2020
Cornell Guide for Integrated Field Crop Management

Cornell Cooperative Extension

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

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Authors

Jenn Thomas-Murphy (Soil and Crop Sciences Section; *contact editor*)

Gary Bergstrom (Plant Pathology and Plant-Microbe Biology Section; *disease management*)

Jerry Cherney (Soil and Crop Sciences Section; *forage production/variety selection*)

Jaime Cummings (New York State Integrated Pest Management Program; *integrated pest management*)

Karl Czymmek (Department of Animal Science; *soil fertility/nutrient management*)

Julie Hansen (Plant Breeding and Genetics Section; *forage production/variety selection*)

Michael Helms (Pesticide Management Education Program; *pesticide information)*

Michael Hunter (CCE North Country Regional Ag Team; *weed management*)

Quirine Ketterings (Department of Animal Science; *soil fertility/nutrient management*)

Joe Lawrence (PRO-Dairy Program; *silage corn hybrids*)

Murray McBride (Soil and Crop Sciences Section; *sewage sludge utilization*)

Harold van Es (Soil and Crop Sciences Section; *soil health/management*)

Robert Schindelbeck (Soil and Crop Sciences Section; *soil health/management*)

Elson Shields (Department of Entomology; *insect, slug, and nematode management*)

Margaret Smith (Plant Breeding and Genetics Section; *grain corn hybrids/small grain variety selection*)

Michael Stanyard (CCE Northwest NY Regional Ag Team; *weed management*)

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Abbreviations and Symbols Used in This Publication

A	acre	EC	emulsifiable concentrate	SP	soluble powder
AI	active ingredient	F	flowable	ULV	ultra-low volume
D	dust	G	granular	W	wettable
DF	dry flowable	L	liquid	WDG	water-dispersible granules
DG	dispersible granule	P	pellets	WP	wettable powder
E	emulsion, emulsifiable	S	soluble		

* .... Restricted-use pesticide; may be purchased and used only by certified applicators
† .... Not for use in Nassau and Suffolk Counties

Every effort has been made to provide correct, complete, and up-to-date pest management information for New York State at the time this publication was released for printing (October, 2019). Changes in pesticide registrations, regulations, and guidelines occurring after publication are available in county Cornell Cooperative Extension offices or from the Pesticide Management Education Program web site (pmep.cce.cornell.edu).

Trade names used in this publication are for convenience only. No endorsement of products is intended, nor is criticism of unnamed products implied.

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The guidelines in this bulletin reflect the current (and past) authors' best effort to interpret a complex body of scientific research, and to translate this into practical management options. Following the guidance provided in this bulletin does not assure compliance with any applicable law, rule, regulation or standard, or the achievement of particular discharge levels from agricultural land.

Cover photo: Corn silage trials have resumed and a plot was harvested at the Cornell University Ruminant Center Dairy in Harford, NY in late September 2019. *(Photo by: Joe Lawrence, Dairy Forage Systems Specialist, PRO-DAIRY Program)*

2 GENERAL INFORMATION FOR CROP PRODUCTION *(continued)*

4 FORAGE CROPS GUIDELINES *(continued)*

5 SMALL GRAIN CROPS GUIDELINES *(continued)*

1 Pesticide Information

1.1 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 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.

Information about pesticide certification and classification is available from your Cornell Cooperative Extension office (cce.cornell.edu/localoffices), regional NYSDEC pesticide specialist (www.dec.ny.gov/about/ 558.html), the Pesticide Applicator Training Manuals (https://www.cornellstore.com/books/cornell-cooperative-ext-pmep-manuals), or the Pesticide Management Education Program (PMEP) at Cornell University (psep.cce.cornell.edu).

1.2 Use Pesticides Safely

Using pesticides imparts a great responsibility on the user to protect their health and that of others and to protect the environment. Keep in mind 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 preparing a container for disposal. 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.

1.2.1 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.

1.2.2 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.

1.2.3 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.*** The required PPE are based on the pesticide’s toxicity, route(s) of exposure, and formulation. Label required PPE are the minimum that must be worn during the pesticide’s use. Pesticide users can always wear more protection than the label requires.

The type of protective equipment used depends on the type and duration of the activity, where pesticides are being used, and exposure of the handler. Mixing/loading procedures often require extra precautions. Studies show you are at a greater risk of accidental poisoning when handling pesticide concentrates. Pouring pesticide concentrates from one container to another is the most hazardous activity.

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. Consult the product label for more information on using engineering controls in place of PPE.

1.2.4 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 minimize drift and runoff hazards. See product labels for specific application and equipment requirements.

2 General Information for Crop Production

2.1 Introduction

This publication includes the most up-to-date information on growing field crops in New York, drawn from Cornell research, extension demonstrations, and on-farm experience. It has been designed as a practical guide for farmers, for merchants who provide sales and services to producers, and for others who advise them. Our aim is to supply the best information available to help those who make management decisions. We do not consider this a cookbook but rather a source of practical information to use in the development of sound planning and good management.

In any statewide publication, we must deal with a spectrum of crop environments; information and guidelines must cover general farm situations. Though we have tried to make these as specific as possible for various conditions in New York, each farmer must determine how these varieties and practices will work on his or her farm. The information in this publication should be considered general rules. Additional information is available in the publication **Cornell Field Crops and Soils Handbook**, revised in 1987 and available through Cornell Cooperative Extension offices or directly from the Section of Soil and Crop Sciences at Cornell, 607-255-2177. For further information on any topic in this booklet, you may contact your local Cornell Cooperative Extension office or write to the Section of Soil and Crop Sciences Extension Office, 237 Emerson Hall, Cornell University, Ithaca, NY 14853.

2.2 New York State Climate

2.2.1 Growing Degree Days for Corn and Soybeans

Crop plants require heat from their atmospheric environment to develop, grow, and mature. The effect of this heat is cumulative as the growing plant progresses through its life cycle.

Temperature is an indirect measure of the heat available in the atmosphere. Heat sufficient to cause growth and development in a plant is indicated when the daily mean temperature warms to a certain level, called the base or threshold temperature. Below (cooler than) this level there is essentially no growth. Different species of crop plants have different base temperatures. Corn and soybeans have a base temperature of 50°F.

The growing degree day—sometimes called a heat unit—has become a useful indirect measure of the heat available for growth and development of corn and soybeans. In the 86/50 method it is assumed that for corn and soybeans, growth increases linearly from 50°F to 86°F, at which peak growth occurs, and growth remains at peak for temperatures above 86°F. The maximum temperature for the day is set at an upper limit of 86°F, and the minimum temperature is set at the lower limit of 50º F. On each day of the growing season the crop receives a number of growing degree days equal to the number of degrees that the daily adjusted mean temperature is higher (warmer) than the 50°F base temperature. Growing degree days are then accumulated each day as the crop progresses toward maturity.

To calculate the daily growing degree days for your farm, first, determine the adjusted mean air temperature for each 24-hour day during the growing season. For a day with a high temperature of 60ºF and a low of 40ºF, for example, the low temperature would be set at the lower limit of 50ºF. The adjusted mean temperature for the day would be 55ºF. Subtracting 50ºF, the base temperature for corn and soybeans, from the mean temperature gives 5 growing degree days for that day. If, on the other hand, the high temperature for a given day is 90ºF and the low is 66ºF, the high temperature would be set at the upper limit of 86ºF. The adjusted mean temperature for the day would be 76ºF. Subtracting 50ºF, the base temperature for corn and soybeans, from the mean temperature gives 26 growing degree days for that day. On any day that the adjusted mean temperature is 50ºF or colder, the number of growing degree days is recorded as zero.

Records are kept for each day of the growing season, from the first frost-free day in the spring through the last frost-free day in the fall. By adding together the growing degree days supplied each day, the accumulated total for the frost-free growing season is determined.

The distribution of average accumulative growing degree days in New York State is presented in Figure 2.2.1. These data, applying to the freeze-free season, were determined from temperature records kept by numerous weather stations around the state during a 30-year period ending in 1980.

2.2.1.1 How to Use Growing Degree Days

Early corn hybrids and short-season soybean varieties need fewer growing degree days than late corn hybrids and long-season soybean varieties to grow and mature.

Use the map (Figure 2.2.l) to determine the growing degree days available for corn and soybean growth in your locality. You can then choose corn hybrids and soybean varieties suited to your vicinity from the groups listed in sections 3.2: Corn-Hybrid Selection and 6.1: Soybean Varieties. You may need to make adjustments to fit local differences in elevation or frost susceptibility.

Table 2.8.1. General adaptability ratings for tillage systems for row crop production by soil management group based on long-term yield potential and cost of production.

Soil Management Group		Moldboard Plow		Chisel Tillage			Ridge Tillage	Zone/Strip Tillage	No-Tillage
		fall	*spring*	*fall*	*frost*	*spring*			
Group IA,B	clays and silty clay loams	2	2-3	2-3	2-3	2-3	1	2	4
Group IIIB	heavy silts with fragipan	4	2	2	2	3	2	3	4
Group IIA,B	silt loams	3	3	3	2	2	2	2	4
Group IIC	silt loams	5	2	4	3	2	3	1–2	2
Group IIIA	coarse sands and gravels	5	2	4	2-3	2	3	1	2
Group IV	sands and coarse loams								
Group V	sands and gravels								

Notes:
- 1 = highly adapted, 5 = poorly adapted
- Ratings do not include environmental concerns. These should be evaluated separately based on site-specific information.
- Relative rankings apply only within a row.
- Adaptability of reduced-tillage systems may be lower when soils are severely compacted or poorly drained.
- No-, strip, zone, and ridge tillage generally perform better in strict corn-soybean rotations.

recommended for establishment of small grains and perennial forages. Such drills are also a preferred tool for establishing cover crops.

2.8.6.2 Maximum Surface Cover

Relative soil loss decreases rapidly with increasing surface residue levels (Figure 2.6.2) and protects the soil from heat and temperature extremes. The amount of residue left on the soil surface after tillage is affected by the amount of residue produced (crop type, yield, harvesting method), overwintering, and the type and number of tillage passes. Table 2.8.2 may be applied to estimate residue levels from various field operations and weathering by multiplying the remaining percentages of residue for each tillage pass, starting with the initial residue levels. For example, assuming 80 percent residue cover after corn harvest for grain, a typical residue level after planting may be:

> 80% (initial) x 90% (overwintering) x
> 70% (spring chisel with straight points) x
> 60% (finishing disk, light setting) x
> 85% (planter with fluted coulters) =
> 25.7% final residue cover

Residue cover may be field estimated by using the Natural Resources Conservation Service (NRCS) “line-transect method.” It involves a measuring tape that is laid out over the soil surface in representative areas. Residue cover is assessed by counting the relative number of tape 1-foot marks that lie directly over a piece of residue. For more information on this method, contact your local NRCS office.

2.8.6.3 Minimum Tillage Intensity and Energy Use

Fuel costs and air pollution from diesel consumption for tillage should be minimized for economic and environmental reasons. Intensive tillage also increases organic matter oxidation, contributing to soil degradation and carbon dioxide emissions into the atmosphere. On lands with complex topography, intensive tillage increases soil translocation and loss of topsoil on the upper slopes. More than one secondary tillage pass often cannot be justified in row crops when using a conservation planter.

2.8.6.4 Optimal Timing

If tillage or planting is performed when the soil is too wet, i.e., its consistency is above the plastic limit (Figure 2.7.2), then cloddyness and poor seed placement may result in poor stands. Therefore, it is always recommended to do the ball test (Section 2.7) on soil from the lower part of the plow layer to ensure that field conditions are right. Tillage is also not recommended when the soil is too dry because it may be hard, especially when compacted, and create excessive dust.

Fall tillage is generally not recommended for row crops except (1) on high-plasticity soils such as clays and clay loams that do not dry sufficiently in the spring, (2) when soils are severely compacted and would then benefit more from freeze-thaw action, (3) for deep tillage, or (4) when used to establish a fall-seeded (cover) crop. In all cases, fall tillage must be evaluated against erosion concerns, and both surface roughness and residue cover should be maximized. Frost tillage provides an alternative to fall tillage that allows for some of its benefits but reduces the erosion

3 Corn Guidelines

High-yielding corn requires moderately well-drained or well-drained soil with a pH above 6.0 as well as timely and skillful management practices. Management practices to consider carefully include planting techniques, hybrid selection, fertilization, and control of insects, weeds, and diseases. Correct management of all these practices is essential for maximum economic yield.

3.1 Planting Techniques

Early planting usually, but not always, results in maximum corn yields. Under central and western New York conditions, corn planted in late April or early May typically out yields either grain or silage corn planted after mid-May (Figure 3.1.1). Early-planted corn also matures earlier, resulting in lower moisture and grain drying costs at harvest, and lodges less. A general guideline for the best time to begin planting corn is about 10 days before the average date of the last 32°F temperature in the spring. If soil conditions are too wet at this time, wait until soil conditions improve. Corn planted in late May under dry soil conditions will consistently out yield corn planted in late April under wet soil conditions. Conversely, if it is warm and dry any time after April 15th in central/western NY, corn growers should be ready to begin planting. Modern corn hybrids tolerate cold soil conditions and seed treatments protect corn from soil pest problems under extended emergence time due to cold soil temperatures. Planting depths of about 1.5 inches for silty clay or clay loam soils and 1.75 to 2.0 inches for silt loam and gravelly loam soils are recommended for April or early May-planted corn. Planting depths of about 1.75 to 2.0 inches for silty clay or clay loam soils and 2.0 to 2.5 inches for silt loam and gravelly loam soils are recommended for most planting dates in May. If soil conditions are dry in the top 2 inches in late May and early June, corn can be safely planted to a depth of 3 inches on silt loam and gravelly loam soils.

To achieve the full yield potential of an early planting date, full-season hybrids (hybrids that match the growing degree days in a region) are necessary (Figure 3.1.1). After the first or second week of May, however, the yield advantage of full-season vs. medium-season hybrids decreases when planted for grain. Furthermore, full-season hybrids may not mature, resulting in low test weight, and/or will have high grain moisture at harvest, if planted after the second week of May. Therefore, for grain production, full-season hybrids should be planted only in late April or during the first 2 weeks of May. For silage production, full-season hybrids can be planted until about May 20. Growers should not plant more than 30% of their crop to full-season hybrids. The majority of corn acreage (~60%) should be planted to medium-season hybrids (100 and 200 growing degree days less than the growing degree days in a region for silage and grain, respectively). If planting must be delayed until early June, early-season hybrids (300-400 growing degree days less than the growing degree days in a region for silage and grain, respectively) are recommended.

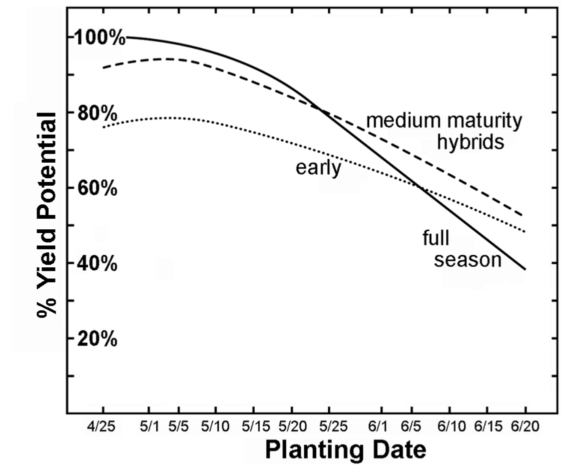

Figure 3.1.1. Effect of planting date on grain yields.

The optimal corn population depends on soil type, hybrid selection, and crop use. For many New York soils (well-to moderately well-drained to somewhat poorly drained silt or clay loams), numerous Cornell experiments have shown that modern hybrids still require a harvest population of only 26,000 to 28,000 plants per acre for maximum economic grain yields (Table 3.1.1). Droughty soils, however, cannot support high populations, and plant populations should be adjusted downward (Table 3.1.1). Likewise, hybrids differ in their response to plant populations, so hybrid selection should influence whether the harvest population is at the high or low end of the recommended range for each particular soil condition (Table 3.1.1). Also, most hybrids require higher harvest populations for silage than for grain production, about 5,000 more plants per acre (Table 3.1.1).

Planting date, tillage practices, pest problems, planter performance, and hybrid selection influence actual corn populations obtained in the field. To compensate for potential problems, it should be assumed that only 90 percent of the kernels planted actually emerge and survive to become harvestable plants in the fall. To obtain 27,000 plants per acre at harvest on a moderately well-drained silt-loam soil, the planting rate should be about 30,000 plants per acre (27,000 divided by 0.90). In some situations such as a no-till situation or an April planting date, it should be assumed that only 85 percent of the kernels will emerge and survive. The planting rate in these situations on a moderately well-drained silt-loam soil should be about 31,765 plants per acre (27,000 divided by 0.85).

damage; (2) midwhorl (8- to 12-leaf stage), for European corn borer, armyworm, foliar diseases, and weed control assessment; and (3) silking and grain fill, for foliage and stalk diseases, European corn borer, corn rootworm beetles, western bean cutworm and ear molds. Pre- and postseason weed surveys are recommended to identify current and future weed control needs.

Information on significant pest damage, including location in the field, should be recorded to help improve the efficiency of future pest management decisions.
For additional information on identifying, monitoring and IPM practices to manage common insect, disease, and weed problems of field corn, see: nysipm.cornell.edu/fieldcrops/scouting_info/default.asp.

For the most current information on field crop pest activity during the growing season see the NYS IPM Weekly Field Crop Pest Report: (blogs.cornell.edu/ipmwpr#).

See Table 3.4.1 and Figure 3.4.1 for suggestions on IPM activities and common pests by crop growth stage and seasonal occurrence.

Table 3.4.1. Field corn pests and crop monitoring activities.

Routine	Occasional
Early Season (emergence to sixth leaf stage)	
Population counts (establishment problems, seed and seedling pests), weeds, cutworm, seedling diseases, damping off; seed corn maggot, watch for “occasional” pests	White grubs, common armyworm, slugs, common stalk borer, billbug, stink bug, corn flea beetle, foliar diseases, nutrient deficiencies, environmental stress (e.g., cold weather, excessive moisture or drought, birds, deer, hail)
Mid-Season (sixth leaf stage through early silk stage)	
Presidedress nitrogen sampling (PSNT); watch for “occasional” pests	Weed escapes, common armyworm, European corn borer, western bean cutworm, foliar blights, common stalk borer, potato stem borer, hopvine borer, vertebrate pests, nutrient deficiencies, environmental stress, hail
Pollination (throughout silking and early grain fill stages)	
Corn rootworm, northern corn leaf blight, northern corn leaf spot, eyespot, gray leaf spot, common rust; watch for “occasional” pests	European corn borer, western bean cutworm, foliar blights, stalk rots, vertebrate pests, nutrient deficiencies, environmental stress, hail
Late Season (harvest and postharvest)	
Ear mold assessment, yield checks, weed inventory survey, soil sampling	European corn borer, foliar blights, stalk rots, ear molds, vertebrate pests, environmental stresses, lodging assessment

Figure 3.4.1. Field corn IPM scouting calendar.

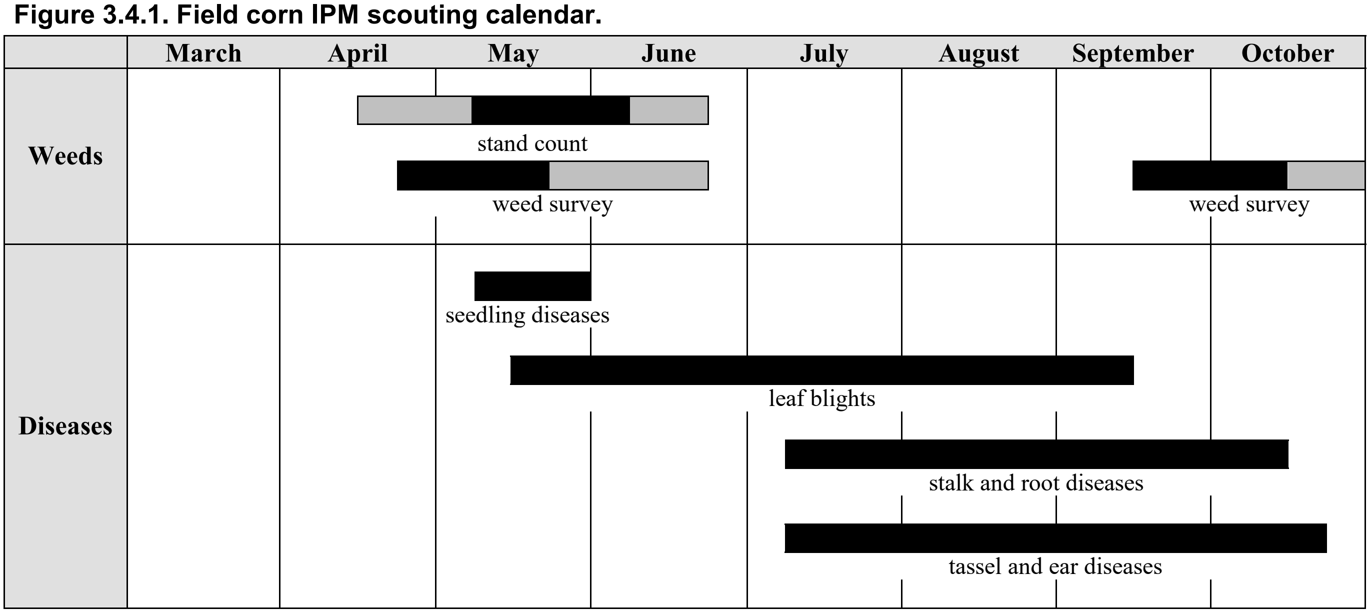

Table 3.7.4. Burndown for zone/no-tillage corn.

Weed Situation	Amount of Product(s) per Acre	Remarks and Limitations
Previously cropped with no cover crop	20 fl. oz. Roundup PowerMax **or** 24 fl. oz. Durango DMA **or** 3-4 pt. *Gramoxone SL 2.0	**GROUP 9 or 22 HERBICIDES•** Apply from 7 days before planting up to and at the time of planting. When using *Gramoxone SL 2.0 for burndown, add a nonionic surfactant to the spray tank to enhance penetration and total kill. If weed cover is minimal, a burndown herbicide may not be needed depending on what other herbicides are being applied.
	22 fl. oz. Roundup PowerMax **or** 24 fl. oz. Durango DMA + 2-3 fl. oz. *†Sharpen **or** 10-18 fl. oz.*†Verdict	**GROUP 9, 14, and 15 HERBICIDES•** Apply prior to crop emergence with adjuvants according to label. Either *†Sharpen or *†Verdict will enhance burndown of annual broadleaf weeds. *†Sharpen will provide residual control of annual broadleaf weeds while *†Verdict will provide residual control of annual grasses and broadleaf weeds. *†Verdict rates vary depending on soil texture. A postemergence treatment may be required for full season weed control. If weed cover is minimal, a burndown herbicide may not be needed depending on what other herbicides are being applied.
Problem Weed Dandelion	0.38-0.5 oz. Express + 1 pt. of 3.8 lb./gal. 2,4-D LVE	**GROUP 2 and 4 HERBICIDES•** Apply in fall to actively growing dandelions or in spring at least 14 days before planting corn. Add crop oil concentrate according to label. This combination has provided the most consistent dandelion control.
	22 fl. oz. Roundup PowerMax **or** 24 fl. oz. Durango DMA + 1 pt. of 3.8 lb./gal. 2,4-D LVE	**GROUP 4 and 9 HERBICIDES•** Apply in fall or in spring prior to planting corn. Addition of crop oil concentrate may enhance dandelion control.

*Restricted-use pesticide.

• Refer to Section 3.7.3 for information on herbicide resistance management and site of action groups.

Table 3.7.5. Components of some prepackaged corn herbicide mixtures.

Product	Formulation	Active Ingredients of Each Herbicide per Gallon		
Acuron	3.44L	2.14 lb.*†Dual II Magnum	+	1.0 lb. *atrazine + 0.24 lb. Callisto + 0.06 lb. bicyclopyrone
Acuron Flexi	3.26L	2.86 lb.*†Dual II Magnum	+	0.32 lb. Callisto + 0.08 lb. bicyclopyrone
†Bicep II Magnum/†Cinch ATZ	5.5L	2.4 lb.*†Dual II Magnum	+	3.1 lb. *atrazine
†Bicep Lite II Magnum/†Cinch ATZ Lite	6L	3.33 lb.*†Dual II Magnum	+	2.67 lb. *atrazine
*†Degree Xtra	4.04L	2.7 lb. *†Harness	+	1.34 lb. *atrazine
*†FulTime NXT	4.04CS	2.7 lb. *†Surpass NXT	+	1.34 lb. *atrazine
*†Harness Max	3.85L	2.05 lb. *†Harness	+	0.188 lb. Callisto
*†Harness Xtra	6L	4.3 lb. *†Harness	+	1.7 lb. *atrazine
*†Harness Xtra 5.6L	5.6L	3.1 lb. *†Harness	+	2.5 lb. *atrazine
*†Keystone LA NXT	6SE	4.3 lb. *†Surpass NXT	+	1.7 lb. *atrazine
*†Keystone NXT	5.6SE	3.1 lb. *†Surpass NXT	+	2.5 lb. *atrazine
*†Lexar EZ	3.7L	1.74 lb. *†Dual II Magnum	+	0.224 lb. Callisto +1.7 lb. *atrazine
*†Lumax EZ	3.67L	2.49 lb. *†Dual II Magnum	+	0.249 lb. Callisto + 0.935 lb. *atrazine
*†Resicore	3.29L	1.75 lb. *†Surpass NXT	+	0.188 lb. Callisto + 0.119 lb. *†Stinger
*†SureStart II	4.25L	3.75 lb. *†Surpass EC	+	0.38 lb. *†Stinger + 0.12 lb †Python

4 Forage Crops Guidelines

4.1 Forage Varieties

4.1.1 Alfalfa

Often called the queen of the forages, alfalfa tops all other perennial forage crops as a producer of homegrown feed. High-yielding and versatile, alfalfa serves well for hay, silage, green chop, and pasture. It produces high-protein and palatable feed, which livestock like and do well on. Alfalfa also fills an important role in crop rotations, improving soil structure and building soil fertility for future grass and grain crops.

Alfalfa is a deep-rooted, drought-tolerant crop that does best on deep, well-drained soils. Alfalfa also needs a well-limed soil; it gives top performance on soils with pH levels of 6.5 or higher. It does poorly on acidic soils, and soil acidity is often noted as the major limiting factor on alfalfa growth in New York. Acidic soils must be limed to a pH of 6.5 or higher to maintain high-yielding alfalfa stands.

On well-drained soils, alfalfa can produce high yields for many years, but it will yield poorly and die soon on poorly drained soils. Tile and other drainage aids can improve the soil's ability to grow good alfalfa. Trefoil and red clover offer better choices for good production on sites with poor or spotty drainage patterns.

Alfalfa seedlings need phosphorus and potassium at planting time. Older stands need topdressing to maintain high yields. An ample fertility program provides nutrients for recovery after harvest, good winter survival, and high yields. Phosphorus and potassium are musts, but nitrogen rarely, if ever, pays on alfalfa because nitrogen-fixing bacteria in root nodules can provide enough nitrogen for top yields. For details on fertilizer suggestions, see Table 4.6.1.

Insect pests cause sporadic damage in alfalfa, varying with season and locality. Potato leafhopper feeding can lower second-cut yields in some years. The alfalfa weevil and blotch leaf miner, formerly serious, are now largely controlled through introduced insect parasites and predators. The alfalfa snout beetle can cause severe damage in the several counties where it occurs. Check control guidelines in the section "Management of Insects in Forage Crops (section 4.10)."

New York alfalfa trials test yield of new varieties (Table 4.1.1 to 4.1.6). Modern alfalfa varieties have been bred for resistance to five or more diseases that can thin alfalfa stands in New York. These diseases include **bacterial wilt**, caused by bacteria present in most New York alfalfa soils; **Verticillium wilt**, a soilborne disease that can kill susceptible plants in their second or third year; **Phytophthora** root rot, caused by a soilborne water mold often found in wet areas of fields; **anthracnose**, found in warmer areas of the state, particularly the Hudson Valley; and **Fusarium wilt**, common in New York soils and may occur but is not documented as a widespread problem in New York. Phytophthora hits hardest in the seedling year, and the other diseases affect mature stands in their second and third years of production.

Check for variety reactions to these specific diseases as well as for yield and fall dormancy ratings. Choose varieties that are listed as R (resistant) or HR (highly resistant) for diseases found in your area. View resources online and table 4.1.6 to determine disease resistance ratings and other characteristics for alfalfa varieties. View tables 4.1.1 to 4.1.3 for fall dormancy ratings and relative yield comparisons. Both Aphanomyces root rot and pea aphid occur here but the value of varietal resistance may not be established for these and some other pests.

Several varieties have been developed at Cornell for specific adaptation to New York State conditions. These include ReGen, Ezra, Seedway 9558 SBR (selected for resistance to alfalfa snout beetle) and SW315LH (selected for resistance to potato leafhoppers).

Improved feeding value has been a goal of alfalfa breeders for years. Several recent varieties have been released with claims of improved feeding quality. Our tests show that minor differences in feeding quality do exist. However, effects on milk production have yet to be established. Timely cutting and leaf-saving harvest practices are far more important in affecting forage quality than leaf or plant type. Choose varieties with strong disease resistance and high yield potential that are well adapted to your farm and needs. Optimal yield and forage quality is at the one-tenth bloom stage.

New leafhopper-resistant varieties are available that have improved resistance and agronomic characteristics (see Table 4.1.2). Leafhopper resistance comes from fine hairs on stems and leaves, and results in significantly lower numbers of hoppers in resistant alfalfa stands compared to conventional alfalfa. Resistant varieties will surpass other strains when leafhopper pressure is heavy. Spraying in the seeding year may still pay under heavy hopper pressure.

4.1.2 Birdsfoot Trefoil

Birdsfoot trefoil is a long-lived legume with high yield potential on slightly acidic soils with drainage less than the best for alfalfa. Trefoil also does well as perennial forage on hard-to-plow meadows and pastures. Trefoil is bloat free, and no case of bloat has ever been recorded in animals grazing on trefoil. On fields where drainage is a problem, trefoil can out yield alfalfa and outlive red clover by many years. Birdsfoot trefoil should be planted with a perennial forage grass and at harvest time, leave 5 to 6 inches of stubble to allow for regrowth of the trefoil.

Table 4.1.4. 2018 Yields of Red Clover varieties in trials planted in 2016 and 2017 in Central New York (CNY – Ithaca). Company contact in Table 4.2.4.

T/A = average tons per acre dry matter per year			
Red Clover	**Company**	**Second Prod. Yr. Yield**	**First Prod. Yr. Yield**
EVOLVE	DLF Pickseed USA Inc.	99	
FF9615	La Crosse Seed		100
FSG 402	Seedway		100
Marathon (check)	Public Check	97	99
UNO	Mountain View Seeds		93
# Trial Entries		*8*	*14*
Check Variety Mean (T/A/Yr)		*5.47*	*6.17*
Trial Mean (T/A/Yr)		*5.42*	*6.16*

Table 4.1.5. Alfalfa trials harvested for yield in 2018: trial location, NY region, Seeding year, soil series, elevation, number of harvests and number of production years.

Trial Location, NY Region*, Seeding Year	**Soil series, elevation, # of harvests in 2018, # of production years**
Ithaca, CNY, 2015	Williamson silt loam, 1000 ft., 3 harvests in third production year.
Chazy, NNY, 2015	Raynham variant silt loam, 185 ft., 3 harvests in third production year.
Ithaca, CNY, 2016	Erie Chippewa channery silt loam, 1054 ft. 3 har. in second production year.
Cobleskill, ENY, 2016	Barbour Tioga fine sandy loam, 1170 ft., 3 harvests in second production year.
Ithaca, CNY, 2017	Williamson silt loam, 1000 ft., 3 harvests in first production year.
Geneva, WNY, 2017	Honeoye and Lima loam, 486 ft., 3 harvests in first production year.
Ithaca, CNY, 2018	Erie Chippewa channery silt loam, 1054 ft. 0 harvests in seeding year.
Cobleskill, ENY, 2018	Barbour Tioga fine sandy loam, 1170 ft., 1 harvest in seeding year.

*CNY – Central New York, ENY – Eastern NY, WNY – Western NY, NNY – Northern New York.

Table 4.1.6: Alfalfa cultivar Features

For more information log on to http://plbrgen.cals.cornell.edu/research-extension/forage-project/ny-forage-yield-results
Cultivars listed are currently tested in Cornell Alfalfa Trials. Yield data for cultivars in new trials will be available next year.

			Disease Resistance Ratings*					**Marketing Co. Contact Information**	
Alfalfa Cultivar	**Marketing Company**	**FD**	***BW***	***VW***	***FW***	***AN***	***PRR***	***Phone***	***Web or E-mail Address***
LUKAL	Albert Lea							800-352-5247	www.alseed.com
LUZELLE	Albert Lea								
AFX 429	Alforex	4	HR	HR	HR	HR	HR	877-560-5181	www.alforexseeds.com
59W205	BrettYoung	5	R	HR	HR	HR	HR	800-665-5015	www.brettyoung.ca/
KINGBIRD	BlueRiver Org. Seed	5	HR	HR	HR	HR	HR	800-370-7979	www.blueriverorgseed.com
RED FALCON	BlueRiver Org. Seed	4	HR	HR	HR	HR	HR		
ROBIN	BlueRiver Org. Seed	5	HR	HR	HR	HR	HR		
TOUCHSTONE EQ	Chemgro	4	HR	HR	HR	HR	HR	800-346-4769	www.chemgro.com
RR APHATRON 2XT	CROPLAN	4	HR	HR	HR	HR	HR	651-765-5710	www.croplan.com
REBOUND 6XT	CROPLAN	4	HR	HR	HR	HR	HR		
HYBRIFORCE-3400	Dairyland Seed Co.	4	HR	HR	HR	HR	HR	800-236-0163	www.dairylandseed.com
HYBRIFORCE-3430	Dairyland Seed Co.	4	HR	HR	HR	HR	HR		
HYBRIFORCE-4400	Dairyland Seed Co.	4	HR	HR	HR	HR	HR		
MAGNUM 8	Dairyland Seed Co.	4	HR	HR	HR	HR	HR		

5 Small Grain Crops Guidelines

Small grains, which include winter and spring wheat, winter and spring barley, oats, and rye, play an important role in crop rotations on many New York farms. Under good soil conditions and management practices, small grains can produce profitable yields of grain for the cash market or farm feeding. Equally important is the value of the straw crop.

Oats and rye tolerate acid or poorly drained soils better than wheat or barley does. Nevertheless, maximum yields of both crops are attained on moderately well-drained or well-drained soils with a pH above 5.8. For maximum wheat production, wheat must be cropped on moderately well-drained or well-drained soils with a pH above 6.0. Barley requires well-drained soils with a pH above 6.3, the same as needed for alfalfa production.

5.1 Planting Techniques

5.1.1 Winter Grains

Winter wheat should be planted with a grain drill to a depth of 1 to 1-1/2 inches during the couple of weeks after the Hessian fly-free date. The optimal planting is thus from mid-September until early October in most regions of winter wheat production. Depending upon the fall or winter conditions, wheat can be successfully planted until early November but at a lower yield potential. Soft white winter wheat has a broad optimum seeding rate range and rates of about 120 pounds or 2 bushels per acre usually result in the highest grain and straw yields. If planting is delayed beyond early October, the optimal rate is 150 pounds or 2-1/2 bushels per acre. Soft red winter wheat also has a broad optimum seeding rate range and rates between 1,000,000 and 1,300,000 seeds per acre result in highest grain yields when planted in September and about 1,500,000 seeds/acre for highest straw yields. If planting is delayed after mid-October, soft red winter wheat should be seeded at rates of 1,500,000 seeds for acre if just for grain and 1,800,000 seeds/acre if the straw is also harvested.

Barley is less hardy than wheat and is not susceptible to Hessian fly. Winter barley can thus be planted a few days earlier than wheat, that is, from September 10 to September 20. Because barley is very susceptible to barley yellow dwarf virus, planting before this time is strongly discouraged. It is best to sow the seed with a grain drill at a depth of 1 to 1-1/2 inches. Seeding rates should be in the 96 to 120 pounds per acre or 2- to 2-1/2-bushel range.

Rye is the hardiest of all winter grains and thus can be successfully established with an early to mid-October planting date. For seed production, rye should be sown with a grain drill at a depth of 1 to 1-1/2 inches. The seeding rate should be in the 110 pounds or 2-bushel range.

5.1.2 Spring Grains

Spring grains should be sown as early in the spring as possible. In central New York, a yield decrease of about 1 bushel per acre per day can be expected in oats and barley for each day the crop is planted after April 15. With spring wheat, a yield loss of about 1/2 bushel per acre per day can be expected if planting occurs after April 15. All spring grains should be sown with a grain drill to a depth of 1 to 1-1/2 inches. The optimal seeding rate for oats is 96 pounds or 3 bushels per acre, whereas spring barley and spring wheat do best at 2 bushels per acre. If oats or barley is to be used in forage seeding, seeding rates should be reduced by 50 percent.

See the *Cornell Field Crops and Soils Handbook* for more detailed planting information.

5.2 Variety Selection

5.2.1 Winter Wheat

Wheat is an important cash crop in central and western New York. Most New York wheat is classified as soft red winter wheat, but some soft white winter wheat is also grown. Millers use the soft wheats to produce high-quality, low-protein flours for use in pastries, crackers, cookies, and breakfast cereals. Soft red wheats are inherently more resistant to pre-harvest sprouting than soft white wheats.

Winter wheat varieties are tested every year in Cornell trials, and results of multiyear evaluations are shown for soft white wheat varieties from Cornell's breeding program in Table 5.2.1 and for both Cornell and commercial soft red wheat varieties in Table 5.2.2. Please note the following points when using these tables. Varieties are in order from those that have been tested the longest to those most recently entered into the testing program. For each trait, the number of years of data used to assess that trait are noted at the top of the table. The more years of evaluation, the more precise the data will be. The **table includes only varieties that have been tested for at least two years in Cornell trials**. All the winter wheat varieties reported in these tables are good options for New York growers. Their yields are good and all have acceptable milling and baking quality, test weight, and lodging resistance.

5.2.1.1 Soft White Winter Wheat

Only varieties developed by Cornell University's soft white wheat breeding program are evaluated in Cornell trials at this time. Results of variety evaluations are reported in Table 5.2.1. Special traits of some of these varieties are noted below, but recall that **all the varieties listed in the Table are good options for New York growers**.

CALEDONIA is a good yielder with excellent standability. It has attractive, light-colored straw.

Table 5.7.1. Efficacy of fungicides for wheat disease control based on appropriate application timing*

Fungicide(s)				Powdery mildew	Stagonospora leaf/glume blotch	Septoria leaf blotch	Tan spot	Stripe rust	Leaf rust	Stem rust	Fusarium head blight	Harvest Restriction
Class	**Active ingredient**	**Product**	**Rate/A (fl. oz)**									
Mixed modes of action[5]	**metconazole 7.4%** **pyraclostrobin 12%**	**TwinLine 1.75 EC[3,5]**	**7.0-9.0**	G	VG	VG	E	E	E	VG	NL	Feekes 10.5

[*] *Adapted for New York by Gary C. Bergstrom from information developed by the USDA-NIFA Committee on Management of Small Grain Cereal Diseases (NCERA-184).*
Efficacy ratings for each fungicide listed in the table were determined by field-testing the materials over multiple years and locations by the members of the committee. Efficacy ratings are based upon level of disease control achieved by product, and are not necessarily reflective of yield increases obtained from product application. Efficacy depends upon proper application timing, rate, and application method to achieve optimum effectiveness of the fungicide as determined by labeled instructions and overall level of disease in the field at the time of application. Differences in efficacy among fungicide products were determined by direct comparisons among products in field tests and are based on a single application of the labeled rate as listed in the table. Table includes systemic fungicides available that have been tested over multiple years and locations. The table is not intended to be a list of all labeled products. This information is provided only as a guide. It is the responsibility of the pesticide applicator by law to read and follow all current label directions. No endorsement is intended for products listed, nor is criticism meant for products not listed. Members or participants in the NCERA-184 committee assume no liability resulting from the use of these products. ***Efficacy categories: NL=Not Labeled; NR=Not Recommended; U=Unknown efficacy or insufficient data to rank product efficacy; P=Poor; F=Fair; G=Good; VG=Very Good; E=Excellent.***
[1] Efficacy may be significantly reduced if solo strobilurin products are applied after stripe rust infection has occurred
[2] Rates of 5.0 to 5.7 fl oz are labeled only for applications at flowering to suppress Fusarium head blight; Lower rates of 4.3-5.0 fl oz are labeled for applications to control foliar and stem diseases.
[3] Aerial application is not allowed in New York.
[4] This product is not for sale, distribution, or application in Nassau or Suffolk Counties.
[5] Aerial application of this product is not allowed within 100 feet of aquatic habitats.
[6] Application of this product is not allowed within 100 feet of coastal marsh.

Table 5.7.2. Scouting-based criteria for deciding on foliar fungicide applications to winter wheat.

Wheat Stage	When	Scouting Observations	Decision	
Stem elongation	early May	Adequate stand, vigorous plants	(NO)	Discontinue monitoring
			(YES)	Continue monitoring
Before flag leaf emergence	mid-May	Disease on any of top three leaves of at least 50% of main tillers	(NO)	Don't spray now; continue monitoring
			(YES)	Spray with efficacious fungicide from Table 5.7.1; continue monitoring
Head emergence	late May	Disease on either of top two leaves of at least 50% of main tillers; forecast of wet weather in next week	(NO)	Don't spray
			(YES)	Spray only with efficacious triazole or triazole & SDHI product
Initiation of flowering	late May to early June	Moderate risk of Fusarium head blight development based on regional risk advisory, and/or significant foliar disease on top two leaves	(NO)	Don't spray
			(YES)	Spray only with efficacious triazole or triazole & SDHI product

Table 5.7.3. Influence of grain price and yield on the relative profit of a single foliar fungicide application.[1]

	Yield Increase (Bu/A)			
Wheat Price ($/Bu)	0	5	10	15
	Relative Profit ($/A)			
3.00	-30	-15	0	15
3.50	-30	-12.5	5	22.5
4.00	-30	-10	10	30

6 Soybean Guidelines

6.1 Soybean Maturity Group Selection

Varieties of soybeans differ in maturity as much as corn varieties do, but they are classified by a different maturity system. The varieties that require the least heat to mature are placed in Group 00. In progressively warmer parts of our state, the appropriate maturities are Group 0, Group I, and Group II and early Group III. Early Group III and late mid to late Group II varieties mature dependably only in the warmer parts of central and western New York.

In the warmer regions of central and western New York, we recommend planting most of the crop with mid-Group II to early Group III varieties with a May planting date. If fields are to be planted to wheat after soybean harvest, growers should consider early Group II or late Group I varieties to insure planting wheat before mid-October. If planting occurs during the first 10 days of June, we recommend planting about 50% to early Group II and about 50% of the acreage to late Group I varieties with mid or early Group I varieties in fields that will have a subsequent wheat crop. If planting is delayed beyond June 10, we recommend planting early Group I or Group 0 varieties in central and western New York. We do not recommend planting soybeans after June 20 in these regions.

In areas of northern New York next to the lakes, we recommend planting about 50 percent of the acreage to early Group II and about 50 percent to late Group I varieties with a May planting date. Away from the lakes in northern New York, we recommend planting 70 percent of the acreage to Group I and 30 percent to Group 0 varieties. If planting is delayed until June in northern NY, we recommend planting mostly Group I varieties next to the lakes and Group 0 varieties away from the lakes. We do not recommend planting soybeans in northern NY after June 15.

6.2 Soybean Planting

The best soybean yields occur on well-drained, but not sandy, soils having a pH of 6.5 or above. The critical stage for soybean yield is in August and droughty soils that typically dry out in August will have disappointing yields. Soybeans have a very broad optimal planting date with optimum dates from about May 5-25 in the warmer regions in central and western New York. Soybeans can be successfully planted in late April or early May in these regions but final stands may be more erratic so an insecticide/fungicide seed treatment is recommended for late April and early May plantings. Mid to late Group II and early Group III varieties can be planted in these regions up until about May 20 and then just Group II varieties until June 1. If a wheat crop is to be planted after soybean harvest, then a late Group I vs. a Group II variety planted in late May will mature earlier and allow for a more timely wheat planting date. In the cooler regions in central and western New York and in Northern New York, optimum planting time is during the midlle two weeks of May. Early Group II and Group I soybean varieties should be planted at this time in these regions.

Although soybean yields decline with June plantings, high yields can still be achieved by planting early Group II or Group I varieties in central and western New York and early Group I and Group 0 varieties in Northern New York until about June 15. The earlier-maturing varieties, which tend to be short in stature, yield better at a row spacing of 15 inches or less. Soybean plantings after June 20 in central/western NY and after June 10 in NNY can be risky, even with Group 0 varieties, especially if the remaining part of the growing season is cool or if frost occurs before October 1.

It is important to place the soybean seed into the ground at a precise depth and in firm contact with the soil so choice of planting equipment is especially critical. A corn planter usually does a better job of planting than a grain drill, but soybeans typically yield about 5% less in 30-inch vs. 7.5 inch row spacing in New York even with lower final stands. In addition, modern drills have much better depth control than older grain drills.

Seeding rate depends on both row spacing and seed size. We recommend seeding rates, for seed not treated with insecticide or fungicide, of about 170,000 seeds per acre for 7.5 inch row spacing (~7.5 seeds per 3 ft.), 160,000 seeds/acre for 15-inch row spacing (about 14 seeds per 3 feet), and 150,000 plants per acre for 30-inch row spacing (~26 seeds per 3 ft.). If an insecticide/fungicide seed treatment is used, seeding rates can be reduced by 10,000 to 20,000 seeds per acre. Planting depth should be about 1.25 to 1.5 inches, depending on soil moisture conditions, and should not exceed 2 inches. Soybeans, however, can emerge reasonably well from a 2.5 inch depth, if soil crusting is not prevalent during actual emergence from the soil. Likewise, soybeans can be planted at the 1.0 inch depth, but the seed is susceptible to drying out, if conditions are dry after planting. We recommend the use of inoculum for soybean plantings in New York, especially on fields with a limited soybean history. On fields where soybeans have been grown for more than 20 years, however, inoculum may not be necessary. Likewise, the use of an insecticide/fungicide seed treatment is not necessary but can help stand establishment, especially on early-planted soybeans. Soybeans, however, can fill in the gaps very well and perfect stands are not required for maximum soybean yields.

6.3 Managing the Crop

Use soil test results to determine both lime and fertilizer requirements (see Table 6.3.1). Soybeans do not require supplemental nitrogen fertilizer if optimally fertilized for phosphorus and sulfur and at optimal pH because soybeans can fix nitrogen through a symbiotic relationship with *Bradyrhizobium* bacteria. If used, band-placed fertilizer should be at least 2 inches to the side and 2 inches below the seed. Do not place any fertilizer in contact with the

8 Appendix

8.1 Trade and Common Names of Field Crop Pesticides

Table 8.1.1 Fungicides.

Trade Name[1]	EPA Registration Number	Common Name
Absolute 500 SC	264-849	tebuconazole + trifloxystrobin
Affiance SC	10163-332	tetraconazole + azoxystrobin
Aframe Plus 2.2 SE	100-1324	propiconazole + azoxystrobin
Allegiance FL	264-935	metalaxyl
Alto 100 SL	100-1226	cyproconazole
*†Aproach SC	352-840	picoxystrobin
*†Aproach Prima 2.34 SC	352-883	cyproconazole + picoxystrobin
Apron XL	100-799	mefenoxam
Avaris 200 SC	100-1178-5905	azoxystrobin + propiconazole
Caramba 0.75 SL	7969-246	metconazole
Domark 230 ME	80289-7	tetraconazole
Endura 0.7 DF	7969-197	boscalid
*†Evito 480 SC	66330-64	fuoxystrobin
Fitness	34704-1031	propiconazole
Headline AMP	7969-291	pyraclostrobin + metconazole
Headline EC	7969-186	pyroclostrobin
Headline SC	7969-289	pyraclostrobin
*†Priaxor 4.17 SC	7969-311	pyraclostrobin + fluxapyroxad
Proline 480 SC	264-825	prothioconazole
Prosaro 421 SC	264-862	prothioconazole + tebuconazole
Quadris Flowable	100-1098	azoxystrobin
Quadris Top	100-1313	azoxystrobin + difenconazole
Quilt	100-1178	azoxystrobin + propiconazole
Quilt Xcel	100-1324	azoxystrobin + propiconazole
Stratego YLD	264-1093	trifloxystrobin + prothioconazole
Tilt 3.6E	100-617	propiconazole
†Topguard	67760-75	flutriafol
Topsin M 70 WP	73545-11-70506	thiophanate-methyl
TwinLine 1.75 EC	7969-247	pyraclostrobin +metconazole

*Restricted-use pesticide
†Not for use on Long Island, NY
[1]Trade names are given for convenience only. No endorsement of products is intended nor is criticism of unnamed products implied.

Table 8.1.2. Insecticides.

Trade Name[1]	EPA Registration Number	Common Name
*Asana XL	352-515	esfenvalerate
*Baythroid XL	264-840	beta-cyfluthrin
*Counter	5481-545	terbufos
*Diazinon	Multiple	diazinon
Dimethoate	Multiple	dimethoate
*Force 3G	100-1075	tefluthrin
Gaucho 480	264-957	imidacloprid

Table continues on next page.