonia*. Black rot is the fruit infecting phase of the disease. The fungus enters the rind, allowing other organisms to enter and rot the entire fruit. The fruit rot phase often develops on stored winter squash. Gummy stem blight is the foliar and stem infecting phase. The fungus causes water soaked areas and pale brown spots on leaves. Brown cankers form on stems, as well as streaks having an amber exudate. On older plants it spots the fruit, foliage, petioles and stems. On fruit the spots are circular, yellow to light green in color eventually turning gray to brown to finally black. On butternuts, tan scabby patches are seen while the fruit is in the field. When the fungus is seed borne it causes damping-off which usually kills the seedlings. The fungus overwinters in seed and residue from diseased plants.

#### Control:

Plough down refuse immediately after harvest. Follow at least a two year rotation of non cucurbit crops. Plant disease free seed and be sure not to use seed from infected fruit. Minimize moisture on leaf surfaces by using drip irrigation, and avoid damaging fruit while harvesting. Post harvest

fruit rots can be reduced by careful handling, curing and storage temperature control. If using pesticide controls, scout plants frequently and apply fungicides at first sign of disease and at 7 to 10 day intervals. Refer to the AgraPoint Guide to Pest Management for winter squash a listing of fungicides and their application method.

### **Powdery Mildew**

Powdery mildew (*Erysiphe cichoracearum*) causes a white powdery growth on the lower and upper surfaces of leaves. As the disease advances, leaves turn yellow, brown, wither and die. Fruit may be malformed, sunburned and ripen prematurely resulting in poor flavour and texture, and an overall decrease in size and quality. Powdery mildew is favoured by temperatures of 20°C – 26°C and humid, wet weather.

#### **Control:**

Many resistant varieties exist and should be used whenever possible. Good weed control and sanitary practices will help to control this disease. Avoid over head watering and remove and destroy vines at the end of each season. If using pesticides, scout plants frequently and apply appropriate fungicides at first sign of disease and at 7 to 10 day intervals. July and August is usually the most critical control period. Refer to the AgraPoint Guide to Pest Management for winter squash for a listing of fungicides and their application methods.

### **Cucumber Mosaic Virus**

Cucumber mosaic virus (CMV) will infect plants at any stage of growth. If seedlings are infected, the cotyledons wilt, turn yellow and generally the plants are stunted. Younger leaves develop a dark green, yellow mottled and wrinkled look. On older leaves, 1-2 mm greenish-yellow translucent lesions form. The leaf edges curl downwards and the leaf surface becomes wrinkled and mottled with yellow and green colouring. Eventually older leaves die. Once infection occurs, few fruit develop, however, if they do, a green-yellow mottling will occur on the stem and entire fruit surface, along with green warts. CMV is transmitted by aphids and cucumber beetles. It also survives in plant sap and can be transmitted by pruning knives or pickers hands.

#### **Control:**

Eliminate all weed hosts and avoid planting two consecutive winter squash crops. Scout regularly to monitor for the presence of aphids. Refer to the AgraPoint Guide to Pest Management for winter squash for a list of insecticides and their application methods. Farm workers should follow good hygiene practices to decrease the chance of spreading the disease. Use varieties that have tolerance or resistance to this disease.

### **Fruit Rots in Storage**

A number of diseases attack winter squash in storage. Black rot, *Sclerotinia*, *Alternaria*, *Rhizopus*, *Botrytis*, *Fusarium*, *Penicillium* and *Cladosporium*. All may occur as fruit rots in storage. Rots can originate from actual fruit infection in the field or from a dusting of fungus spores that later infect the fruits in storage.

#### **Control:**

Control of fruit rots involves the season long practices of seed treatment, good field drainage, adequate crop rotation, insect control, fungicide sprays, harvest care and especially post harvest storage temperature and humidity control.

## **4.3 INSECTS**

### **Seedcorn Maggots**

Seedcorn maggots (*Delia platura*) are small yellowish-white maggots 6 mm long with a pointed anterior end (head). The adult is a small, 5 mm greyish-brown fly. Maggots feed on seed and

roots, causing poor plant growth. Seedcorn maggots attack deeply planted seeds. Maggots are usually a problem in direct seeded crops during cool, wet springs when germination is delayed.

Control:

Try to plant as shallow as needed in a well prepared seedbed. Early germination is necessary to get good plant stands and prevent injury. Later planted crops are not as susceptible to this pest. Good weather conditions are necessary to completely control the pest. Avoid planting susceptible crops in fields very recently manured. Chemical seed treatment is essential. Refer to the AgraPoint Guide to Pest Management for winter squash for a listing of insecticides and their application methods.

### **Stripped Cucumber Beetle**

The adult stripped cucumber beetle (*Acalymma vittatum*) is 5 mm long with a black head, yellow thorax and three longitudinal black stripes on yellow forewings. This insect overwinters in the adult stage under leaves or dense grass, emerging in May or early June. Two weeks after emerging the beetles mate while feeding on plant tissues and flowers. The orange-yellow eggs are laid in the soil at the base of host plants and hatch within 10 days. Upon hatching, the larvae burrow into the soil, feed on the roots of the plant for about a month, and then pupate in the soil. In July, the next generation of adults emerges and they feed on the rind of squash fruit until frost forces them to seek shelter. In Nova Scotia there are two generations per year.

This insect is a vector for two problematic winter squash diseases; bacterial wilt and cucumber mosaic virus. These two diseases are transmitted to the plant while the insect feeds.

Control:

Cultural control methods include using varieties that are less attractive to beetles and rotating crops to distant fields to delay infestations. Sanitation is very important. Do not leave cucurbit debris in fields over winter, plough debris under after harvest. There has been research that suggests Blue Hubbard squash can be used as a trap crop; however the research is not very conclusive. If this method is attempted, be sure to plant the trap crop completely around the cash crop for best protection. Spray the trap crop on a cool morning after attracting the beetles. Try avoiding peak beetle infestations by planting later in the growing season, or using transplants that may be more tolerant of feeding activity.

Physical control methods include using floating row covers to protect young plants, but it must be removed when flowers first appear. Another method of control includes using yellow sticky cards or tape to trap the adult beetles. Replace them regularly as they become covered with insects and debris.

Biological control options include maintaining high levels for the following natural predators which are commonly found in fields: soldier beetles, tachinid flies, brachonid wasps and bats.

If using pesticides controls, scout plants frequently and apply an insecticide when the threshold has been reached. It is best to scout for this insect in the early morning or evening, and be sure to examine the foliage and soil-stem areas. Apply a spray when beetles exceed 0.5-1 per plant. Refer to the AgraPoint Guide to Pest Management for a list of insecticides and their application methods.

### **Flea Beetle**

Flea beetles (*Phyllotreta* spp.) are small shiny black beetles about 2 mm in length. The adults have hind legs well developed for jumping, and they are very active early in the growing season, especially during periods of dry sunny weather. Adults seriously damage seedlings and transplants, and to a lesser extent larger plants, by chewing small pinholes through the leaves. Adults overwinter in the soil and emerge early in the spring to feed on young plants. Eggs are

laid on or near the roots where white larvae feed. Mature larvae pupate in the soil near the host plant. Depending on species, there are one or two generations a year.

Control:

Heavy damage can occur quickly, usually under hot humid weather conditions, just after crop emergence from the soil. Apply insecticides only if insect populations are high. Refer to the AgraPoint Guide to Pest Management for winter squash for a list of insecticides and their application methods.

### **Aphids**

Aphids (*Aphis gossypii*) do not cause serious damage to winter squash, but certain species can transmit viral diseases such as CMV to this crop. Aphid feeding may cause leaves to become distorted, and honeydew, excreted by the insect, may serve as a growing point for mould.

Control:

Use reflective mulches and plant later crops away from existing fields. Eliminate all virus host plants, mainly perennial broadleaf weeds.

Biological control options include maintaining high numbers of the following natural predators which are commonly found in the field: syrphid flies, lacewings and predaceous midge produce larvae which will feed on aphids and the adults and larvae of minute pirate bugs, big eyed bugs, lady beetles, soldier beetles and parasitic wasps like *Diaeretiella rapae* will also consume aphids.

If using pesticides, scout plants frequently and apply a spray when insects are present on 10-20% of the leaves. Refer to the AgraPoint Guide to Pest Management for winter squash for a list of insecticides and their application methods.

### **Squash Bug**

Squash bug (*Anasa tristis*) is a periodic pest of winter squash. The adult is 1-2 cm long and dark to grey brown in colour. The tops of their bodies are flattened with wings not completely covering the orange and brown edges of the abdomen. It prefers sheltered areas, under vines and fruit, and overwinters as an adult to emerge in midsummer. Squash bugs suck sap from the plant; while at the same time inject a toxin into the plant when it feeds. The toxin can cause wilting of young plants and dried, black areas on older plants.

Control:

Cultural control involves sanitation and trap crops. Remove all plant debris, or disk in immediately after harvesting the crop. It is also possible to trap the adults. At night, adults will gather under a board placed on the ground near squash plants. In the morning, gather and destroy the insects.

Biological control for squash bug includes using a parasitic fly, *Trichopoda pennipes* that will affect adults, as well as wasps that parasitize the eggs.

If using pesticide control, scout plants frequently and spray when there is a more than one egg mass per plant before or after flowering. Refer to the AgraPoint Guide to Pest Management for winter squash for a listing of insecticides and their control methods.

## **4.4 PHYSIOLOGICAL DISORDERS**

### **Oedema**

This is a physiological disorder that affects cucurbits during fruit enlarging when moisture availability is uneven. The stress causes raised, circular shaped lesions that are corky or crusty on the fruit surface. These lesions may be irregularly spaced or just on the side exposed to sunlight.

## 5.0 HARVEST AND HANDLING

In Nova Scotia, winter squash are harvested from mid August until October. Temperatures of 10°C causes chilling injury to fruit and freezing weather increases the sugar content in fruit, decreasing quality. For best quality, harvest before the vines are frosted.

There are several characteristics to consider when determining if the fruit is mature and ready to be harvested. One, the stems turn grey, corky and start to shrivel. Two, the rind or skin hardens and can't be scratched or dented by a thumbnail. Three, the shiny fruit surface colour will change to a dull colour. Four, winter squash should be about 1-3 kg in size. As a caution, dead vines do not necessarily mean the fruit is mature and ready to be harvested. Also, for best quality, harvest when squash are externally moisture free.

In Nova Scotia, winter squash is harvested by hand, generally pulled or cut from the vine. Generally in NS there is a continuous harvest throughout the harvest period; however there can also be just one main harvest in the fall. When removing fruit from the vine, 2-5 cm of stem should remain on the fruit to aid in a quick curing process, and prevent fungal infection from entering the fruit by means of the stem.

During harvest winter squash can be placed in appropriate bulk bins, baskets or on racks which will give good air circulation in the curing process. Handle carefully and avoid bruising. Do not handle harvested fruit by the stem because it may separate easily and allow disease organisms to enter.

### 5.1 CURING

After harvesting, winter squash must be put through a process called curing. There are several objectives of curing: harden the shell/rind, heal surface wounds, reduce the high water content of the fruit, prolong storage life by decreasing respiration rate and protecting against storage rots, thereby improving eating quality.

There are three ways to cure squash; one, leave in field for 10 to 14 days when weather is warm and dry, and the sun will toughen the skin. Two, indoors at room temperature (21°C) for 30 days, three, indoors, using artificial heat for 3-20 days at temperatures of 20-30°C and 85% humidity.

Generally acorn type squashes are not put through the curing process because it causes a decrease in the storage life and eating quality.

### 5.2 STORAGE

The storage life of winter squash ranges from 2 to 6 months and in Nova Scotia that is usually from October to early March. Acorn types will only store for 4-8 weeks. The optimum storage conditions are in a cool, dry place with temperatures of 12.5-15°C and 50-70% relative humidity. CA storage of 7% CO<sub>2</sub> is beneficial to reducing loss of green colour, however yellow squash do not benefit. Low O<sub>2</sub> is not beneficial either.

Winter squash is a warm season crop and as a result, chilling injury may occur if stored at temperatures below 10°C. A temperature of 2°C for 30 days will result in increased rot when the fruit is removed from storage and placed into room temperature. However, storage temperatures above 15°C will cause shrinkage and high respiration rates. Humidity is also vital to long term storage of winter squash. High humidity will increase storage rots, and low humidity will increase weight loss and shrinkage.

Winter squash should not be stored with high ethylene producing crops since they will cause squash to turn color, become stringy, decay, and the stem may be abscised.

To keep high quality winter squash in storage, air circulation is a must.

## **6.0 FOOD SAFETY: A Prerequisite to Quality**

(Kendra Heffel, Food Safety & Quality Systems Specialist / Auditor, AgraPoint International)

In order to produce high-quality winter squash, food safety issues must be addressed; retailers and end consumers demand it. There are several important and simple steps to be taken to ensure the safety of the winter squash crop:

### Premises and Production Sites

Ensure that contamination hazards have been addressed such as flooding, past pesticide usage, environmental pollution (soil, air or water) and animal access is restricted as much as possible. A field history should be maintained for each production site, as well as soil test results. Buildings that house product should be clean, have adequate drainage, and have no entry points (i.e. holes, crevices, cracks) for pests. Either a self-managed or third party serviced pest control program may be used, with documentation maintained of pest activity and any chemicals or bait used. Regular inspections must be conducted and documented to prove due diligence and ensure no additional hazards have arose.

### Crop Production Materials

If applicable to the crop, ensure, via testing and/or certification letters, that seed is approved and is not contaminated by pathogens. All crop production materials must be purchased and received from approved suppliers. Pesticides must be applied by, or under the supervision of, a licensed operator. Detailed application records must be maintained for all fertilizer, pesticide, manure, compost, mulch and all other soil amendments. Pre-harvest intervals must be met for all pesticide applications, and manure must not be applied less than three months before harvest. A copy of pesticide labels should be maintained on file for cross-reference with application records. All materials should be stored in a controlled-access location, separate from product and packaging materials, and kept covered, clean and dry. Pesticide containers must be triple rinsed after use, and not used for any other purpose.

### Water

Agricultural water is defined as water used for irrigation and the application of pesticides and fertilizers. Agricultural water does not have to be tested, however potential hazards must be identified and addressed (i.e. animal access, upstream contamination, runoff and spills, condition of well). Preventive measures such as buffer zones, level ground, fences and ditches, must be implemented to aid in contamination avoidance.

Water that is used for fluming product, cleaning equipment, and in hygiene facilities, if sourced from a private well, must be tested twice annually (at beginning of season and midway) for total coliforms and E.coli. Producers using municipal water must receive notice if the water source becomes contaminated. If wash water is treated (eg. chlorine), treatment records must be maintained.

### Equipment, Cleaning and Maintenance

Calibration procedures and records for equipment such as sprayers, irrigation equipment and spreaders must be maintained. Sprayers should be calibrated at the beginning of each season, midway through, and anytime maintenance is performed (eg. nozzle replacement). All food contact equipment must be easy to clean, made of non-porous materials and inspected for damaged or loose parts. Cleaning solutions and maintenance materials (eg. lubricants, greases) that may come into contact with product or food-contact surfaces must be food-grade, and stored in designated areas.

### Employee Hygiene and Training

Even smaller operations need to ensure their employees receive the proper training and that training is documented. Refresher training in food handling and hygiene practices must be provided at least annually, at the beginning of the production season. Hygiene facilities must be provided for employees and hand-washing signs posted as visual reminders. A visitor policy must also be established that details restricted access areas of buildings.

### Sorting, Storing and Traceability

All new and reusable packaging materials must be clean and free of debris and stored separate from product or pesticides. Market ready packaging materials must be food-grade. While sorting, foreign objects must be removed, as well as rotten product and crop debris. Careful attention must be paid, while sorting and storing product, to maintain traceability documentation from the field, row, plot, etc. Product that requires temperature control must be stored in predetermined and monitored environment. Prior to transporting product, vehicles must be inspected for condition and possible hazards to the product. All information about the product leaving the premises must be documented.

Further information is available within select commodity manuals provided by the Canadian Horticultural Council ([hgale@hortcouncil.ca](mailto:hgale@hortcouncil.ca)) and may be obtained from provincial associations or direct from CHC. Following the guidelines within these manuals will ensure that all possible hazards to the product have been evaluated and assessed. By going one step further, and participating in a third party audit of your On-Farm Food Safety (OFFS) programs, you can provide your customers with the confidence they seek from your operation and products.

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