

# **Sustainable Vegetable Production for Hobby Farmers**

## **Soil Improvement**

The critical base of all crop production is the soil. If the soil is not appropriate for the crops planned, either the success will be poor or there will be failure. Some of the key soil factors are pH, depth, drainage, organic matter and fertility. There are soils and locations where the limitations are so severe that it would be best to avoid them for vegetable production. Examples might be soils where the bedrock is 15 cm below the surface, pure sand and pure clay. Aside from these extremes, virtually every soil can be improved prior to crop production. In many cases, treatments can be applied that are not that difficult but will be highly valuable.

Most soils in Nova Scotia will tend to be on the acid side of neutral, or below 7.0 on the pH scale. Soils that have not been cropped recently could be under pH 6.0 which is unacceptable. For vegetable production the soil pH should be around 6.5, or a range of 6.2 to 7.0. Soil testing is available from the provincial department of agriculture, for a small fee, and specific directions on sampling the soil and soil sample boxes can be picked up at the regional agriculture offices. It is critical that soil testing be conducted on any new vegetable plot and existing plots should be tested from time to time also.

Agricultural lime is used to increase the pH of an acid soil. It would be best to apply it at the recommended rate in the fall and also rake or till it in. Even though finely powdered, lime does not dissolve and work its way through the soil immediately. The benefits of the application occur gradually over 2-3 years. But the first application, at the recommended rate, will make a major improvement in the first year.

The depth of the soil is critical for successful vegetable production. This relates primarily to rooting depth which in turn relates to nutrient and moisture availability. A depth of 30 cm is just about essential and 45-60 cm would be much better. There are ways to improve the original situation. Raised beds and rows can increase the rooting depth under the crops. 'Double digging' is a specific procedure (described in many books) that will roughly double the depth that can be tilled by regular digging or a rototiller. Truly shallow soils such as those over bedrock, hardpan, or clay should be avoided as they will be almost impossible to manage, particularly in terms of moisture availability (and excess moisture also).

Drainage is related both to soil depth and soil type. Given adequate depth, the soil type can usually be amended to an acceptable condition. The process could take several years, and then require annual maintenance on many soils. For sandy soils, clay soils, and all soils low in organic matter, the heavy application of good compost or the careful application of appropriate organic material will always be beneficial. It is almost impossible to apply too much compost to a vegetable plot. Uncomposted organic material such as leaves and grass clippings can be applied directly as a mulch but generally it would be better to till them in either in fall or spring. Well-made compost will be free of plant diseases due to the heating and breakdown that occurs. Clean tree leaves and grass clippings will not cause plant disease problems either but garden refuse

must be thoroughly composted before returning to the garden. (It must be composted or buried for pest management reasons in any case.)



Aside from drainage, organic matter is also critical relative to soil structure, moisture availability and fertility (nutrient availability). It would be highly unusual to have too much organic matter and on most Nova Scotia soils compost and other clean organic matter can safely be applied every year. The maintenance of a healthy, living, nutrient-rich soil, from natural sources, is the foundation of successful vegetable production. Obviously, the crop will benefit horticulturally but pest management of soil insects and root diseases will also be assisted due to all the beneficial organisms that are found in a healthy soil. There are beneficial fungi, nematodes, mites and insects! A healthy soil is almost like a tropical rain forest in terms of balance and species diversity.

## Land Preparation for Weed Management

It is likely safe to say that land preparation for most new vegetable gardens is started too late. It is hard to avoid this problem because once we decide to be a vegetable grower, we want to get going right away, often in the spring. This is a very 'human' problem but if we can plan further ahead, our long-term success will be much higher.

Any new piece of land will have a huge supply of weed seeds in the soil and usually a well-established sod that includes both annual and perennial grasses and weeds. This is where planning ahead becomes important. On a larger scale, a piece of land should be plowed at least the fall before planting will occur. If the sod is properly buried by the plow, almost all of it will die over winter. On a medium scale, sod can be killed in summer by being covered with solid black plastic, a very heavy layer of mulch, or whatever. On a very small scale, the sod can be dug off to a depth of say 10 cm, put on the compost pile, and returned when thoroughly composted. However it is done, the sod must be killed while the nutrient and organic matter value must be retained and/or returned.



With the sod plowed under, dead, or removed, it is time to begin tillage procedures. (Soil amendments such as lime and compost can also be added.) A tractor-powered rotovator or a rototiller will mix the soil with any amendments while stimulating many weed seeds to germinate. Every time that the soil can be tilled, disked or raked before the actual spring planting, weed seedlings will be killed and more seeds will germinate. It is true that a rototiller can damage soil structure over time but it would be very unusual for anyone to spend too much effort at weed reduction during the land preparation stage. If this stage is done well, everything later will be easier.

## **Management of Weed Competition**

We do not have the time in this factsheet to enter the debate as to why a plant is classified as a 'weed', the fact is that this is a human definition that reflects man's priorities, and so forth. The desired crop and the pest are both plants. There is so much evidence that significant or excessive weed populations will reduce crop production, primarily through direct competition for nutrients, water and sunlight, that this will not be discussed either. However, this does not equate to zero tolerance for weeds, which is not scientific, not justifiable economically, and not environmentally responsible.

The critical factors in weed management are timely and regular efforts. Whether using tractor-drawn implements, a small rototiller, or a hoe, it is easiest to eliminate weeds when they are small and have just started to grow. Even a perennial that has re-started from part of an older plant can be pulled and removed when it has only a few new roots.

Most weed seedlings are destroyed by the actual tillage procedure (cut up), by being buried, or by being left on the surface to dry out. The smaller the weed, the more delicate it is, and this is why both timely and regular efforts are required. A weed with a 10 to 15 cm root system (not all that old in some cases) may need to be pulled by hand and removed to the compost pile to guarantee control.

The competitive impact of weeds on the vegetable crop is also more critical earlier in the growing season than later. Uncontrolled weed competition while the crop is just becoming established can set the crop back for the entire growing season. In mid-summer and later when the crop is well-established, new weed seedlings or a few escapees may be close to harmless. At this point the crop should have a good root system and leaf canopy. It should be noted that drought without available irrigation could be an exception to this concept. Also, it is never good weed management to allow flowering and seed production to occur as you are just making next year more difficult.

Scouting (or regular observations) is a key part of good weed management. You must observe the rate at which new weed seedlings are appearing, any unusual weed species in or near the garden that require special attention, and any flowering weeds that must be removed immediately. At the home garden or hobby farm level, scouting can be a spare time fresh air activity. The key here is that you will focus on the weeds and not be distracted by your vegetables, your natural focus.

Farm manure is great for the soil but it must be well-composted as it is a known source of weed seeds. Horse manure is particularly bad in this regard.

## **Control or Avoidance of Plant Diseases**

Some vegetable crops can be grown at the home garden or hobby farm level without a major focus on plant diseases. In many cases a crop will be obtained despite a low level of disease. The great diversity in a home garden or typical hobby farm prevents a given disease from taking the entire production. Most diseases only attack a specific family of vegetable crops (see below).

Also, minor blemishes on the exterior of many crops can be ignored; you are not likely growing for your local supermarket.

On the other hand, there are several basic strategies that will help to reduce disease pressures and of greater importance, prevent them from becoming worse year after year. Most of these require little additional effort on your part.

Over the past 100 years the science of plant breeding has made tremendous progress in the selection and breeding of varieties with disease resistance. This is natural, genetic resistance that was present at some level in the original wild species and, in many cases, also present in some cultivated varieties. Controlled crosses followed by careful selection under disease pressure allows this genetic resistance to be combined with the best varieties.

Gardeners who do not want to use pesticides, or who just want to be as sustainable as possible, should read the variety descriptions in their seed catalogues very carefully. You will find phrases such as 'very good resistance to most common diseases' or 'high tolerance to diseases'. When used this way the word 'resistance' should mean that a given disease will not even occur on that variety while 'tolerance' means that a disease may occur at low levels, under worst conditions, but will have no impact on crop yield. The difference is really just for clarity because in either case the disease will have no effect.

Why not choose disease resistance when it is available? Careful examination of the current edition of one of the largest, mainstream Canadian seed catalogues finds disease resistance or tolerance available in summer cabbage, lettuce, eggplant, cucumbers (pickling, European, regular), green peas, sweet pepper, potatoes, radish, zucchini, winter squash, and tomatoes (field and greenhouse). More resistant varieties would be available in seed catalogues that focus strictly on organic growers but the point being made here is that choices are available in all seed catalogues.

Several aspects of good horticultural management also reduce plant disease problems. A vigorous plant growing under good conditions is less susceptible to most diseases. Soil fertility, soil drainage, high soil microbial activity and adequate spacing (to reduce humidity through air movement and sunshine) will all increase plant disease tolerance or reduce actual disease pressure (e.g. reduced humidity). However, with the very worst diseases such as potato late blight, regular scouting and extreme sanitation procedures are required for success.

The last point leads into garden sanitation issues. Some diseases such as clubroot of the cole crops survive in the soil from year to year. Once it is present nothing can be done about it, except in this specific case the pH can be raised to 7.2 or higher. But many other diseases, including potato late blight, overwinter on old plant material such as cull potatoes and unharvested tubers. All dead plant material should be removed from the garden as soon as a crop is finished producing and composted in a hot, active compost pile. This procedure may not work for tubers and roots and with a critical disease like potato late blight, cannot be trusted.

A fall or winter green manure crop/cover crop stimulates healthy soil microbial activity when it is later tilled under. This will reduce the pressure from various organisms that might attack the crop roots.



Crop rotation is the last major strategy that can have a very positive impact on disease problems. Only a few diseases such as grey mold (*Botrytis*) can attack a wide variety of plant species (and it is typical of a 'generalist' such as this that it attacks lower leaves and soft fruit). Almost all of the diseases that cause us real problems attack only one family within the plant kingdom, for which they are 'specialists'.

The major vegetable crop families are:

1. Tomatoes, peppers, eggplant, potatoes
2. Cucumbers, squash, pumpkins, melons
3. Cabbage, broccoli, cauliflower, Brussels sprouts, turnip, radish
4. Onions, leeks, garlic
5. Spinach, beets, Swiss chard
6. Peas, beans
7. Carrots, parsnips, parsley

It is beyond the scope of this document to provide detailed directions or plans for crop rotation. These are available in many gardening books but the rules are simple in any case:

- Do not follow a crop by itself or by any other member of that crop family

- Rotate a crop as far away from the previous year's location (the entire crop family) as garden size allows
- Allow as many years from a previous year's location (the entire crop family) as garden size and number of crops grown allows.

This may seem complicated but it is feasible and is useful at any level of application.

## Control of Insect Pests

Most home gardeners and hobby farmers probably have more critical problems with insect pests than with plant diseases. Certainly it is not uncommon to see potato plants almost stripped of their leaves by the Colorado potato beetle, or seedling carrots and bean seedlings destroyed by earwigs. These are situations where some sort of control effort must be applied.

A quick course in insect biology may be helpful. All true insects can be divided into two groups according to how they grow from egg to adult. (Many aphids are born alive, without an egg stage). In the first group, which includes grasshoppers, crickets, earwigs, aphids, and the 'true' bugs, the newly hatched (or born) insects are more or less miniature copies of the adult insects. The major difference is in the wings but even these are present as small pads in the later nymphal stages. (See life cycle of the squash bug at right).



In the second group, which includes moths and butterflies, beetles, ants, bees and wasps, the larval stages are completely different from the adult stage and a radical change (the pupal stage) is required between the last nymphal stage and the adult.

These two different developmental patterns are related to when, and for how long, a given insect species will be causing feeding damage. In the case of grasshoppers, aphids and earwigs, all nymphal stages and adults are feeding stages so damage will occur over a number of weeks. When multiple generations occur, as in the aphids, feeding can occur over much of the growing season.

In the case of moths and butterflies, only the larvae (caterpillars) will feed on the specific crop. The corn earworm feeds on corn kernels and the various cutworms feed on various plants just above the soil level. Any control effort here should be applied against the small larvae because it will be much more effective then but also because the feeding damage is much greater from the last one or two larval stages.

The beetles are a more confusing group. In species such as the Colorado potato beetle the larvae and adults both feed on the leaves whereas in a group such as wireworms the larvae are in the soil feeding on roots and tubers while the adults (click beetles) are above ground causing minimal concern.

Is there any tolerance for pest insects in your garden? Yes, of course there is. In commercial agriculture the term economic threshold is used. An economic threshold is that population level at which treatment can be justified economically, based on a reasonable estimate of damage to be prevented **plus** the negative value of secondary results such as pesticide-related outbreaks of other pests, and the secondary cost of their control. The economic threshold is seldom, if ever, zero pests. In a home garden the economic threshold would be less precise but the basic concept would be very similar. A few aphids on the peas or a few flea beetles on the cabbage do not require immediate attention. An informed gardener will learn the level of threat from each major pest and the potential for an increase or a decrease from different pest levels. The point here is: What are the factors that should determine future pest numbers and additional damage?

- Is the damage almost complete for this year due to pest biology?
- Is it almost as easy to find lady beetles on the plants as it is to find aphids?
- Have earwigs already destroyed the growing points on 20% of the bean seedlings and wet weather will continue to prevent the effective use of diatomaceous earth?
- Have Colorado potato beetles already taken 10% of the leaf area and the larval stage has only been hatching out for several days so far?

Scouting is the most important part of insect pest management and it is not as difficult as you might expect. Adult Colorado potato beetles have a very strong tendency to be out in full view on the upper leaves. Flea beetles occur on the upper surfaces of cole crop leaves and can easily be seen if you move slowly. The striped cucumber beetle adults can easily be seen on newly emerged or transplanted cucurbits. Carrot seedlings and the growing points on bean seedlings can be checked each morning to determine whether earwigs are present (badly chewed overnight). Corn earworm larvae always start feeding on the upper tip of the ear, because the eggs are laid in the silk.

So you don't need to be a trained entomologist to scout for most vegetable insect pests. The basic requirement is some knowledge of the biology and habits of perhaps one or two dozen species. Scouting is primarily a process of keen observation, based on the self-confidence that you know what you are looking for. It is true, however, that you may need to have been gardening for several years, taken some sort of training, or have one or more good books to have that level of self-confidence.

There are insect control procedures that do not involve the use of any type of pesticide. Here are some examples.

1. The adult **Colorado potato beetle** is a weak flier and usually finds the crop by walking from its overwintering site. Therefore, on smaller plots it is feasible to erect a vertical barrier such as sheet metal buried at the bottom in the soil. The material used must be hard and smooth, some man-made material. A related concept is to dig a trench outside of the crop with clean, vertical walls. If this is done carefully, and the beetles caught are destroyed daily, there will be some success. Both of these controls are only feasible on small plots. If the adult beetles reach the crop, they have a strong tendency to be on the highest leaves, generally in full view. With a quick hand, it is remarkably easy to catch these adults and drown them in a container of soapy

water. A daily check for 2-3 weeks can actually have a major impact on later larval numbers and total feeding damage.

2. The **striped cucumber beetle** is the main pest of the cucumber, squash and pumpkin group. This pest spends the winter in the adult (beetle) stage, in unmanaged areas such as fence lines, woods and other rough areas. It is a strong flier. The critical stage to protect is the newly emerged seedling or the young transplant up to at least the third true leaf stage. (True leaf refers to the normal leaves that come out after the two seedling leaves.) It would be better to protect up to 5 or 6 true leaves. Light-weight floating row covers can be used to exclude the over-wintered beetles from the young plants. Obviously, the better this is applied (edges buried in soil, held down by boards, hoops used, etc.), the more successful it will be. **The floating row cover**



**must be removed at flowering as cucurbits are bee-pollinated.** Floating row covers can also protect several other crops in their early stages.

3. During daylight **earwigs** are usually hiding in small, tight spaces. Rolled-up newspapers (use elastics) or so-called earwig traps (boards with many parallel grooves) can be placed at numerous spots around the edge of the garden. Once each day these traps are picked up quickly and opened out / tapped into a bucket of soapy water. All the earwigs trapped will be drowned and there is no need to contact them.

There are a few sustainable pesticides that can be used by the home vegetable gardener. However, do not assume that every insecticide allowed under certified organic production should be considered sustainable. That's not really true.

\* The natural, botanical insecticide pyrethrum is widely available as a home garden (Domestic) insecticide and is accepted under virtually all production systems. If applied directly on the insect pests, it is effective against a wide range of species. Its residual strength, however, is close to nil (which is part of the reason it is judged sustainable).

\* There are a variety of Domestic insecticidal soaps available that are remarkably effective when applied directly on small, soft-bodied pests such as aphids, caterpillars and beetle larvae. The technical name is 'potassium salts of fatty acids', often strengthened with a minute per cent of pyrethrins. It is generally a bad idea to prepare your own insecticidal soap because in many cases you will cause as much damage to the plants (phytotoxicity) as to the insects.

\* Another sustainable insecticide is diatomaceous earth, which is often sold as insect dust with the technical name 'silicon dioxide'. This natural product is from ancient deposits of the skeletons of diatoms. Used as a dust, it is effective when it can be applied directly against many insects. It can also be applied for its residual value on a crop that needs to be protected (e.g. against night-feeding earwigs), but it is only effective for as long as it remains dry. Multiple treatments are the norm. Rapidly increasing leaf area, as in cucurbits, can also require repeat



treatments. Diatomaceous earth can be effective but a daily check will be required to obtain satisfaction.

What about biological controls for the home garden or hobby farm? The main point that needs to be understood here is that a garden that is managed as discussed in this publication will have a great diversity of natural biological control present. A rich soil with high organic matter, a diversity of crop species, no broad-spectrum long residual life pesticides, and a relatively small space surrounded by a mix of other habitats, are all key factors that promote biological diversity and effective biological control. The constant warfare in the soil between pests and beneficials would have to be understood to be believed. Above ground, lady beetles, hover flies, dragonflies, insect parasites, spiders and birds are all hard at work. Aside from managing the garden so as to allow all of this to occur, there is no great potential for additional manipulation. As many adult beneficials require nectar or pollen for food, growing a variety of flowering plants in or around the garden is the obvious priority for encouraging more biological control. Bird houses are fine but will not really be used by species like song sparrows and robins that feed on the ground, in your garden. These species require dense shrubbery, ground cover, evergreens and dense deciduous trees for nesting habitat. This should be included in your landscaping plans.

## **Management of Birds and Mammals**

Most home garden vegetable crops are not attacked by either birds or mammals. Virtually all birds seen there are feeding either on insects or weed seeds. Crows would be the one exception as they will at times remove the larger seeds, such as corn seed. Scaring tactics using Mylar ribbons, suspended aluminum pie plates, a scarecrow or a tethered dog can be quite effective if installed exactly when needed. Crows are highly intelligent and will figure out the true danger before too long.

Raccoons and White-tailed deer are the only mammal pests in a typical home garden. Raccoons are extremely fond of sweet corn and will do whatever is required to reach it. Deer are less predictable but can be heavy feeders on pea vines, spinach and Swiss chard. Other crops are also browsed at times.

If a medium to large dog is kept outdoors in any case, it can be quite effective as a deterrent if housed right next to the garden. Needless to say, not many small to medium size dogs are housed outdoors anymore and with the current coyote population, that is definitely the best plan. An electric fence is the only other simple control technique against raccoons and deer that can be expected to work. The current designs use light-weight wires and posts. Kits are available for home gardeners. A single wire at 40 cm. height can be effective against deer in some situations. More permanent, specific fence designs for deer are available here:

<https://novascotia.ca/natr/wildlife/nuisance/deer.asp>

An electric fence for raccoons should have two wires, at 15 and 30 cm. above the ground. The fence only needs to be energized at night. The height to the bottom wire must be uniform all the way around.

## Impact on the Environment

The impact on the environment from the procedures outlined in this publication should be neutral to positive. The objective is to maintain the soil in a more fertile and biologically active condition than it was originally (unless you started with one of Nova Scotia's very best soils, in which case maintenance is the objective). There may be less plant diversity than under wild vegetation but the diversity compared to commercial agriculture is very high. Additional flowering plants in or around the garden were recommended for beneficial insects. The insecticides mentioned are low-impact, non-residuals that would have minimal impact on beneficial insects (they would need to be sprayed directly to be affected) and no impact on birds and mammals. The home garden or hobby farm as discussed here will provide good feeding habitat for native songbirds such as robins, song sparrows and chipping sparrows.

## Sources of Additional Information

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