Yellow Cooking Onions

VEGETABLE CROPS PRODUCTION GUIDE FOR NOVA SCOTIA

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1.0 INTRODUCTION

The common yellow cooking onion (*Allium Cepa*) belongs to the Amaryllidaceae (Amaryllis family). Garlic, leeks, chives, bunching onions, Spanish onions and shallots are all related species sharing similar odours and tastes. Asia is considered the centre of origin for the species, and by the Middle Ages, the onion culture had spread to Europe.

In the field, germination temperature for this crop ranges from 8 to 30 ^{0}C, with the optimum germination temperature at 24^{0}C. Following germination, optimal growing temperatures are 18-20^{0}C. The onion is tolerant of frost, but seedlings are generally only tolerant down to -1^{o}C. Cool weather during early growth of the plant promotes formation of seed stalks (bolting). The onion bulbs quicker in warm than at cool temperatures. At 40^{o}C, bulbing is retarded.

Photoperiod will have a significant impact on the quality of the onion crop. Leaf development and formation, as well as bulb formation are enhanced by long days. If temperatures are high enough, early onion varieties will start bulb initiation when there is 13 hours of light, while later varieties require 16 hours of light for bulb initiation.

For optimal results, the yellow cooking onion should be grown on sand or sandy loam soil that is well drained and contains a high amount of organic matter. Coarse and heavy soils should be avoided.

Generally, most onion crops will mature in 75-120 days. Onions from seed do not usually mature until mid September.

The fresh and storage markets are the main markets for the yellow cooking onion, as it can be grown for roadside sales, grocery stores and restaurants.

2.0 CROP ESTABLISHMENT

Commercial productions in Nova Scotia are established by direct seeding. Growers growing for farm markets or home gardeners may establish the crop from transplant plugs or bare root transplants.

2.1 DIRECT SEEDING

Yellow cooking onion seeds may be pelleted for precision seeding. This type of seeding produces more uniform size, less culls and higher yields. Field seed as early as possible in the spring, usually around mid May, at a depth of 0.5 to 1.5 cm. In Nova Scotia, the main production system used is raised beds with five rows. Beds are spaced 1.5 to 2 m apart. Another production system includes raised beds with double rows spaced 7.5 cm apart.

2.2 TRANSPLANT PLUGS

One advantage to using transplants, over direct seeding, includes an earlier harvest. Transplanted onion crops usually mature at least 5-10 days earlier than seeded onion crops.

Begin greenhouse seeding in early March by placing 3-5 seeds per cell into plastic plug trays. Germination will be achieved with a temperature of 18-24^{o}C. Seedlings will grow best with a day time temperature of 16-18^{o}C and a night time temperature of 8-15^{o}C. Onion transplants are usually clipped to 8 -12 cm height several times to produce sturdy plants and are usually transplanted out at the 8-10 week old stage.

2.3 BARE ROOT TRANSPLANTS

Bare root transplants may be grown in a greenhouse environment beginning in early April. Both, transplant plugs and bare root transplants are not used in commercial plantings due to high cost and high labor demands.

3.0 CROP MANAGEMENT

3.1 IRRIGATION

Onions have a shallow and limited root system which penetrates mainly the upper 30 cm of the soil. This crop should be irrigated frequently throughout the growing season. To determine the amount of moisture and frequency of irrigation, soil type and actual precipitation amounts should be considered. Generally, most soils should receive 25 mm of water per week from the combination of rainfall and irrigation. Soil moisture is important in the growth of new roots, as new roots will not grow into dry soil. The soil moisture must reach the base of the bulb periodically if the newly formed roots from the stem are to grow into the soil. Overhead irrigation is the main method used by Nova Scotia growers.

3.2 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 www.gov.ns.ca/agri or phone (902) 893-4683. 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

Onions require a highly fertile, well balanced soil. Manure is not recommended in onion production for two reasons; one, weeds are a serious problem in this crop and two, due to the delayed availability of nitrogen and thus postponing maturity.

Lime

Optimum soil pH for yellow cooking onion growth range from 6.5 to 6.8. On peat soils, pH of 5.5 is sufficient. The soil should contain adequate calcium for crop growth and to maintain soil pH. This means that calcium must be evenly distributed and incorporated into the field. Crop failure is common on fields with inadequate liming. Also, some cultivars may be more sensitive to pH than others.

Nitrogen

Yellow cooking onions require 110 kg N/ha per season on mineral soils. Apply half or two thirds of the nitrogen preplant and incorporate it in to the soil. Side dress the remainder in mid to late June after the seeded onions are about 15 cm tall. Excessive nitrogen especially in the later part of the growing season may cause delayed maturity (thick necks) and soft bulbs. Excess nitrogen in combination with other environmental factors such as excess of moisture may also be the cause of onion bulbs splitting at the basal end. Foliage will become pale green to yellow in colour if there is a deficiency of nitrogen.

Phosphorous

A soil test is required to determine phosphorus requirements. If phosphorous is required, heavy applications must be broadcast and preplant incorporated. Phosphorus is most important for early growth and is more available if placed near the seed. Deficiency symptoms include thick-necked onions, pale green foliage, slow growth and delayed maturity.

Potassium

Application rates depend on soil test results. Potassium should be broadcast and preplant incorporated. Too much potassium applied in a band at planting can injure young seedlings and reduce crop yield and quality. The danger of fertilizer injury is greater on sandy and sandy loams than on silt loam and clay loam soils. Deficiency symptoms include poor growth, tip burn and dark green leaves.

Micronutrients

Copper
Deficiency occurs on acidic mineral or peat soils. Onion bulbs show poor-coloured skins, and produce thin, pale yellow scales that cause poor colour and keeping quality. Copper may be mixed with the fertilizer and applied. Approximately 50 kg of copper sulphate per hectare is recommended on peat soils as an initial application. This compound can be applied by spraying it onto the soil surface and incorporating into the soil. Extreme caution should be maintained as this material is extremely corrosive to metal, not to mention it will also injure foliage quite readily.

Manganese
Deficiency symptoms include yellowing between the leaf veins, and this usually occurs in soils with a high pH. Soil application of this element is not suggested due to the large amounts required. Foliar applications of manganese sulphate are recommended, starting when the plants are about 15 cm tall with 1.5 to 2.75 kg manganese per hectare in 300L of water and repeated in 4 to 5 sprays 10 days apart. Use the low rate on small plants increasing the rate as the season progresses.

Molybdenum
Deficiency may occur when onions are grown on acid mineral or peat soils. A seed treatment has proven beneficial. The treatment is accomplished by dissolving 15 g of sodium molybdate in 45 mL of water. Spray this solution from an atomizer bottle on 2.3 kg seed spread thinly on a plastic sheet. Do not use excessive water as this can cause the chemical to penetrate the seed embryo and cause injury. Mix the seed thoroughly and let dry. Spraying the plants with sodium molybdate at rates supplying 0.1 to 0.25 kg molybdenum per 1000 L also will help to avoid deficiency symptoms. On new peat soils apply an initial application of 10 kg of either ammonium molybdate or sodium molybdate per hectare.

Zinc
Zinc deficiency in onions shows up as a stunting and marked twisting and bending of yellow striped foliage. High phosphorus in the soil and/or in the fertilizer can cause or increase the severity of zinc deficiency. If zinc deficiency becomes a problem spray the foliage with zinc sulphate at rates supplying 0.6 kg zinc per 1000 L of water. One way to prevent zinc deficiency is to broadcast apply zinc fertilizer to the soil at a rate of 4 kg Zn/ha. Up to 14 kg Zn/ha can be applied, which will correct a deficiency for 3 years. Not more than 4 kg Zn/ha should be banded.

Boron
On peat soils an initial application of 1.5 kg of actual boron is recommended. On high pH sandy soils with low organic matter and where boron has not been used on rotational crops, foliar or soil sprays of boron may be considered.

3.3 CROP ROTATION
There are many benefits to crop rotation including the suppression of diseases, insects and weeds. In addition, crop rotation improves soil fertility because it is allowed to replenish naturally and soil structure improves because of the alternating between deep rooted and fibrous rooted crops.

Crops within a family tend to be susceptible to the same pests, therefore rotation of non susceptible crops (or groups) for several years allow 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. Also, tillage practices and timing are different for dissimilar crops resulting in a decrease in the weeds ability to permanently establish. Another benefit of crop rotation for weed management purposes is with certain crops, there is a better chance at controlling different weeds. For example, in a broadleaf crop, grass control will be easier because of the use of grass killing herbicides and visa versa.

To create a crop rotation schedule, there are several things to be considered including types of vegetables grown, size of root system, size of planting rows, amount of fertility required for the crop and how much organic matter is left in the soil by the crop. Start designing the crop rotation by making a list of all vegetables to be grown and group them together by botanical relationship (e.g. *brassicaceae, solanaceae, alliaceae*). Each year, change the location of the entire group within the field. This way, the same crop group will not be planted on the same piece of land two years in a row. Secondly consider the size of the root system of the crop to be grown. Deep rooted plants will help to break up the soil, while shallow rooted crops will not. Thirdly, consider the size of the plant rows. Wide rows will allow for more weed seeds to germinate, but on the other hand, tillage equipment may be able to go through them with more ease than in narrow rows. The fourth consideration should be given to whether or not the crop to be planted is a heavy feeder. A heavy feeder will deplete the soil of nutrients quicker than a non heavy feeder. The final consideration for a crop rotation is whether or not the crop will leave a lot of organic matter in the soil. Leaving organic matter behind is beneficial for replenishing the soil of nutrients lost to the crop while it was growing.

A long rotation of more than five years is better than a short rotation of two years. Also, ask yourself the following questions when putting together a rotation: Is the rotation profitable? Are the yields sustainable? Does it make use of nitrogen produced by an earlier crop? Are herbicide residues left?

Due to disease and insects pressures (refer to the pest management section of this guide), it is best to plant onions once every four years. Onions have shallow roots which will not help in improving soil structure and aeration. This crop has small seeds that require a finely manicured seed bed and is usually direct seeded into the ground early in the growing season, so previous crop residues will not be tolerated.

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. For more information on IPM techniques, refer to the AgraPoint Guide to Pest Management.

4.1 WEEDS

Onions do not compete well with weeds. Good weed control requires the integration of cultural, physical and chemical techniques. Usually a pre emergence herbicide application is followed by a post emergence application, along with cultivation and hand weeding. Refer to the AgraPoint Guide to Pest Management for a listing of herbicides and their application methods. Onions

should be planted in soil where the annual weed seed population has been reduced by cultural procedures such as crop rotation, fallowing or stale seedbed.

Care must be taken to avoid fields where residual herbicides from previous years persist in the soil as crop injury may occur.

4.2 DISEASES

4.2.1 Damping-off and Root Rots

Damping-off (*Pythium* spp.) occurs in seedlings which may cause them to topple over and die because of decay at the soil line. Surviving seedlings may be stunted because of a brownish rot on the roots and shoot.

Pink root (*Phoma terrestris*) is a type of root rot which results in reduced bulb size. Affected plants wither, turn yellow and roots have a pink colour which eventually turns brown to black.

Control: Treat seed with a fungicide for control of damping-off. To control pink root, practice a rotation of several years. Refer to the AgraPoint Guide to Pest Management for a listing of fungicides and their application method.

4.2.2 Botrytis Leaf Blight

Botrytis leaf blight is caused by the fungus *Botrytis squamosa*, which favours warm (16-28^{o}C), wet weather. Symptoms include white, oval shaped spots 1 to 5 mm in length with light green to silvery halos. The centres of the spots become sunken and straw coloured. When spots become numerous, the leaf tips die back down the entire length of the leaf.

Control: To sample for the presence of this fungal disease in onion crops, simply pick 15-50 onion plants randomly across the whole field and examine the 3 outer (oldest) green leaves. Count the number of Botrytis lesions on each leaf and record your counts. The threshold is an average of 1 lesion/leaf for cooking onions. Example: An examination of 20 plants (=60 leaves) produced a count of 30 lesions on 20 plants. Therefore, 30 lesions/60 leaves equals an average of 0.5 lesions/leaf. If crop thresholds are reached, refer to the AgraPoint Guide to Pest Management for a listing of fungicides and their application method.

Other control practices include appropriate plant spacing to allow for adequate air movement through the crop, and irrigation schedules that do not extend the leaf wetness periods. Using at least a four year rotation and destroying infected crop debris after harvest, as well as refuse heaps of onions culled from storage can help minimize botrytis pressure.

4.2.3 Downy Mildew

The air-borne fungus *Peronospora destructor* is the pathogen that causes Downey Mildew of onions. Downy mildew first appears on leaves as elongated patches varying in size and slightly paler than the rest of the foliage. Under moist, humid and cool conditions, these areas become covered with a purple-grey velvety growth, which may spread to surrounding tissue. Leaves fold over at the affected areas and the leaf tips wither. Several cycles of sporulation and infection can occur and three or four of these cycles can destroy an onion crop over a period of 30 to 45 days. Onions that are severely infected do not cure properly and are susceptible to storage rots.

Control: When entering the onion field scan the entire field for possible weak spots. If a pale area is observed, inspect it closely. While sampling for Botrytis also look for downy mildew. Control measures must begin early after detection in order to be successful. Downy mildew also tends to develop in ‘waves’ every 7-12 days. Refer the AgraPoint Guide to Pest Management for a listing of fungicides and their application method.

Other control practices include using selected varieties with tolerance to this disease, as well as using at least a two year crop rotation. Destroying infected crop debris after harvest and refuse heaps of onions culled from storage can also help minimize disease pressure.

4.2.4 Purple Blotch

This disease is caused by the fungus *Alternaria porri* and it frequently develops after Botrytis leaf blight or Downy mildew has appeared, or after warm (18-30^{o}C) wet periods. Purple blotch appears on leaves as brown spots 1 to 3 cm in length with red-purple margins. The brown areas may have alternating dark and light zones giving a target board effect. Leaves weakened by purple blotch may fall over.

Control: Practice monitoring methods similar to those described for leaf blight. Use disease tolerant varieties, remove cull piles and use a crop rotation to reduce disease inoculums.

4.2.5 Botrytis Neck Rot and Smudge

These rots occur mainly during storage, but can be found on maturing bulbs in the field. Pathogens which cause the disease include *Botrytis aclada, B. byssoidea* and *B. squamosa*. Infection occurs at harvest time through the neck. There is usually a separation between healthy and diseased scales within the onion. As the disease progresses, the tissue become grayish and a grey mold may also develop. Black sclerotia eventually appear in the affected tissue

Control: Be certain onions are mature before harvesting. Cure and dry onions properly (see curing section). Store under cool, dry conditions. Use at least a two year crop rotation and remove cull onions from the field. As well, avoid excessive applications of nitrogen which can delay onion senescence and promote thick necks.

4.2.6 White Rot

This is a very destructive disease of the onion family, caused by the fungus *Sclerotium cepivorum*. It occurs in several areas of Canada, but is not know to occur in the Atlantic Provinces. It has been found in British Columbia, Manitoba, southern Ontario and eastern Quebec. The characteristic symptoms are a white fluffy fungal growth and soft rot around the base of the bulbs. Masses of tiny black sclerotia form in the fungal growth and in bulb tissues. These sclerotia allow the fungus to survive in soil for 4 to 5 years or longer. The disease is favored by moderate soil moisture and often develops in patches.

Control: Avoid the use of infected onion sets or transplants, as they can introduce the disease to new areas. Wash all equipement, pallet boxes, etc that have been in an infected field, and wear different footwear while in an infected field. Follow a 4 to 5 year rotation.

4.2.7 Bacterial Diseases

There are at least three different diseases caused by bacteria (*Pseudomonas and Erwinia spp*): slippery skin, sour skin and soft rot. Wet growing seasons, warm temperatures and damaged onion leaves or bulbs increase the incidence of these diseases. Onions with slippery skin may appear alright on the surface, however when they are squeezed the inner portions, which may be rotted, will slide out through the neck. Sour skin will first appear as tan or brown partially rotted leaves on the growing plant. A soft rot develops near the neck and these leaves can be easily pulled off the onion. Diseased scales will separate from healthy ones. Soft rot affects many crops and is often present as a secondary infection to other insect, disease or mechanical injury. Soil is the main source of infection and symptoms can range from a spongy, water-soaked scale to complete bulb breakdown.

Control: Do not over irrigate, avoid mechanical injury and keep insect damage under control. Harvest when onions are fully mature and when weather is dry. Cure and store properly.

4.2.8 Smut

This is a very serious disease of the onion family in Canada, caused by the soil-borne fungus *Urocystis magica*. The first symptoms appear on the cotyledons and young leaves in the form of longitudinal blisters, which are blackish with a silver sheen and contain the spores of the fungus. Seedlings may die before emergence or if they survive the fungus may become systemic and remain for the entire season. The bulbs become covered with the blackish lesions and blisters. When the blister splits, spores are released into the soil where they remain viable for 15 years. Onions are susceptible only from germination until the first true leaf emerges, a period of 12 to 15 days.

Control: Avoid contaminating smut-free fields with infected soil or crop residues. Equipment sanitation is an important practice that should be used when moving between fields. Use smut-free sets or seedlings. Treat seed with a suitable systemic fungicide. Refer to the AgraPoint Guide to Pest Management for a listing of fungicides and their application method.

4.3 INSECTS

4.3.1 Onion Maggot

Onion maggots over winter in the pupal stage with adult flies emerging from the middle of May to the end of June. Adults resemble the common housefly, but are slightly smaller (6 mm) and pale grey in colour. The elongate white eggs are laid in the soil at the base of onion plants. The creamy-white larvae emerge within one week, and reach a length of 7 mm when full grown. From the middle of June to the end of July, the larvae enter the soil to pupate. Within a week, adult flies emerge to lay eggs again. There are two generations in most provinces, or a full first and a partial second. Sometimes even a partial third generation is produced in a long mild fall.

Control: Follow a good crop rotation; if possible avoid planting in fields adjacent to land that had onions on it the previous season. Onion maggot flies are more highly attracted to onion sets than seedlings. If onion maggots have been a problem it would be possible to use onion sets along the margins of the field as a trap crop. When injury is seen, or if onion maggots are know to be a problem in your area, apply a furrow treatment. After harvest remove and dispose of any onions that are left in the field.

Numerous beneficial organisms work to suppress the population of onion maggots in the field. These include rove beetles, of which there are both predatory and parasitic species; predaceous ground beetles and soldier beetles; robber flies and other predatory flies; predatory mites and spiders; and at least three species of wasp parasitoids, including a tiny braconid wasp, *Aphaereta pallipes*.

First generation onion maggot thresholds are a combination of trapping and visual scouting. Place four traps (of 3 yellow or blue sticky boards each) centrally along each field edge. Check traps weekly. Assess the percent damage using plots containing 100 onions repeated four times within the field:

Amount of Damage	Action
< 2% damage	Do not spray
2-5% damage & 5 flies /trap/day	Spray
>5% damage & 2 flies/trap/day	Spray

Refer to the AgraPoint Guide to Pest Management for a listing of insecticides and their application method.

4.3.2 Onion Thrips

Onion thrips are minute insects that puncture the leaves or stems and suck up the exuding sap. This causes the appearance of whitish blotches on the leaves. The insects may be found in greatest numbers between the leaf sheaths. Thrips are slender, yellow, active insects at most, 1 mm in length. They usually enter field boarder areas first and become problems especially under hot, dry weather conditions.

Control: The threshold for spraying thrips can be determined by counting the number of insects on the leaves. Treat the crop when the number of thrips observed exceeds the threshold of 3 thrips per leaf for cooking onions. Follow the steps below to determine the spray threshold:

1. Observe the newest leaves on the plant. The greatest number of thrips will be found between the new leaves.
2. Count the number of thrips per plant found on 30 to 50 plants through the field.
3. Calculate the average number of thrips per plant
4. Divide the leaf number to give the average number of thrips per leaf.

After the crop is harvested, the tops should be raked together and burned.
Refer to the AgraPoint Guide to Pest Management for a listing of insecticides and their application method.

4.4 PHYSIOLOGICAL DISORDERS

On some Nova Scotia fields, dry onion bulbs are splitting at the basal plate. Currently research projects are underway to determine the factors of this physiological problem. Excessive nitrogen and moisture are the leading hypothesized factors causing onion splitting. Further work needs to be done in order to mitigate impact of this disorder on yield and quality.

5.0 HARVESTING

There are three things to look for in an onion crop when determining if the bulbs are ready to be harvested:

a. Tops falling over
b. dieing roots
c. soft neck tissues

When these three signs are present, food material stored in the leaves is transferred to the bulbs to help increase bulb size. Too much nitrogen or water will have an unfavourable effect on this process.

Harvesting of the onion crop tends to begin when 60% of the tops are down and the outer skins on the bulbs are dry. This process is carried out by a windrowed machine, which undercuts and lays the onions in rows (windrows). The onion bulbs are left in windrow until inside neck tissues are dry before topping and storing. For this method to be successful, warm, dry weather is needed.

5.1 SPROUT INHIBITION

If the onion crop will be placed in storage, an application of a sprout inhibitor containing maleic hydrazide (Royal MH 60 SG or Drexel Sprout-Stop 60 SG) is useful in stopping or slowing down the production of sprouts. Maleic hydrazide is absorbed by the plant and will affect plant growth by stopping cell division, but not cell expansion. This compound is not very useful on onion cultivars with a short storage life. Products containing maleic hydrazide should be applied when the bulbs are fully mature, have at least 5-8 green leaves, and necks soft enough for the tops to fall if they have not already done so. The spray is often applied when 50% of the tops have fallen, but all tops are still green. This condition usually occurs about 10 to 14 days before harvest time. It is highly advised to read and carefully follow the directions on the labels of these products before they are applied to the crop.

5.2 HANDLING

Onions bruise very easily and symptoms of mishandling may not appear until weeks after harvest. Bruising usually occurs because of incorrect harvest equipement adjustment or long drops from elevators and conveyers and may result in increases in bacterial soft rot during storage.

5.3 CURING

The objective of putting onions through a curing process is to remove moisture from the bulb, as well as to develop skin colour. Properly cured onions will have a tight neck and dry outer scales that rustle, due to the fact that about 5% of their original weight was lost.

The curing process can take place in the field or in a storage room with warm forced air. Favourable outdoor curing conditions exist when air temperatures average 24-30^{o}C and the relative humidity is 60% or lower. If the weather remains warm and dry, the process can be finished in 7- 10 days. If the season is too damp or cool for field curing, dry in storage at a temperature between 27 to 35^{o}C with relative humidity at 70% to 80% for two weeks or cure with forced-air ventilation at 27 to 35^{o}C. Curing with forced air at 35^{o}C can be completed in as little as 48 hours. Best skin colour develops when onions are cured at 24 to 32^{o}C with 80% relative humidity.

Onions grown from seed in Nova Scotia will generally require artificial drying. Tobacco kilns can also been used to successfully dry onions.

5.4 STORAGE

Onions are frequently stored in bulk storage, two to four meters deep, constructed so that the bulbs can be cured by forcing air up through them. This method is considered more efficient and economical than curing and storing in crates. When the curing process is finished, the cooling process begins. This is completed by gradually lowering the temperature to 0^{o}C and maintaining the humidity at a range of 65-70 percent. Properly cooled onions can be successfully stored at 0^{o}C for 6 to 8 months. With forced air circulation, it may be possible to allow the humidity to be as high as 85 percent. However, condensation on bulbs must be avoided as it encourages decay and degradation of surface colour. It should also be cautioned that root growth and decay are stimulated at a high humidity, while sprouting occurs at higher temperatures. As well, thick necked onions will not keep and should be removed before storing.

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