2017
Cornell Integrated Crop and Pest Management Guidelines for Commercial Vegetable Production

Cornell University
Cooperative Extension

These guidelines are not a substitute for pesticide labeling. Always read and understand the product label before using any pesticide.

Chapter 1 – Integrated Crop and Pest Management

1.1 Background

Cornell University and Cornell Cooperative Extension actively promote the use of Integrated Crop and Pest Management by New York farmers in order to address agricultural concerns. In many areas of New York State, there are horticultural, economic, social, and political pressures to reduce environmental impacts of and pesticide use in crop production. Public concerns with nutrient and sediment movement into ground and surface water and pressure against pesticide applications are growing. In other regions, agricultural producers are being asked to submit nutrient and soil management plans to address the offsite impacts of their practices. In addition, the development of pesticide resistance in key pests; registration of fewer and more expensive new chemicals for pest control; loss of existing products; and increased competition from other regions continue to push New York agriculture to look for nonchemical alternatives.

Integrated Crop and Pest Management requires a combination of long and short term production strategies to maximize net profit while minimizing risks of undesirable environmental impacts of practices. Some of these practices include site selection, crop specific production strategies, nutrient management, and cover cropping. IPM is a pest control strategy that promotes the use of a variety of tactics including pest resistant cultivars and biological, cultural, and physical controls. Pesticides are a control tactic employed in IPM, but they are only used when needed. Pesticide use is thus minimized without jeopardizing crop quality or yield. Applying multiple control tactics minimizes the chance that pests will adapt to any one tactic and allows farmers to choose the most environmentally sound, efficacious, and economically efficient pest management program for their situation.

This manual provides information and references which will allow New York vegetable growers to practice IPM for many of their crops. While information for the proper use of pesticides is included in the manual, a variety of other information is included that can help growers reduce reliance on pesticides and take advantage of alternatives to pesticides which may be less expensive, less environmentally harmful, and more acceptable to the non-farming community.

1.2 Practicing IPM

In an IPM program, it is important to accurately identify the pests (vertebrates, diseases, insects, and weeds) and assess pest abundance. It is important to have knowledge of the biology and ecology of the pest(s) attacking the crop and the factors that can influence pest infestations. An understanding of the influence of factors such as weather and natural enemies on pest abundance will aid the choice of management tactics. IPM programs stress suppression of insect and disease populations to levels that do not cause economic damage, rather than total eradication of a pest. In the case of insect pests, it is important to have at least some pests present to ensure that natural enemies will remain in the crop to suppress subsequent infestations.

1.3 IPM Components

1.3.1 Monitoring (Scouting)

Scouting includes detecting, identifying, and determining the level of pest populations on a timely basis. Insect traps can often be used to detect pests and identify times when scouting should be intensified or control measures should be taken. Scientifically based, accurate, and efficient monitoring methods are available for many pests on vegetable crops in New York. Brief descriptions of the techniques are given in this manual. Consult the listed references for details on scouting and trapping of pests.

1.3.2 Forecasting

Weather data and other information help predict when specific pests will most likely occur. Weather-based pest forecast models for diseases and insects of many crops have been developed in New York. This manual indicates which pests have such models available. Forecasts are available through the Network for Environment and Weather Applications (NEWA) on a daily basis.

Access to a computer network to obtain weather, regional insect, and disease forecasts, is useful but not essential. The Northeast Weather Association provides automated local weather information and the results of pest forecasts on a daily basis. Information on the potential for pest outbreaks can sometimes also be obtained from local Cooperative Extension programs, newsletters, and regional crop advisors.

1.3.3 Thresholds

Use thresholds to determine when pest populations have reached a level that could cause economic damage. Thresholds have been scientifically determined by Cornell researchers. Following the thresholds indicated in this manual has reduced pesticide use by ten to 50 percent, saving significant money for growers.

1.3.4 Management Tactics

Appropriate management tactics to control pests include cultural, biological, and physical controls, as well as chemical controls when they are needed. Taking advantage of some of the simple and relatively inexpensive pesticide alternatives offered in this manual can result in significant savings to growers both in terms of pesticide use and crop loss. Often a thoughtful preventive measure taken before

Chapter 2 – Disease Management

2.1 General Principles

For a vegetable to become truly diseased, several conditions must be present: a susceptible host plant, a pathogenic organism, a good method of distributing the organism, and the proper environment for it to exist, enter the plant, and thrive. When these conditions are met, infection occurs, and a disease agent becomes established. The choice of a proper management tactic must be based on accurate knowledge of the pathogen causing the disease; its life cycle; time of infection; the part of the plant involved; the method of agent distribution; past, present, and future environmental conditions; and certain economic considerations. Effective management techniques include: use of resistant varieties; use of non-infested soil or long rotations; sterilization of soil with steam or chemicals; use of clean seed, either certified or grown in disease-free areas; treatment of seed with heat or chemicals; control of insects and weed hosts; monitoring of weather conditions; use of biological control agents; and proper timing and application of fungicides or nematicides.

Effective management of vegetable diseases requires preventing disease or, if this is not feasible, slowing the spread of disease once it occurs. What can be done to prevent disease outbreaks or reduce the risk of early-season epidemics? Nine procedures and the current estimated percentage of importance of each toward vegetable disease control have been recommended for many years: rotating crops (30%), spraying when necessary (20%), treating the seed (15%), using clean seed (10%), planting resistant varieties (5%), controlling weeds (5%), aerating the soil properly (5%), draining and fertilizing the soil (5%), and practicing good sanitation (5%). It is unlikely that all diseases of a particular crop can be controlled by simply following these procedures. Nevertheless, the extent of disease and the concomitant costs of controlling them can be significantly reduced by following as many of these procedures as possible. Growers should note that this estimate indicates that spraying is only responsible for 20 percent of disease control. Using the other disease control techniques, which contribute 80 percent of disease control cannot only greatly improve disease control, but also lessen the costs of spray materials and result in better quality crops.

2.2 Diagnosis of Disease

The first step in disease management should be accurate diagnosis. It is important to differentiate between infectious diseases (e.g. those caused by fungi, bacteria, phytoplasma, viruses, viroids, and nematodes that can spread from plant to plant) and noninfectious diseases or disorders (e.g., damage caused by mites and insects, physiological disorders, air pollutants, nutrient imbalances, water imbalances and herbicide injury). Growers who have a reasonably good understanding of plant diseases, their symptoms, and the infectious and noninfectious disorders that can affect a particular crop, are more likely to make the correct disease control decisions. Numerous fact sheets and bulletins with full-color illustrations have been developed by Cornell faculty to assist growers in making accurate disease diagnoses. (See references in each disease section). In addition, samples can be sent to the Plant Disease Diagnostic Clinic in Ithaca (607-255-7850).

2.3 Disease Management Tactics

2.3.1 Crop Rotation and Tillage

Rotating fields to different crops each year cannot be overemphasized as one of the most important and easily implemented disease control strategies. This practice avoids the buildup of certain plant pathogens in the soil. The longer the rotation, the less likely that an early-season disease outbreak will occur. Because pathogens usually attack members of the same plant family, it's best to avoid planting successive crops belonging to the same family. Choices of unrelated crops to be rotated include beans to sweet corn, leafy vegetables to cucurbits, cucurbits to crucifers, and crucifers to sweet corn. Rotating beans with a grain crop such as barley, oats, rye, wheat, or field corn or with a forage crop is beneficial for root-rot control. One or two years in a grain crop are often long enough to prevent severe root rot when a field isn't heavily infested.

Some soilborne diseases are not readily controlled by rotation. Such diseases are caused by pathogens that produce structures that can withstand the effects of time and nonhost crops. Examples include clubroot of crucifers, Phytophthora blight and Fusarium wilt of several crops. Other pathogens have such a wide host range that they can survive indefinitely because so many crops and weed species serve as hosts. These pathogens include Sclerotinia, Rhizoctonia, Verticillium and root-knot nematodes. Other pathogens are not affected by rotation because they overwinter in southern states, and new inoculum is blown into the area every year. This group includes sweet corn rust and downy mildew of cucurbits.

Many pathogens can overwinter successfully in association with plant debris and are unable to survive once the crop residue decomposes. Destruction of current-season crops can eliminate reservoirs for overlapping plantings. Fall tillage is important because it reduces the amount of inoculum that survives the winter.

Fields with a history of poor stand establishment and root diseases should not switch immediately to no-till or reduced tillage practices. The severity and incidence of root diseases and other pests should be reduced first by employing an appropriate crop rotation, deep tillage and other good soil management practices.

Table 2.3.1 Registered fungicides by crop.

X = registered; Superscript numbers = days to harvest (DTH). No number = 0 DTH or intended for seed or soil use at planting, or at peak bloom for Rovral use on beans.

	Crop																									
Fungicide (*active ingredient*)	CLASSIFICATION	Asparagus	Bean, Dry	Bean, Snap	Beet	Broccoli	Brussels sprouts	Cabbage	Cabbage, Chinese	Carrot	Cauliflower	Cucumber	Eggplant	Lettuce and Endive	Melon	Onion, Dry bulb	Onion, GB	Peas	Pepper	Potato	Pumpkin, W. Squash	Spinach	Summer Squash	Sweet Corn	Tomato	Watermelon
Actigard (*acibenzolar-S-methyl*), SAR	P1					X^{7}	X^{7}	X^{7}	X^{7}		X^{7}	X		H^{7} L^{7}	X	X^{7}			Chili ^{14}		X	X^{7}	X		X^{14}	X
Aliette (*fosetyl-Al*)	33					X^{3}	X^{3}	X^{3}	X^{3}		X^{3}	X$^{0.5}$		X^{3}	X$^{0.5}$	X^{3}					X$^{0.5}$	X^{3}	X$^{0.5}$		X^{14}	X$^{0.5}$
Apron XL (*mefenoxam*), direct seeding	**4**		X		X													X						X		
Armicarb, Kaligreen MilStop (*potassium bicarbonate*)	**NC**											X	X		X				X		X		X		X	X
Blocker 4F (*PCNB*), application method varies	14		X	X		X	X	X	X		X									X						
Bravo, Echo, OLP (*chlorothalonil*)	M5	X^{190}	X^{14}	X^{7}		X^{7}	X^{7}	X^{7}	X^{7}	X	X^{7}	X			X	X^{7}	X^{14}			X^{7}	X		X	X^{g,14}	X	X
Cabrio EG (*pyraclostrobin*), no aerial	**11**				X	X	X	X	X	X	X	X	X	X	X	X^{7}	X^{7}		X		X	X	X		X	X
Cabrio Plus (*pyraclostrobin + metiram)*, no aerial	**11 +** M3																			X^{3}						
Captan (seed)	M4		X	X		X	X	X			X							X								
Catamaran (*chlorothalonil + potassium phosphite*)	M5 + 33		X^{14}	X^{7}		X^{7}	X^{7}	X^{7}	X^{7}	X	X^{7}	X			X					X^{7}	X		X		X	X
Cease (*B. subtilis*), Gr. Hs.	Bio				X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X		X	X
Contans (*Coniothyrium minitans*)	**Bio**							X		X				X						X						
Copper, fixed[a] (see end of table)	M1		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X^{some}	X	X
CruiserMaxx Legumes (🐝*thiamethoxam + mefenoxam + fludioxonil*), seed	Ins + **4** + **12**		X	X														X								
†CruiserMaxx Potato (🐝*thiamethoxam + fludioxonil*), seed piece	Ins + **12**																			X						
Curzate 60DF (*cymoxanil*), seed piece and foliar	**27**											X^{3}		He^{3} Le^{1}	X^{3}					X^{14}	X^{3}	X^{1}	X^{3}		X^{3}	X^{3}
Decree (*fenhexamid*), Gr. Hs., Tsp.	**17**											X	X	X					X						X	

Chapter 3 – Insect Management

3.1 General Principles

The goal is to avoid or reduce insect pest populations to levels that do not cause economic loss. Management of insect pests should ideally include a variety of tactics that are integrated to reduce pest infestations and damage to acceptable levels and minimize the chance that pests will adapt to any one management tactic. In many cases, certain insect pest infestations never exceed economically damaging levels and do not require control. The most common management tactics used against insect pests include pest resistant or tolerant varieties, and cultural, physical, mechanical, biological, and chemical controls.

Integrated pest management requires an understanding of the pest's biology and ecology, the crop production system and the agroecosystem. For example, temperature is the primary factor determining the rate at which insects develop; higher temperatures increase the rate of development. Therefore, temperature can be important when determining the frequency of insecticide applications. Degree-day models can aid in determining how fast insects are developing and the timing of applications. In addition to temperature, other factors influence the pest populations such as rainfall, host quality, host availability and the ability of the pest to disperse long distances.

Knowledge of when pests typically infest a crop and the crop stage that is most vulnerable to yield loss when damaged by the pest will impact the management options used. For example, if the pest attacks the seedling stage of the crop every year, a preventative tactic might be selected (e.g., resistant cultivar, insecticide at planting). If the pest only occasionally attacks the crop, a decision to control the pest should be made only when infestations are likely to reach an economically damaging level (see more below).

Understanding the population dynamics of insect pests in the agroecosystem can inform decisions about how best to manage the pest in the vegetable crop. For example, a pest may initially infest a crop (e.g., alfalfa or wheat) or non-crop (e.g., weeds) that do not require control, thereby allowing subsequent generations to build that may disperse into and damage a nearby vegetable crop.

Action Thresholds and Sampling. The decision to use an insecticide, or similar tactic, against an insect infestation requires an understanding of the level of damage or insect infestation a crop can tolerate without an unacceptable economic loss. The level of infestation or damage at which some action must be taken to prevent economic loss is referred to as the "action threshold." Action thresholds are available for many vegetable crops and should serve as a guide for making control decisions. Thresholds should be adjusted based on market value, environmental conditions, variety, etc. To estimate the severity of pest infestations, the crop must be sampled. Sampling may involve examining plants and recording the number of pests or the amount of damage observed, or traps may be used to capture the pest species to estimate pest activity and possibly abundance. Sampling is conducted at regular intervals throughout the season or during critical stages of crop growth.

3.2 Management Options

3.2.1 Pest-Resistant Crops

An important management option for the control of insect pests is the use of crop varieties that are resistant or tolerant. A resistant variety may be less preferred by the insect pest, adversely affect its development and survival, or the plant may tolerate the damage without an economic loss in yield or quality. For example, vine crops (squash, cucumbers, melons) that have lower concentrations of feeding stimulants (cucurbitacins) are less preferred by cucumber beetles. Sweet corn varieties with tight husks are less likely to be infested by corn earworm, and some varieties are resistant to the bacteria transmitted by corn flea beetle that causes Stewart's wilt. *Bacillus thuringiensis* (Bt) sweet corn varieties have been genetically engineered to resist European corn borer. Some cabbage varieties have been classically bred to tolerate onion thrips damage. Advantages of pest-resistant or tolerant crop varieties include ease of use; compatibility with other integrated pest management tactics; low cost; cumulative impact on the pest (each subsequent generation of the pest is further reduced); and reduced negative impact on the environment.

3.2.2 Cultural Control

There are many agricultural practices that make the environment less favorable for insect pests. Crop rotation, for example, is recommended for management of Colorado potato beetle. Beetles overwinter in or near potato fields and they require potato or related plants for food when they emerge in the spring. Planting potatoes far away from the previous year's crop prevents access to needed food, and the relatively immobile beetles will starve. Selection of the planting site may also affect the severity of insect infestations. Cabbage planted near small grains is more likely to be infested by onion thrips that disperse from the maturing grain crops.

Trap crops are planted to attract and hold insect pests where they can be managed more efficiently and prevent or reduce their movement onto crops. Early-planted potatoes can act as a trap crop for Colorado potato beetles emerging in the spring. Because the early potatoes are the only food source available, the beetles will congregate on these plants where they can be more easily controlled. Adjusting the timing of planting or harvesting is another cultural control technique. Earlier planted sweet corn is less likely to be infested by corn earworm and fall armyworm, which typically arrive mid to late in the season.

Table 3.2.1 Some commonly used insecticides on vegetables.

Not all registered products are listed in this table or in crop sections.

Insecticide (*Active Ingredient*)	*Mode of Action*[1]	Crop: Asparagus	Bean, Dry	Bean, Snap	Beet	Broccoli	Brussels sprouts	Cabbage	Cabbage, Chinese	Carrot	Cauliflower	Cucumber, Melon, and Watermelon	Eggplant	Lettuce and Endive	Onion, dry bulb	Onion, green bunching	Peas	Pepper	Potato	Pumpkin and S/W Squash	Spinach	Sweet Corn	Tomato, field
*†Actara (*thiamethoxam*)	*4A*				X	X	X	X	X	X	X	X	X	X				X	X	X	X		X
*Admire Pro Systemic Protectant (*imidacloprid*)	*4*		X	X	X	X	X	X	X	X	X	X	X	X			X	X	X	X	X		X
*ΔAgri-Mek 0.15EC (*abamectin*)	*6*											X	X					X	X	X	X		X
Align (*azadirachtin*)	*18*																		X				
*Ammo 2.5 EC (*cypermethrin*)	*3A*					X	X	X	X		X			X		X							
*Asana XL (*esfenvalerate*)	*3A*		X	X		X	X	X	X	X	X	X	X					X	X	X		X	X
Assail 30SG (*acetamiprid*)	*4A*			X		X	X	X	X		X	X	X	X	X	X	X	X	X	X	X		X
Avaunt (*indoxacarb*)	*22*					X	X	X	X		X		X	X				X	X			X	X
*Baythroid XL (*beta-cyfluthrin*)	*3A*		X		X	X	X	X	X	X	X	X	X	X			X	X	X	X	X	X	X
Beleaf 50 SG (*flonicamid*)	*9C*					X	X	X	X		X	X	X	X				X	X	X			X
*†ΔCoragen (*chlorantraniliprole*)	*28*					X	X	X	X		X	X	X	X				X	X	X	X		X
*Counter (*terbufos*)	*1B*																					X	
*ΔDanitol 2.4EC (*fenpropathrin*)	*3*					X	X	X			X	X								X			X
Deadline bullets (*metaldehyde*)						X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
*Diazinon 50W (*diazinon*)	*1B*			X	X	X	X	X	X	X	X	X		X	X		X	X	X		X	X	X
*Diazinon 14G (*diazinon*)	*1B*			X	X	X	X	X		X	X	X		X	X		X	X	X		X	X	X
Dimethoate (*dimethoate*)	*1B*		X	X		X	X	X	X		X	X		X			X	X	X		X		X
DiPel DF (*Bt var. kurstaki*)	*11*	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Entrust SC (*spinosad*)	*5*	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
*Force CS (*teflurthrin*)	*3A*																					X	
Fulfill (*pymetrozine*)	*9A*	X				X	X	X	X		X	X	X	X				X	X	X	X		X
*ΔGladiator (*zeta-cypermethrin + avermectin*)	*3/6*											X	X	X				X	X	X			X
*Hero (*bifentrhin + zeta-cypermethrin*)	*3A*			X		X	X	X	X		X		X					X			X	X	
Javelin (*Bt var. kurstaki*)	*11*					X	X	X	X		X			X									
Kryocide (*cryolite*)	*9B*												X						X				X
*Lannate LV (*methomyl*)	*1A*	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Lorsban 15G (*chlorpyrifos*)	*1B*					X	X	X	X		X			X	X							X	

Chapter 4 – Weed Management

4.1 General Principles

Weeds reduce yield and quality of vegetables by competing directly for light, nutrients, and water and by interfering with harvest operations. Early-season competition is most critical and a major emphasis on control should be made in this period. Weed control requires good management practices in all phases of production. Because there are so many different kinds of weeds, they cannot be managed by a single method. The first step in managing weeds is identification. Some of the common problem weeds in New York State are highlighted below.

4.1.1 Problem Weeds in Vegetable Production

Galinsoga. Because of its biology and its tolerance to vegetable herbicides, galinsoga may quickly become a major weed once it is introduced into a vegetable field. Galinsoga is not sensitive to day length and, as a consequence, begins to flower and produce seed when it has about five or six pairs of leaves. It continues to form seed until it is killed by frost. Fresh seed drops onto the soil surface and soon sprouts because there is little or no dormancy. The new seedlings begin to flower at the fifth or sixth node, and the cycle is repeated. Three to five generations per season are often observed in Ithaca, New York. Cultivation is only partially helpful because Galinsoga roots quickly and easily reestablish themselves from cut stems and uprooted plants unless conditions are very dry for several days after cultivation.

Many herbicides used on vegetables are only slightly helpful for control of Galinsoga. Ineffective chemicals include *†Dacthal, *Eptam, Prefar, and Treflan. Several herbicides are extremely toxic to Galinsoga: *AAtrex, *†Dual, *†Lasso, Lorox, and metribuzin.

Velvetleaf. This robust, annual weed is increasing rapidly in upstate New York areas. It often escapes in fields where preemergence herbicides are used without mechanical cultivation. It has fairly large seeds that last many years in the soil and are not destroyed when fed to cattle. Because of their size, seeds can germinate anywhere in the top several inches of soil. Seedlings emerge from a range of depths, appearing over a period of many weeks, and most surface-applied herbicides used at planting are relatively ineffective on seedlings that emerge late. Unfortunately, even late seedlings can produce mature seeds before frost.

Although several herbicides are active against velvetleaf, they usually do not provide season-long control. Fields should also be cultivated. *AAtrex, Basagran, *Eptam, Lorox, Prowl, and 2,4-D have activity against velvetleaf. Herbicides such as *†Dacthal, Prefar, *†Dual, *†Lasso, and Treflan, however, have little activity regardless of timing.

Nightshade. Nightshade, a warm-season summer-annual weed, is becoming a problem in New York. Eastern black nightshade (*Solanum ptycanthum*) is the most common and widespread species, but hairy nightshade (*Solanum sarracoides*) is predominant in some areas. These weeds are particularly problematic in tomato, potato, snap bean, and dry bean fields. Few herbicides currently registered for vegetable crops effectively control nightshade. Therefore, to stop an infestation, it is important to identify the weed and eradicate it before the plants produce seeds. *AAtrex, used in sweet corn, will control nightshade, and thus corn can be used as a rotational crop to reduce control problems in other vegetables. The acetamides (*†Lasso, *†Dual, †Frontier) suppress nightshades. Additional research will be required, however, to determine the effectiveness of these herbicides in controlling the different nightshade species.

Quackgrass. This common perennial problem grass is controlled most efficiently by a combination of chemicals and tillage. Check specific crop guidelines for control.

Nutsedge (nutgrass). Tubers do not sprout until the soil is warm. In most fields, weeds such as lambsquarters, mustard, ragweed, and quackgrass emerge two or three weeks earlier. Nutsedge grows vegetatively until midsummer, forming the first tubers as the days shorten slightly in July. As days shorten more sharply in August and September, tuber formation is greatly accelerated. In the fall, even small plants form tubers.

In many vegetable crops, even temporary control is difficult. Furthermore, reducing the severity of a heavy infestation or eliminating nutsedge from a field is difficult because tubers may last four or more years after they have formed. Fortunately, nutsedge is sensitive to dense shade, and successful control measures need to capitalize on this characteristic. For example, when planted early at close spacing, most pumpkins and squash provide the shade needed. For dry and snap beans, potatoes, and sweet corn, nutsedge can be controlled by selective herbicides. See specific crop information. Some general suggestions include: use heavy crop shading if possible; plant crops at close spacings; cultivate between rows until crop foliage takes over; plant and harvest early on fields for which selective chemicals are not available. Fall tillage and nonselective chemicals can then be used. When selective chemicals are available, delay planting and treatment until tubers have sprouted. Herbicides do not damage dormant tubers. Both cultural practices and herbicides are needed; neither can do the job alone.

Perennial broadleaf weeds. Perennial broadleaf weeds such as bindweed, Canada thistle, horsenettle, and milkweed are not easily controlled while vegetable crops are growing. Cultivation alone is only partially adequate, and effective herbicides are very damaging to crops.

Table 4.2.1 Commonly used herbicides on vegetables in New York.

Not all registered products are listed in this table or in crop sections.

Herbicide (*Active Ingredient*)	*Mode of Action*[1]	Asparagus	Bean, Dry	Bean, Snap	Beans, Lima	Beet	Broccoli	Brussels sprouts	Cabbage	Carrot	Cauliflower	Cucumber	Eggplant	Lettuce and Endive	Melon	Onion	Peas	Pepper	Potato	Pumpkin	Spinach	Squash	Sweet Corn	Tomato, field	Watermelon
*†Optill (*saflufenacil + imazethapyr*)	*2 & 14*																X								
*†Outlook (*dimethenamid*)	*15*		X													X			X				X		
Permit (*halosulfuron*)	*2*																						X		
Poast (*sethoxydim*)	*1*	X	X	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X
Prefar (*bensulide*)	*8*						X	X	X		X	X	X	X	X			X				X		X	X
Prowl (*pendimethalin*)	*3*	X	X	X						X						X	X	X	X				X	X	
Raptor (*imazamox*)	*2*		X	X													X								
*Reflex (*fomesafen*)	*14*		X	X																					
Reglone (*diquat*)	*22*		X																X						
Roundup WeatherMax (*glyphosate*)	*9*	X	X	X		X	X		X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X
Sandea (*halosulfuron*)	*2*	X	X	X								X	X		X			X		X		X		X	X
*Select (*clethodim*)	*1*	X	X			X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X		X	X
*†Sharpen (*saflufenacil*)	*14*																X								
metribuzin (*metribuzin*)	*5*	X								X							X		X					X	
Sonolan (*ethalfluralin*)	*3*		X																						
*Spin-Aid (*phenmedipham*)	*5*					X															X				
*†Stinger (*clopyralid*)	*4*					X	X	X	X		X										X		X		
Strategy (*ethalfluralin + clomazone*)	*13*											X			X					X		X			
Treflan (*trifluralin*)	*3*	X	X	X			X	X	X	X	X						X	X	X				X	X	
(*2,4-D*)	*4*	X																					X		

[1]Modes of action:

1= Inhibitors of acetyl CoA carboxylase (ACC) (graminicides)
2=Inhibitors of acetolactate synthase (ALS/AHAS) (sulfonyl ureas)
3=Inhibitors of microtubule assembly (dinitroanilines)
4=Synthetic auxins (growth regulators) (e.g. 2,4-D)
5=Inhibitors of photosystem II Site A (triazines)
6=Inhibitors of photosystem II Site B (bentazon, bromoxynil)
7=Inhibitors of photosystem II Site A-II (ureas)
8=Inhibitors of lipid synthesis (thiocarbamates)
9=Inhibition of EPSP synthase (glyphosate)
13=Inhibition of DOXP synthase (clomazone)
14=Inhibitors of Protox (diphenyl ethers)
15=Inhibition of long chain fatty acids (chloroacetamides)
19=Inhibitors of indolacetic acid (IAA) (phthalamates napthalam)
22=Inhibition of photosystem I (paraquat)
27=Inhibition of hydroxyphenyl-pyruvate-dioxygenase (HPPD) (triketones, pyrazolones)

[2] Under Special Local Needs registration.

Chapter 6 – Pesticide Information and Use

6.1 Pesticide Classification and Certification

The Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) created two classifications of pesticides – general-use and restricted-use. **General-use pesticides** may be purchased and used by anyone. **Restricted-use pesticides can** only be purchased by a certified applicator. Restricted-use pesticides must be also be used by a certified applicator or someone under their supervision.

The same federal law that classifies pesticides divided applicators into two groups: private and commercial. **Private applicators** use or supervise the use of pesticides to produce agricultural commodities or forest crops on land owned or rented by the private applicator or their employer. A farmer must be certified as a private applicator in order to purchase and use restricted-use pesticides on agricultural commodities. (No certification is needed if a farmer does not use restricted-use pesticides.)

A **commercial applicator** uses or supervises the use of pesticides for any purpose or on any property not covered by the private applicator classification. In New York, a commercial applicator must be certified to purchase or use any pesticide whether it is general- or restricted-use.

More information about pesticide certification and classification is available from your Cornell Cooperative Extension office (cce.cornell.edu/learnAbout/Pages/Local_Offices.aspx), regional NYSDEC pesticide specialist (www.dec.ny.gov/about/558.html), the Pesticide Applicator Training Manuals (store.cornell.edu/c-876-manuals.aspx), or the Pesticide Management Education Program (PMEP) at Cornell University (psep.cce.cornell.edu).

6.2 Use Pesticides Safely

Using pesticides imparts a great responsibility on the user to be a good steward of their health and that of others. Keep in mind that there is more to "pesticide use" than the application. Pesticide use includes mixing, loading, transporting, storing, or handling pesticides after the manufacturer's seal is broken; cleaning pesticide application equipment; and preparation of a container for disposal. All of these activities require thoughtful planning and preparation. They are also regulated by state and federal laws and regulations intended to protect the user, the community, and the environment from any adverse effects pesticides may cause.

6.2.1 Plan Ahead

Many safety precautions should be taken *before* you actually begin using pesticides. Too many pesticide applicators are dangerously and needlessly exposed to pesticides while they are preparing to apply them. Most pesticide accidents can be prevented with informed and careful practices. **Always read the label on the pesticide container before you begin to use the pesticide.** Make sure you understand and can follow all directions and precautions on the label. Be prepared to handle an emergency exposure or spill. Know the first aid procedures for the pesticides you use.

6.2.2 Move Pesticides Safely

Carelessness in transporting pesticides can result in broken containers, spills, and contamination of people and the environment. Once pesticides are in your possession, you are responsible for safely transporting them. Accidents can occur even when transporting materials a short distance. You are responsible for a pesticide accident so take every effort to transport pesticides safely. Be prepared for an emergency.

6.2.3 Personal Protective Equipment and Engineering Controls

Personal protective equipment needs depend on the pesticide being handled. **Required personal protective equipment (PPE) are listed on pesticide labels.** These requirements are based on the pesticide's toxicity, route(s) of exposure, and formulation. Label PPE requirements are the minimum that must be worn during the pesticide's use. Pesticide users can always wear more protection than the label requires.

The choice of protective equipment depends on the activity, environment, and handler. The type and duration of the activity, where pesticides are being used, and exposure of the handler influences the equipment you should use. Mixing/loading procedures often require extra precautions. Studies show you are at a greater risk of accidental poisoning when handling pesticide concentrates. Pouring concentrated pesticide from one container to another is the most hazardous activity. More information on personal protective equipment can be found online at umes.edu/NC170/Default.aspx?id= 7184.

Engineering controls are devices that help prevent accidents and reduce a pesticide user's exposure. One example is a closed mixing/loading system that reduces the risk of exposure when dispensing concentrated pesticides. More information on engineering controls can be found online at umes.edu/NC170/Default.aspx?id=7196.

6.2.4 Avoid Drift, Runoff, and Spills

Pesticides that move out of the target area can injure people, damage crops, and harm the environment. Choose weather conditions, pesticides, application equipment, pressure, droplet size, formulations, and adjuvants that applied over a known area. Liquid chemical application requires information on the volume (gallons) of material applied.

The equipment required to calibrate a broadcast sprayer using this technique includes a tape measure, a stopwatch, and a measuring jar graduated in ounces. Personal safety protection equipment should also be worn when working around the sprayer.

The most accurate calibrations are performed by measuring the output of each nozzle (gallons per minute, gpm), measuring nozzle pressure (pounds per square inch, psi) with a pressure gauge on the spray boom, and measuring travel speed (miles per hour, mph) in the field with the sprayer operating.

6.12.4 Travel Speed Calibration

Travel speed is a critical factor in maintaining accurate application rates and will influence spray deposition depending on location within the canopy. The slower a sprayer travels, the greater the uniformity in spray deposition. Although there is inconsistency in research results that try to determine the effect of travel speed on average spray deposition, all studies to date have been in agreement that the higher the travel speed, the greater the variability in spray deposit. Variation in spray deposit is an important factor where uniformity of spray coverage throughout the canopy is required. Conclusions from research were drawn using travel speeds of 1-4 mph.

Factors that will affect travel speed include

- weight of sprayer to be pulled
- slope of terrain
- ground conditions traveled over (wheel slippage!)

The best way to measure travel speed is to pull a sprayer with tank half filled with water on the same type of terrain that the sprayer will be operated on.

Set up test course at least 100 feet long, measure the course with a tape measure. Do not pace the distance. The longer the course the smaller the margin of error. Run the course in both directions.

Use an accurate stop watch to check the time required to travel the course in each direction. Average the two runs and use the following formula to calculate the speed in MPH.

Formula: $\text{MPH} = \dfrac{\text{ft. traveled}}{\text{sec. traveled}} \times \dfrac{60}{88}$

Your figures:

Tractor gear ___________ Engine revs.___________

MPH = ft. traveled x 60/88 = sec. traveled

6.12.5 Boom Sprayer Calibration

Step 1. Record your tractor sprayer speed from above
MPH = _______________

Step 2. Record the inputs

	Your Figures	Example
Nozzle type on your sprayer (all nozzles must be identical)	____________	11004 flat fan
Recommended application volume GPA(from manufacturer's label)	____________	20
Measured sprayer speed	____________	4 MPH
Nozzle spacing	____________	20 inches

Step 3. Calculate the required nozzle output

Formula: $\text{GPM} = \dfrac{\text{GPA x mph x nozzle spacing}}{\text{5940 (constant)}}$

Example: $\text{GPM} = \dfrac{20 \text{ x } 4 \text{ x } 20}{5940} = \dfrac{1600}{5940} = 0.27 \text{ GPM}$

Your figures: GPM= ___x___x___ / 5940 = _____ / 5940 = GPM

Step 4. Operate the sprayer

- Set the correct pressure at the gauge using the pressure regulating valve
- Collect and measure the output of each nozzle for one minute
- The output of each nozzle should be approximately the same as calculated in Step 3 above
- Replace all nozzle tips more than 10% inaccurate

6.12.6 Banded Boom Sprayer Calibration

The only difference between the boom sprayer calibration mentioned above and calibrating for a banded sprayer is the input value used in the formula in Step 3.

For a single nozzle banding applications:

Nozzle spacing = sprayed band width or swath width (in inches)

For multiple nozzle directed applications:

Nozzle spacing = row spacing (in inches) divided by the number of nozzles per row.

Minimally, vegetable sprayers should be calibrated at the beginning of the spraying season. Accuracy is important to

Chapter 8 – Soil Management

8.1 Soils and Fertility

Fertility management is part of overall soil management involving proper tillage practices, crop rotation, cover crops, water management (irrigation and drainage), liming, and weed management. Although it is important in obtaining maximum economic yields, fertilization alone will not overcome shortcomings in the other areas mentioned above. Such problems should be corrected first so as to benefit fully from organic and inorganic fertilizer supplements and to sustain high yields and quality over the long term. Information on Soil Testing, Soil pH and Fertilizers is below in sections 8.8, 8.9 and 8.10.

8.2 Field and Soil Evaluation

Plan ahead when selecting new lands or fields. Soils for growing vegetables should be well drained, fairly deep, reasonably level, properly limed, and in good tilth (have good structure). Medium-textured soils (sandy to silty loams with good organic-matter content) are generally most satisfactory; well-drained, sandy soils with a slight to moderate southern slope are most favorable for early plantings and certain warm-season vegetables. For a summary of soil types and soil management groups in New York State, please see the general information section of the Cornell Guide for Integrated Field Crop Management. Detailed soil survey maps are available through local Cornell Cooperative Extension, NRCS and SWCD offices. For the soil types in your fields search online: *Web Soil Survey* from USDA-NRCS. After determining whether the soil is suitable, check for perennial weeds, correct pH, and soil nutrient levels before planting.

8.2.1 Soil Health

Soils in good health provide a desirable medium for root development, have pore space for both air and rapid percolation of excess water, have a high water-holding capacity so crops can withstand dry periods, are less prone to erosion, and resist the tendency to crust. Healthy soils have low levels of soil-borne disease organisms, and high levels of beneficial soil organisms. Many agricultural practices cause soil structure to deteriorate. Compaction, which results from the use of equipment on wet soils, is particularly damaging. Tillage tools break down soil aggregates, the tiny, basic building-blocks of good soil structure; intensive cultivation accelerates loss of organic matter and causes soil to crust. Obviously, all unnecessary operations should be avoided. Prepare the soil only enough to provide an adequate seedbed. Never plow, till, plant, or cultivate soils when they are wet. A ball of soil which crumbles when pressed with the thumb is likely dry enough. One mistake can reduce the yield of the crop regardless of the level of other inputs. For detailed information on soil health and the Cornell Soil Health Test search online: *Cornell Soil Health.*

8.3 Crop Rotation

Vegetable crops within the same plant family (crucifers, legumes, vine crops, Solanaceous crops, etc.) tend to share the same diseases. As a rule of thumb, don't include that plant family more than once every three years in the rotation. Include cover crops in the same family as well.

Rotation with forage, hay, and cereal crops is an effective way to maintain the organic matter and structure of soils used primarily for vegetables. A good stand of legume or grass-legume sod can also provide substantial nitrogen upon decomposition, thus reducing the nitrogen fertilizer requirement for the next vegetable crop planted. Grass and/or legume sods have a place in the rotation to maintain the porosity of fine-textured soils, improve the water-holding capacity of coarse soils, and may reduce the buildup of disease, insect, and weed pests. Note: All legumes, whether crops or cover crops, share many of the same diseases.

8.4 Cover Crops

Cover crops are planted to protect and improve the soil, suppress weeds and diseases, and help cycle nitrogen. Integrating cover crops into vegetable production systems offers many benefits, but provides some challenges as well. For cover cropping to be successful, it is important to know the intended purposes, consider key management factors, and understand the characteristics of different cover crop species.

Cover crops offer a way to add organic matter to soils; improve soil tilth and reduce compaction; protect soil from wind and water erosion; add or recycle plant nutrients; increase the biological activity of soil; retain soil moisture; and in some cases, suppress weeds and diseases. No single cover crop can do all of these things. Matching the need and opportunity to the right cover crop requires information and planning.

Cover crops need to be treated with the same care as cash crops in order to get the intended value. The best success will come with practices that favor a fast start, and that leave no gaps in the stand. These include: sufficient temperature, soil moisture, and soil fertility; practices such as preparing an adequate seedbed by drilling seed or broadcasting and cultipacking; inoculating legume seed with the proper *Rhizobium* inoculant; and, correcting pH or soil fertility problems. In some cases escaped weeds must be controlled with herbicides or by mowing the cover crop in midseason.

Cover crops must also be killed on time. Before planting, know when and how the cover crop will be killed, and have access to the means of termination. Cover crops that are killed too soon don't deliver the benefit for which they were planted. If killed too late, they can reseed, leave clumps that insufficient time for an adequate reaction with the entire plow layer, a split application is recommended. At least half of the recommended lime should be added to the surface and disked in before seeding to provide a pH favorable for good seedling establishment in the zone near the seed. When soils require more than four tons per acre, split the lime application by plowing one-half down and disking the remainder into the surface. Smaller lime applications to maintain pH above 6.0 can be made anytime before seeding and can either be applied to the surface or plowed down. When rotations are used, the last summer or fall that a field is in sod is a good time to apply smaller maintenance applications of lime. At this time the soil is firm, and lime can be applied with less likelihood of soil compaction.

8.10 Fertilizers

8.10.1 Nitrogen, Phosphorus, and Potassium

Although necessary for high-yielding crop production, fertilizer nutrients can escape from the agricultural system, thereby increasing the potential for environmental damage. Nutrients escape in various ways depending on the chemical and biological nature of the element involved. Obviously, this escape can be accelerated if fertilizers are added in excess of plant requirements or if they are applied or otherwise handled improperly.

Regardless of the chemical form added, nitrogen can convert rapidly to nitrate; in this form it does not bind to the soil but rather moves downward with water as the water moves through the soil. Thus, excessive nitrate-nitrogen poses a threat to the quality of ground water. Nitrogen is also lost to surface water as soils erode, removing soil organic matter.

Using nitrogen efficiently is probably the biggest challenge in fertility management. Vegetables are responsive to nitrogen, and no one wants to risk inferior yield or quality because of a deficiency. However, it is difficult to accurately determine the nitrogen contributions from soil organic matter, manure, or incorporated legumes because temperature and moisture can play a significant role. Also, sources of nitrogen convert to nitrate-nitrogen when conditions are optimal for plant growth, and in this form nitrogen moves with water and can be leached out of the system.

Guidelines for efficient use of nitrogen.

1. Limit nitrogen applications prior to planting, and avoid deep plow-downs.
2. Band either at planting or as a sidedressing to apply nitrogen most efficiently.
3. Apply nitrogen close to the time the crop is most active in taking it up.
4. Avoid “insurance” applications of nitrogen.
5. Maintain the proper pH.
6. Use plastic mulch to limit leaching and facilitate nitrogen release from nonfertilizer sources.
7. Avoid over fertilization which will lead to leaching.
8. Account for nitrogen from organic matter, cover crops, composts, manure, etc., which becomes available as the soils warm.
9. Consider using the pre-sidedress soil nitrate test (PSNT) to determine nitrogen contributions from nonfertilizer sources.
10. Use cover crops to retain nitrogen and other nutrients and limit leaching.

Phosphorus is usually tightly bound to soil particles with only small amounts in the soil water. Phosphorus may also occur in organic soil materials, some of which are water soluble. Most phosphorus loss is attributable to surface runoff and soil erosion. Techniques that help prevent nutrient loss to the environment include prevention of soil erosion, avoidance of overfertilization or insurance applications, and timing and placement of fertilizer applications in a manner to achieve efficient plant uptake.

Fertilizers are applied to improve plant growth by providing nutrients not adequately supplied by the soil. When the soil contains enough of a particular nutrient to support optimal plant growth, there is no need to supply additional quantities of that nutrient. See Section 8.8 on soil testing. The most common nutrients in commercial fertilizers are nitrogen (N), phosphorus (P), and potassium (K). Phosphorus and potassium are shown on fertilizer labels as the oxides P_2O_5 and K_2O, respectively. For conversion multiply P_2O_5 by 0.44 to get P, and multiply K_2O by 0.83 to get K. Calcium (Ca) and magnesium (Mg) are usually supplied by liming. See Section 8.9 on lime recommendations. New York soils in the proper pH range are not usually deficient in minor nutrients. See Section 8.10.2 for more details on minor nutrients.

Some common fertilizer materials and their analyses are given in Table 8.10.1. The materials shown in the table are used both for direct application to the soil and for the manufacture or blending of other complete fertilizers. Materials providing secondary nutrients and micronutrients are listed in Table 8.10.2.

8.10.2 Secondary Nutrients and Micronutrients

The secondary nutrients - calcium (Ca), magnesium (Mg), and sulfur (S) - are as important for normal growth as the primary nutrients but either are not required in large quantities or are usually supplied through means other than fertilizers. Micronutrients, often referred to as minor elements, include boron, zinc, manganese, copper, molybdenum, and iron. They are as important to normal plant growth and reproduction as are the primary and secondary elements. The difference is that micronutrients are required in small amounts because crops remove less than a pound per acre (less than an ounce per acre of some elements). Micronutrients are seldom deficient in New York soils when the pH is between 6.0 and 6.5 on upland

Chapter 13 – Beans – Dry, Snap, and Lima

13.1 Recommended Varieties

Dry beans. Consider the following varieties for the indicated dry bean classes. All have canned well in our trials: *Light Red Kidney* - CELRK, Chinook 2000, Pink Panther, Wallace; *Dark Red Kidney* - Cabernet, Montcalm, Red Hawk; *Black Turtle Soup* - Black Knight, Black Velvet, Eclipse, Midnight, Shania, T39, Zorro.

Snap bean varieties. Listed in order of maturity within each class.

Table 13.1.1 Recommended bean varieties

Fresh-market green	Flat Pod – Italian
Valentino	Roma II
Caprice	Furano
Prevail	Dulcina
Inspiration	
Ambition	**Fresh-market wax**
Frontier	Gold Mine
Wyatt	Eureka
Lewis	
	Processing
	Use varieties recommended by processors

13.2 Planting Methods

Dry beans should be planted between May 20 and June 20. Insecticide-fungicide seed treatments assist early dry bean plantings, but best germination occurs at soil temperatures of 60°F or above. When weather and soil conditions permit, late-May and early-June plantings often yield as much or more than plantings made in mid-June or later. Optimal germination of snap bean seed occurs at soil temperatures of 75° to 80°F. The minimum temperatures at which snap bean germination will occur are 55° to 60°F. For recommended spacing of dry and snap beans, see Table 13.2.1. Bean seed is sensitive to chilling during the initial stage of germination, which is referred to as imbibition. If the soil is cold at this time, permanent damage may occur. If, however, imbibition occurs under warm injury when planted in cold soil. It is particularly susceptible conditions, the seed can later tolerate cool soil temperatures and still germinate normally. The most critical period is the first 24 hours after planting. Seed with low vigor is especially sensitive to chilling injury, and dry seed is injured more easily than seed with a higher moisture content. Increasing the moisture content of the seed by placing it in an environment of high relative humidity for several days before planting can help minimize injury.

Planting dates for fresh-market and processing snap beans are May 1 to July 25. The crop matures in 50 to 60 days, depending on the specific variety and desired pod size. Only western-grown, certified, dry and snap bean seed should be planted.

A good rotation helps reduce the incidence of foliar diseases and lowers the population of plant pathogens that cause root rot. Corn and cereal grains are excellent rotation crops. If a field with a previously noted root rot problem is to be planted to beans, plant as late as possible in the season when the soil is warm. To allow for adequate aeration and drainage of excess moisture, avoid compacting the soil. Planting on raised beds or ridges will help reduce root rot severity because the soil will be warmer and drier than the unridged soil. Seed should be treated with recommended fungicides.

Dry beans are not usually irrigated because of the lower cash value of the crop relative to the cost for irrigation. Nevertheless, one or two well-timed irrigations near blossom set and early pod fill can increase yields significantly if the crop is undergoing drought conditions.

A deficiency of water in the plant resulting from a lack of soil moisture or excessive transpiration can lead to deformed or pithy snap bean pods. Both yield and quality can be increased by irrigation before bloom and during pod enlargement if there is moisture stress. Irrigation during bloom with irrigation guns that produce large droplets is not advised because blossoms can be knocked off the plant.

13.3 Fertility

Use lime to maintain a pH of 6.0 to 6.5. See Table 13.3.1 for the recommended rates of nitrogen, phosphorus, and potassium.

Table 13.2.1 Recommended spacing of dry and snap beans.

Type of bean	Row (in inches)	In-Row (plants/foot)	Comments
Dry	28-32"	4-6	Because seed size varies greatly between varieties, make sure the proper amount is planted. Red kidney classes require 75 to 100 pounds per acre, whereas black turtle soup and navy/pea beans run at 35 to 40 pounds per acre. Adjust the plant rate for the percentage of germination.
Snap	30-36"	5-7	If closer row spacing and a higher plant population per acre is used, a proportionately higher rate of fertilizer should be applied.

13.5.6 Sclerotinia white mold, *Sclerotinia sclerotiorum*

Time for concern: From open blossoms through the end of harvest
Key characteristics: The fungus will initially attack bean blossoms as blossoms are a readily available source of food. Symptoms appear as white, fluffy cottony growth on blossoms, stems and pods. As the fungus grows, mounds of white mycelium harden and darken. These dark, black structures become sclerotia which enable the fungus to overwinter. Bean *blossoms* are an excellent source of nutrients for the fungus. Therefore control measures must be initiated at bloom. See Reference 6.

Management Option	***Guideline***
Scouting/thresholds	Follow the white mold forecasting system in Reference 3. Begin spray applications at early bloom.
Note(s)	White mold tends to develop in dense, plant canopies. The disease tends to be worse in fields where leaves have mechanical damage or pesticide injury, weedy fields, and where dead leaves are on the ground. The fungus can grow on dead and living material. White mold tends to develop when wet weather is persistent.
Coverage	The best coverage can be obtained by using high gallonage (50 gallons per acre minimum) and high pressure (100 to 200 psi). Use three nozzles per row mounted eight to ten inches above the plants and angled toward them. Fungicide sprays must be directed to the blossoms to obtain good control.
Resistant varieties	No resistant varieties are available, however plant architecture influences disease development. Select varieties with open canopies that hold pods high off the ground.
Crop rotation	If there is a field history of white mold, beans should not be preceded by a bean, tomato, potato, lettuce, or crucifer crop. Grains and corn are good rotation crops.
Site selection	Avoid planting in shaded areas and in small fields surrounded by trees; do not plant in fields that drain poorly or have a history of severe white mold.
Planting	Plant rows in an east-west direction and use wide row spacing, 36 inches, to promote drying of the soil and reduce moisture in the plant canopy.
Fertilization	Avoid over fertilization.
Postharvest	Incorporate crop debris immediately following harvest to allow soil microorganisms the opportunity to feed on the survival structures called sclerotia or degrade disease organisms/overwintering structures.
Seed selection/treatment, and Sanitation	These are not currently viable management options.

Compound(s)

Common name **(Group no.)** Trade name	Rate/A Product	PHI (days)	REI (hours)	Field Use EIQ	Comments
***boscalid* (dry, snap, and lima beans) (Group 7)**					
Endura 70 WDG	8-11 oz	7 Succulent 21 Dry	12	9.2-12.7	Begin application of Endura at flowering or prior to the onset of disease. Do not make more than 2 applications per season.
***Coniothyrium minitans* (dry beans) (Group NC)**					
Contans WG	1-4 lb/A 3-6 lb/A	0	4	0.4-1.4 1.1-2.1	See comments below.

Use higher rate range when equipment will incorporate deeper than 2 inches. This biological fungicide (a mycoparasite) has been tested in several states including New York, Canada, and overseas. The fungicide reduces the number of overwintering structures of *Sclerotinia* called sclerotia in the soil. Contans must be in contact with sclerotia to kill them, so excellent coverage to soil or debris is essential. Contans requires 3 to 10 weeks to effectively colonize and destroy sclerotia. Apply Contans to a *Sclerotinia*-infected crop immediately following harvest and incorporate the debris into the soil and/or apply to soil at time of planting followed by shallow incorporation (or irrigate) to about a 1 to 2 inch depth. It may be tank mixed with many herbicides. Do not turn the soil profile after application of Contans. This will avoid bringing untreated soil that contains viable sclerotia near the surface. Where disease pressure is high, it may be necessary to apply Contans for at least 3 to 4 years to reduce soil levels of sclerotia or every year a susceptible crop is grown in that field; and also to apply other fungicides at bloom to control infection from wind-dispersed spores from unmanaged sclerotia in or near the field. Since the active ingredient is a living organism, Contans needs to be stored in a dry, cool (about 39 F) location (refrigerated in a sealed bag is suitable).

Seedcorn maggot *(continued)*

Compound(s) ***Common name*** **(Group no.)** Trade name	Rate/A Product	PHI (days)	REI (hours)	Field Use EIQ	Comments
SEED TREATMENT					
🐝*thiamethoxam* **(Group 4A)**					
ΔCruiser 5FS (seed treatment) 5 lb/gal	1.28 fl oz/ 100 lbs of seed	–	12	1.3 per 100 lbs of seed	See comments below.
Our research has shown that this rate should protect snap bean and dry bean under low to normal pressure. Situations where infestations may be high are in green or animal manure amended soil and prolonged cool and wet conditions.					

** For fungicide seed treatments, see Section 13.5 Disease Management. 🐝 Active ingredient meets EPA criteria for acute toxicity to bees.

13.6.2 Potato leafhopper (PLH), *Empoasca fabae* (Affects both dry and snap beans)

Time for concern: Early June through early August. Plant emergence through prebloom.

Key characteristics: The adult is wedge-shaped, iridescent green in color, and 1/8 inch long. The body is widest at the head. Eggs are laid singly on the underside of leaves. Both adults and nymphs are very active, running forwards, backwards, or sideways. Infested plants may be stunted and have symptoms caused by feeding termed "hopperburn." The first sign of hopperburn is whitening of the veins. These areas become flaccid and yellow in color, then desiccate, turn brown, and die. Leaf curling is also very common. The entire process takes four to five days. See Reference 10 or http://web.entomology.cornell.edu/shelton/veg-insects-ne/pests/plh.html.

Management Option	***Guideline***
Scouting/thresholds	Potato leafhoppers migrate from the southern US each year in April and May. Check for the presence of adult potato leafhoppers by using a sweep net or by placing yellow, sticky traps near field edges. Nymphs are best sampled by visual examination of the undersides of leaves on the lower half of the plant. Bean yields are most likely to be reduced by potato leafhoppers if damage occurs before bloom. **In ΔCruiser-treated fields:** a foliar treatment rarely should be needed before bloom, but may be needed after bloom if pressure is high. ONLY the presence of nymphs indicates that ΔCruiser is no longer working. Adults may be commonly observed on plants early in the season, but they are rarely feeding. This is because ingestion of ΔCruiser causes a cessation in feeding. **In non-ΔCruiser-treated fields:** during prebloom, treat when more than one nymph per trifoliate leaf is found or when the number of adults exceeds 100 per 20 sweeps. On newly emerged beans, lower densities of leafhoppers than those mentioned above may be damaging. See References 3 and 18.
Natural enemies	Although a variety of natural enemies of potato leafhoppers have been reported, their impact on infestations is not well known. Use Reference 9 or https://biocontrol.entomology.cornell.edu/index.php for identification of natural enemies.
Resistant varieties	None available.
Crop rotation, Site selection, Postharvest, and Sanitation	These are not currently viable management options.

Compound(s) ***Common name*** **(Group no.)** Trade name	Rate/A Product	PHI (days)	REI (hours)	Field Use EIQ	Comments
SEED TREATMENT					
🐝*thiamethoxam* **(Group 4A)**					
ΔCruiser 5FS (seed treatment) 5 lb/gal	1.28 fl oz/ 100 lbs of seed	–	12	1.3 per 100 lbs of seed	See comments below.
Our research has shown that this rate should protect snap bean and dry bean through the bloom stage; a foliar insecticide application may be needed before bloom only if pressure is **high** (> 1 nymph per leaf) or after bloom if potato leafhopper pressure is **high** (>1 or 2 nymphs per leaf).					

Compound(s) *Common name* (Group no.) Trade name	Rate/A Product	PHI (days)	REI (hours)	Field Use EIQ	Comments
***zeta-cypermethrin* (Group 3A)**					
*Mustang MAXX 0.8 lb/gal	2.8-4 fl oz	21	12	0.0.5-0.9	

*Restricted-use pesticide. †Not for use in Nassau/Suffolk Counties ΔRate or other application restrictions. See label.
Active ingredient meets EPA criteria for acute toxicity to bees.

13.6.9 Slugs

Time of concern: Early spring and fall. Plant emergence through harvest.
Key characteristics: Adult slugs are between one and two inches in length. Slugs can overwinter at any stage of development. Although slugs cannot survive prolonged subzero temperatures or desiccation, the burrows of small mammals and worms provide insulation. Slugs begin to move, hatch, feed, and lay eggs in the spring when temperatures are consistently above 40°F. There is often little or no slug activity in the field during periods of dry weather; however, there may be extensive feeding in damp areas. See http://hdl.handle.net/1813/42372, http://hdl.handle.net/1813/42359, http://hdl.handle.net/1813/42370, http://hdl.handle.net/1813/42387.

Management Option	*Guideline*
Scouting/thresholds	Record the occurrence and severity of slug damage. No thresholds have been established.
Resistant varieties	No resistant varieties are available.
Site selection/planting, Crop rotation, Post-harvest, and Sanitation	Practices that help dry the soil surface (e.g. conventional tillage and good weed control) will reduce slug populations.
Pesticides	Not available

13.7 Weed Management

Key characteristics: Weed fact sheets (http://nysipm.cornell.edu/factsheets/weeds/default.asp) provide a good color reference for common weed identification. See Reference 15. See Chapter 4 for information on scouting/thresholds, site selection, cultivation, and banding of herbicides.

Management Option	*Guideline*
Scouting/thresholds	Weeds may be unevenly distributed over a field. Localized areas of severe weed infestations or atypical conditions, such as poorly drained areas, high spots, and field edges, may be recorded on a weed map. A weed map should be on file for each field. Make a rough sketch of the field, including landmarks, boundaries, crop row direction, compass directions, roads, planting date, map preparation date, and any other important details. The following information should be indicated on the map: species of weed, size of weed, density of each species, and distribution of weed. Scout fields two to three weeks after planting to evaluate the success of the current season's program and at or near harvest to help predict weed control practices that will be necessary for the following year.
Site selection	Refer to weed maps to avoid problem weeds when choosing fields for beans.
Cultivation	Cultivation can be useful in bean weed control. See IPM Fact Sheed 102FSNCT on mechanical weed control (www.vegetables.cornell.edu/weeds/newcultivationmech.pdf). Also see SARE Sustainable Agriculture Network Handbook Series Book 2 "Steel in the Field: A Farmer's Guide to Weed Management." (www.sare.org/publications/steel/steel.pdf)
Banding herbicides	Banding of herbicides at planting is useful in bean production where cultivation is possible. Herbicide banding can result in up to 60 percent savings in herbicide costs. Contact CCE for more information.

Compounds: (*Listed from earliest to latest application timing.*)

TIMING KEY: PPI = pre-plant incorporated; PreE = pre-emergent; PostE = post-emergence

Timing			
PPI	**PreE**	**PostE**	**PRODUCT NAME** (*active ingredient, weight of active per unit of herbicide, group number*) *Notes*
X			**EPTAM 7-E** (*EPTC, 7 lb/gal, group 8*) *Weeds Controlled:* **In dry and snap beans only:** grasses and broadleaves, except galinsoga, ragweed, and mustard

Compounds: (*Listed from earliest to latest application timing.)*

TIMING KEY: PPI = pre-plant incorporated; PreE = pre-emergent; PostE = post-emergence

PPI	PreE	PostE	**PRODUCT NAME** (*active ingredient, weight of active per unit of herbicide, group number*) / *Notes*
			EPTAM 7-E *(continued)* *Rates (per acre):* 3.5-4.5 pt *AI per acre (lbs/acre):* 3.1-3.9 *PHI (days):* – *REI (hours):* 12 *Field Use EIQ:* 28.9-37.1 *Comments:* **Dry and snap beans only.** Apply and incorporate into the soil immediately. Treating and incorporating 7-10 days ahead of planting and then reworking the soil immediately before seeding may give improved control. Less effective in cold, wet soils or when heavy rains occur 1 or 2 days after spraying.
X			**EPTAM 7-E + TREFLAN HFP** (*EPTC, 7 lb/gal, group 8 + trifluralin, 4 lb/gal, group 3*) *Weeds Controlled:* **In dry and snap beans only:** Redroot pigweed *Rates (per acre):* 2.5-3.5 pt (Eptam) + 1-1.5 pt (Treflan) *AI per acre (lbs/acre):* 2.2-3.1 + 0.5-0.75 *PHI (days):* – *REI (hours):* 12 *Field Use EIQ:* 20.6-28.9 (Eptam); 8.1-12.1 (Treflan) *Comments:* **Dry and snap beans only.** This tank mix combination is often more effective for the control of redroot pigweed than either chemical used alone. Follow soil incorporation procedures for Eptam.
X			**PROWL 3.3EC** (*pendimethalin, 3.3 lb/gal, group 3*) *Weeds Controlled:* velvetleaf *Rates (per acre):* 1.2-3.6 pt *AI per acre (lbs/acre):* 0.5-1.5 *PHI (days):* – *REI (hours):* 24 *Field Use EIQ:* 13.6-40.7 *Comments:* Must be incorporated shallowly. Do not apply preemergence because serious crop injury may result. For best results use with Eptam. No single chemical or combination is totally effective. Do not plant wheat or barley within 120 days or red beets within 12 months of application.
X			**PROWL H_2O, SATELLITE HYDROCAP** (*pendimethalin, 3.8 lb/gal, group 3*) *Weeds Controlled:* velvetleaf *Rates (per acre):* 2-3 pt *AI per acre (lbs/acre):* 0.95-1.4 *PHI (days):* – *REI (hours):* 24 *Field Use EIQ:* 23.4-35.1 *Comments:* Note that rates vary depending on soil texture. Consult label for details.
X			**SONALAN HFP** (*ethalfluralin, 3 lb/gal, group 3*) *Weeds Controlled:* **In dry beans only:** broadleaves and grasses *Rates (per acre):* 1.5-3 pt *AI per acre (lbs/acre):* 0.56-1.13 *PHI (days):* – *REI (hours):* 24 *Field Use EIQ:* 12.4-27.4 *Comments:* **Dry beans only**. Where 3 pints of Sonalan are applied, there is a 13-month crop rotation restriction for planting red beets.
X			**TREFLAN HFP** (*trifluralin, 4 lb/gal, group 3*) *Weeds Controlled:* grasses and broadleaves, except galinsoga, mustard, and ragweed *Rates (per acre):* 1-1.5 pt

Appendix

Table 1. Herbicides mentioned in this publication

Trade Name	Common Name	Formulation	EPA Reg. No.
*†AAtrex 4L	atrazine	4 L	100-497
*†AAtrex NINE-O	atrazine	90 DG	100-585
Accent	nicosulfuron	75 DF	352-560
Aim 2EC	carfentrazone	2.0 EC	279-3241
Assure II	quizalofop p-ethyl	0.88 EC	352-541
*Atrazine 90WDG	atrazine	90 W	34704-622
*Atrazine 4L	atrazine	4 L	34704-69
Balan	benefin	60 DF	34704-746
Banvel	dicamba	4 L	66330-276
Basagran	bentazon	4 L	7969-45-66330
Broadloom	bentazon	4 L	70506-306
Buctril	bromoxynil	2 EC	264-437
Callisto	mesotrione	4SC	100-1131
Caparol 4L	prometryn	4 L	100-620 (SLN NY-140007)
Chateau SW	flumioxazin	51 WDG	59639-99
Clarity	dicamba	4 EC	7969-137
Command 3 ME	clomazone	3 ME	279-3158
Curbit EC	ethalfluralin	3 EC	34704-610
Devrinol 50-DF	napropamide	50 DF	70506-36
*†Dual Magnum	metolachlor	7.62 E	100-816
*†Dual II Magnum	metoachlor	7.64 E	100-818
Eptam 7-E	EPTC	7 E	10163-283
Formula 40	2,4-D	3.8 L	228-357
†Fusilade DX	fluazifop-butyl	2 EC	100-1070
Goal 2XL	oxyfluorfen	2 E	62719-424
Goaltender	oxyfluorfen	4 F	62719-447
Gramoxone Inteon	paraquat	2 EC	100-1217
*†Harness Herbicide	acetochlor	7 EC	524-473
Impact	topramezone	2.8 L	5481-524
*Karmex DF	diuron	80 DF	352-692
*Kerb 50-W	pronamide	50 W	62719-397
Laudis	tembotrione	3.5 EC	264-860
Lorox DF	linuron	50 DF	61842-23
Matrix	rimsulfuron	25 DF	352-556
Moxy 2E	bromoxynil	2 E	9779-346
*†Nortron SC	ethofumesate	4SC	264-613 (SLN NY-120014)
*†Optill	saflufenacil + imazethapyr		7969-280
Option	foramsulfuron	25 G	264-685
*†Outlook	dimethenamid-p	6 EC	7969-156
Permit	halosulfuron	75 DF	81880-2-10163
Poast	sethoxydim	1.5 E	7969-58
Prefar 4-E	bensulide	4 E	10163-200
Prowl 3.3 EC	pendimethalin	3.3 EC	241-337
Prowl H2O	pendimethalin	3.8 CS	241-418
*†Pursuit	imazethapyr	2EC	241-310
Raptor	imazamox	1 AS	241-379
*Reflex	fomesafen	2L	100-993 and SLN NY 130006
Roundup WeatherMAX	glyphosate	5.5 L	524-537
Sandea	halosulfuron	75 DF	81880-18-10163
Satellite HydroCap	pedimethalin	3.8 ME	70506-230
*ΔSelect Max	clethodim	.97 L	59639-132