Spinach

VEGETABLE CROPS PRODUCTION GUIDE FOR NOVA SCOTIA

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1.0 INTRODUCTION

Spinach (Spinacia oleracea) is a member of the Chenopodiaceae (Goosefoot family), which also includes Swiss Chard and Beets. Spinach is a low growing fleshly leaved annual that forms a heavy rosette of either smooth or wrinkled leaves. Cultivation of this crop began in Iran around 400 AD. The Arabs introduced spinach into Spain in 1100 AD and it spread to the rest of Europe by 1400 AD. The first savoyed leaf variety was introduced into North America in 1828.

Spinach varieties are classified by leaf types, and there are three types grown in Nova Scotia; savoy (wrinkled), semi – savoy and flat. Savoy and semi-savoy are used for fresh markets, while smooth (flat) types are used for baby spinach.

Spinach prefers a cool climate. The minimum temperature for seed germination is 2ºC with a maximum germination temperature of 30ºC and an optimum range of 7 to 20ºC. Young plants can withstand temperatures as low as -9ºC. Best crop growth occurs at 15 to 20ºC with a minimum temperature of 5ºC and a maximum of 30ºC. Spinach bolts rapidly when days are both long and hot. Bolting refers to the premature production of a seed stalk and renders the product unmarketable. Selecting varieties resistant to bolting will reduce the problem.

Spinach performs best on well drained sandy loams or loams high in organic matter. Early and over wintered crops should be planted on soils with good drainage and on soils that warm up early in the season. Peat soils may also be used for spinach production. In all instances, the soil pH should be between 6 and 6.8. Spinach is not tolerant to acidic soils, therefore it is recommended to have the soil tested on a regular basis.

2.0 CROP ESTABLISHMENT

2.1 SEED TREATMENT

Seed companies today, are priming spinach seeds, which breaks the photo dormancy inherent in the species. Basically it broadens the temperature range in which the seeds will germinate. Spinach seeds may also be treated with a fungicide to aid in the fight against disease problems. Spinach seed more than a year old rarely germinates over 80%, while older seed is even less viable and germinates more slowly and irregularly.

2.2 SEEDING/PLANTING

In Nova Scotia, the spinach crop is direct seeded as soon as the soil can be worked in early April all the way through to August. For continuous supply of the market, seeding every 10-14 days is recommended. However, from May to July, seeding intervals gradually shorten to 5-7 days and from July – August seeding intervals equal 7-10 days in length.

Spinach is commonly sown into rows spaced 20 - 30 cm apart. In recent years, growers have experimented with spinach being grown in rows 5 cm apart and seed spaced 5 cm apart in the row. Spinach is seeded on raised beds with 10-20 rows in the bed. A bed that is raised a few centimeters will aid in air and water drainage.

For the baby spinach market, commercial growers have been experimenting with seeding in rows spaced 5 cm apart and seeds spaced 1 – 1.5 cm apart in the rows. 2-5 rows of spinach are grown on raised beds which could be 50-100 cm wide.

3.0 CROP MANAGEMENT

3.1 IRRIGATION

Spinach requires a regular supply of moisture since it is a shallow rooted crop and should receive 25 mm of water every five days from rainfall or irrigation. The first five days of plant growth

(germination and seedling emergence) are very moisture dependant and require 5 mm – 12 mm of water. Sprinkler irrigation is used on spinach production in Nova Scotia.

3.2 SEASON EXTENSION

Spinach can be sowed in late August to early September and under favorable conditions it may over winter. Growers may get one cutting from this crop and under normal conditions, reasonable re-growth will occur before winter. Using row covers is essential in spinach over-wintering production. Top quality crops may not always result with this production method as leaf yellowing and some diseases may occur.

3.3 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.

If spinach is stressed by a lack of nutrients, vegetative growth is retarded and the plants are more prone to bolting.

Manure

Manure is not recommended for a spinach production because Canadian Horticulture Council guidelines state manure may not be applied within three months (90 days) of harvest. However composted manure or compost is recommended.

Lime

Lime should be applied to maintain the soil pH in the range 6.5 to 6.8. Spinach is extremely sensitive to soil acidity, therefore it is recommended to get soil tested on a regular basis. On acidic soils, spinach will have low germination, yellowing and browning of the leaf tips, the roots will burn and growth of the plant will be slowed. If the pH is too high, chlorosis may result on leaves.

Nitrogen

70-90 kg/ha of actual nitrogen is required for spinach. If compost or composted manure is applied, than nitrogen fertilizer rates are adjusted accordingly. Apply 50 % of the required nitrogen before planting by broadcasting and working into the soil. The remaining nitrogen is applied in one side dress application 2-4 weeks later. Spinach has a limited root system, and is considered to be a poor feeder. Nitrogen deficient plants appear light green in color and stems are short and stunted.

Phosphorus

A soil test will determine the level of phosphorus requirements. Banding of phosphorous fertilizer is most recommended. For late plantings, phosphorus can be banded or broadcast applied to the soil. Phosphorous is important for root growth and this crop has a relatively high requirement for phosphorus. Symptoms of phosphorus deficiency appear as slow growing plants with bluish-purple tints on their leaves.

Potassium

A soil test will determine potassium requirements. Apply potassium in the fall by broadcasting and working into the soil. Spinach is quite tolerant of salt damage so small amounts of potassium may also be banded. Potassium deficient plants show browning at the tips of the leaves.

Magnesium
Foliar applications of magnesium may enhance the production of dark green leaves. Magnesium deficiency symptoms are similar to nitrogen deficiency and include yellowing on older leaves, while the veins remain dark green. Refer to the table below for sources and rates of magnesium.

Magnesium Application Rates

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

Micronutrients

Boron
Spinach is quite susceptible to boron deficiency, so if a soil test indicates levels below 20 ppm, foliar application of boron is required. Refer to the micronutrient application table below for a list of micronutrient fertilizer sources and rates. Boron deficiency may occur during hot, dry weather. Symptoms include twisted leaves with light spots developing on the petioles and internal break down of the roots and possibly external cankers on roots. Boron toxicity symptoms include spot-like, striped or blotchy yellowing on the leaves. Eventually, leaf tissues will die.

Manganese
Manganese deficiencies may occur on sandy, over limed, high pH 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. Refer to the micronutrient application table below for a list of fertilizer sources and rates.

Molybdenum
Molybdenum applications may be required in organic or peat soils and sometimes on mineral soils, especially where the soil is acidic. If soil tests indicate low levels, foliar apply appropriate amount of molybdenum using the sources and rates indicated in the micronutrient table below. Molybdenum deficiency causes plants to become stunted and lack vigor. Leaves may turn brown along the edges.

Micronutrient Application Rates

			Foliar Applied		Soil Applied	
Nutrient	**Source**	**% Composition**	**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	N/A	1.0-3.0	N/A
Manganese (Mn)[3]	Manganese chelates	5-12 % Mn	0.5 – 1.0	N/A	N/A	N/A
	Manganese sulphate	28 % Mn	0.5 – 1.0	1.8 – 3.6	N/A	N/A
Molybdenum (Mo)	Sodium molybdate	39% Mo	0.1 – 0.25	0.25 – 0.6	N/A	N/A

3.4 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.

Botanical Family	Vegetable Crops
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 pressures, (refer to the pest management section of this guide) it is best not to plant spinach more often than once every three to four years. This crop has shallow roots that will not help to improve soil structure or aeration. Spinach seeds require a finely manicured seed bed; therefore previous crop residues would severely hinder crop establishment. Spinach should not follow red beets or Swiss chard in the rotation.

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 the grown 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 spinach 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. Spinach 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. Due to the limited availability of herbicides, stale seedbed is used frequently in spinach production. 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.
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 Spinach for a listing of herbicides and their application methods.

4.2 DISEASES

Downy Mildew
Downy Mildew (Peronospora farinose f. sp. spinaciae) is a fungus that is a problem in cool, wet weather. Seedlings or mature plants can be affected with symptoms that first appear on oldest leaves and slowly move toward younger leaves. Yellowish or light-green blotchy areas appear on the upper sides of leaves. A white, downy mould then appears on the undersides of the leaf spots; finally, the affected areas die. The fungus overwinters in crop residue and spores are spread by wind or splashing rain. The optimum temperature for infection is 150C – 200C and moisture must be on the leaf surface for spore germination to take place. The time from infection to the production of new spores varies from 5-18 days.

Control:
Choose cultivars that are resistant to the disease and follow a 2 to 3 year rotation. Soil inoculums can be reduced by deeply ploughing under infected residue. Soils with a history of downy mildew or are prone to poor air and water drainage, should be avoided. Fall spinach crops should not be grown in or next to a field that had an infected spring crop. Monitor the crop on a regular basis and look for the presence or absence of yellowish areas on the upper surface and velvet like spores on the undersides of leaves. If disease is discovered, apply a fungicide. Refer to the AgraPoint Guide to Pest Management for Spinach for a list of fungicides and their application methods.

Fusarium Wilt
Fusarium Wilt is caused by the fungus Fusarium oxysporum f. sp. spinaciae. Symptoms include yellowing and wilting on the older leaves, and then progressing to the younger leaves. The plants become pale green, the leaf margins roll inward and the plant will eventually die. The fungus attacks feeder roots first and then the tap root by causing light brown to black lesions and the water-conducting vessels will also turn black. Moist soil conditions and soil temperatures of 270C result in the most severe infections. The fungus is able to survive in the soil for several years and is also spread by contaminated seed or infected plant parts.

Control:
Avoid planting crops from the end of May to mid August if this disease has been a problem on fields. Do not plant the crop when the soil temperatures are high (mid June to late August), and maintain a high soil pH. Use good sanitary practices, plant resistant cultivars if possible and follow a good rotation. Monitor the crop on a regular basis and apply a fungicide at first sign of the disease. Refer to the AgraPoint Guide to Pest Management for Spinach for a list of fungicides and their application methods.

Damping Off
Damping Off and other root rots are caused by several fungi, including Pythium, Phytophthora, Rhizoctonia, Fusarium and Penicillium. Seedling emergence may be poor and there may be a sudden collapse and death of seedlings. Damping Off occurs in cool, wet springs when seed emergence is delayed.

Control:
In the field, use raised beds or well drained soils for early seeding. Avoid seeding into cold, wet soils. At first sign of disease, apply appropriate fungicides. Refer to the AgraPoint Guide to Pest Management for Spinach for a listing of fungicides and their application methods.

Spinach Blight or Yellows
Spinach Blight is caused by the cucumber mosaic virus and is transmitted by aphids and spread mechanically. Young inner leaves become mottled, later changing yellow and finally they are killed. Older leaves gradually turn yellow. Symptoms develop much faster at higher temperatures and high aphid activity.

Control:
Grow resistant cultivars when possible and control weeds in ditches and adjacent fencerows. Follow a good crop rotation and avoid planting spinach near cucumber mosaic susceptible vegetables such as tomatoes and cucumbers. Monitor the crop for the presence of aphids (refer to the section on aphids). Refer to the AgraPoint Guide to Pest Management for Spinach for a list of insecticides and their application methods.

4.3 INSECTS

Spinach Leaf Miner
The adult spinach leaf miner (Pegomyia hyoscyami), is a slender grey fly 4 mm long, frequently seen hovering over the host plants. The adult flies lay eggs on the undersides of the leaves. After hatching, the small, green or white larvae enter the leaves and make tunnels or 'mines' between the leaf surfaces as they feed. Heavy infestations stunt growth. Upon maturing, the larva drops to the ground, pupate, and emerge as flies. Pupae overwinter in the soil and in Nova Scotia there are several generations per year of this pest.

Control:
Cultural controls include destroying infested crop residues and weeds by disking in and maintaining field separation between susceptible crops. Insecticides should be applied when mining damage is first observed. The critical time to monitor is during the young seedling stage. Refer to the AgraPoint Guide to Pest Management for Spinach for a list of insecticides and their application methods.

Aphids
Several species of aphids can affect spinach plants, including the Black Bean Aphid (Aphis fabae Scopoli) and the Green Peach Aphid (Myzus persicae). Green peach aphids are more common and will be discussed here. Aphids are small, soft bodied, slow moving insects. A colony consists of winged and wingless adults and various sizes of nymphs. Aphids may be black, yellow or pink, but mostly are various shades of green. They are often found in large colonies on the under surface of leaves and when aphids feed on spinach it results in a discoloration of foliage, and curling leaves; making the product unmarketable. Aphids feed by piercing plants and sucking out plant sap, resulting in distorted plant parts and a slowing of plant growth. The plants may be covered by a sticky substance, called honey dew, which is excreted by the aphids.

Control:

Scout plants frequently and treat with an insecticide when insects are first observed. Refer to the AgraPoint Guide to Pest Management for Spinach for a list of insecticides and their application methods.

5.0 HARVESTING AND HANDLING

Harvest of spinach usually begins the first week of June and continues until October or as long as weather and cultivar being grown allows.

The crop should be harvested while the leaves are lush green and tender, which occurs before seed stalks harden and leaves yellow and become tough. Spinach should be free of insects, diseases and weeds before being harvested.

The entire plant is usually harvested by cutting just above the ground level when there are at least 5 to 6 leaves - usually 25 to 55 days after seeding within the growing season. Older plants may have 10 to 12 leaves. Cutting should take place at the coolest time during the day and it is very important that the plants are dry during harvesting. In Nova Scotia, mechanical harvesters are used for large plantings, however hand harvesting with shears or a knife are used also. After harvesting, spinach plants will require 10-14 days to produce enough leaves for a second crop, however generally only a small part of the crop is cut a second time due to disease pressure and quality issues.

In Nova Scotia, the common commercial practice for fresh market product is to harvest spinach into large pallets then wash and bag it into retail packs and then hydrocool the filled package. Spinach has one of the highest respiration rates among fruits and vegetables' so cooling is critical. Forced air cooling or vacuum cooling may be used if it is available. Careful handling is necessary as spinach is susceptible to bruising.

5.1 STORAGE AND CONDITIONING

Spinach can be held 10 to 14 days at a temperature of 0ºC and a relative humidity of 95% to 100%. Wilting, yellowing of leaves and decay are likely to occur after 10-14 days in storage. Spinach is very sensitive to ethylene and should not be stored or transported with apples, melons or tomatoes because accelerated yellowing with result.

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