2024
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.

2024 Cornell Guide for Integrated Field Crop Management

Authors

Vipan Kumar (Soil and Crop Sciences Section; *weed science; contact editor*)
Joseph Amsili (Soil and Crop Sciences Section; *soil health/management*)
Gary Bergstrom (Plant Pathology and Plant-Microbe Biology Section; *disease management*)
Jerry Cherney (Soil and Crop Sciences Section; *forage production/variety selection*)
Julie Hansen (Plant Breeding and Genetics Section; *forage production/variety selection*)
Michael Helms (Cornell Cooperative Extension Pesticide Safety Education Program (CCE-PSEP); *pesticide information)*
Michael Hunter (New York State Integrated Pest Management Program; *weed management*)
Quirine Ketterings (Department of Animal Science; *soil fertility/nutrient management*)
Joe Lawrence (PRO-Dairy Program; *silage corn hybrids*)
Harold van Es (Soil and Crop Sciences Section; *soil health/management*)
Erik Smith (CCE Central New York Dairy, Livestock, and Field Crop Program; *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*)
Kirsten Workman (PRO-Dairy Program; *soil fertility/nutrient management*)

Special Appreciation

Special appreciation is extended to Bill Cox, Russell Hahn, Murray McBride, Robert Schindelbeck, and Elson Shields for their contributions to this publication.

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 (February 2024). Changes in pesticide registrations, regulations, and guidelines occurring after publication are available in county Cornell Cooperative Extension offices or from the Cornell Cooperative Extension Pesticide Safety Education Program (CCE-PSEP) (psep.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.

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

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 by:** Mr. Akhilesh Sharma, graduate student, Cornell University School of Integrative Plant Science, Soil and Crop Sciences Section.*

1 PESTICIDE INFORMATION 1

1.1 Pesticide Classification and Certification 1
1.2 Use Pesticides Properly 1
1.2.1 Plan Ahead 1
1.2.2 Move Pesticides Safely 1
1.2.3 Personal Protective Equipment and Engineering Controls 1
1.2.4 Avoid Drift, Runoff, and Spills 1
1.2.5 Avoid Equipment Accidents 2
1.2.6 Pesticide Storage 2
1.3 Pollinator Protection 2
1.4 New York State Pesticide Use Restrictions 2
1.4.1 Restricted-Use Pesticides 2
1.4.2 Additional Use Restrictions 3
1.5 Verifying Pesticide Registration 3
1.6 Check Label for Site and Pest 3
1.7 Pesticide Recordkeeping/Reporting 3
1.7.1 New York State Reporting Requirements 3
1.7.2 New York State Recordkeeping Requirements 4
1.7.3 Federal Private Applicator Recordkeeping Requirements 4
1.8 EPA Worker Protection Standard (WPS) for Agricultural Pesticides 4
1.9 Reduced-risk Pesticides, Minimum-risk Pesticides, and Biopesticides 4
1.9.1 Reduced-risk Pesticides 4
1.9.2 Minimum-risk Pesticides 4
1.9.3 Biopesticides 5
1.10 FIFRA 2(ee) Recommendations 5

2 GENERAL INFORMATION FOR CROP PRODUCTION 6

2.1 Introduction 6
2.2 New York State Climate 6
2.2.1 Growing Degree Days for Corn and Soybeans 6
2.3 Soil Surveys 7
2.4 Soils and Soil Management Groups of New York State 9
2.4.1 Soil Management Group I 9
2.4.2 Soil Management Group II 10
2.4.3 Soil Management Group III 11
2.4.4 Soil Management Group IV 12
2.4.5 Soil Management Group V 12
2.4.6 Other Areas 12
2.5 Soil Health 13
2.5.1 The Cornell Soil Health Test 14
2.6 Runoff and Soil Erosion 16
2.6.1 Tillage Erosion 17
2.6.2 Solving Erosion Problems 17
2.6.3 Wind Erosion 18
2.7 Soil Compaction 18
2.7.1 Effects of Soil Compaction on Crops 19
2.7.2 Diagnosing Plow Layer and Subsoil Compaction 20
2.7.3 Addressing Soil Compaction Problems 21
2.8 Tillage 23
2.8.1 Full-Width Primary Tillage Systems 23
2.8.2 Secondary Tillage 24
2.8.3 Restricted-Tillage Systems 24
2.8.4 Deep Tillage 25
2.8.5 Frost Tillage 25
2.8.6 Selecting a Tillage System 26
2.9 Nutrients and the Environment 29
2.9.1 Nitrate Leaching Index (NLI) 29
2.9.2 NY Phosphorus Index 2.0 30

2 GENERAL INFORMATION FOR CROP PRODUCTION *(continued)*

2.9 Nutrients and the Environment *(continued)*
2.9.3 Groundwater Protection Guidelines....31
2.9.4 Manure Spreading Guidelines During Adverse Weather Conditions....31
2.10 Soil Testing....34
2.10.1 Why Test Soil?....34
2.10.2 What is a Soil Testing Program?....35
2.10.3 How Does a Soil Test Work?....35
2.10.4 How to Collect and Submit a Soil Sample....35
2.10.5 How Often Should Samples be Taken?....36
2.10.6 Variable Rate Management....36
2.10.7 Interpretation of Soil Test Results....37
2.11 Fertilizers....38
2.11.1 Using the Fertilizer Tables....38
2.11.2 Fertilizer Materials....38
2.11.3 Fertilizer Injury....38
2.11.4 Secondary Macronutrients and Micronutrients....39
2.12 Lime Guidelines....41
2.12.1 Lime Rate Table....41
2.12.2 Lime Applications....42
2.12.3 Liming for No-Tillage Production....42
2.12.4 Points to Remember When Using Lime Guidelines Without Buffer pH Data....42
2.12.5 Calcium and Magnesium Content of Limestones....43
2.13 Land Application of Sewage Sludges....44
2.13.1 Application Rates....45
2.13.2 Nutrients....45
2.13.3 Metals....46
2.13.4 Synthetic Organic Chemicals....46
2.13.5 Pathogens....47
2.13.6 Sludge Guidelines....48
2.14 Integrated Pest Management for Field Crops....49
2.14.1 Identification....49
2.14.2 Sampling....50
2.14.3 Analysis....50
2.14.4 Management Alternatives....50
2.14.5 Implementation....50
2.14.6 Evaluation....50
2.15 Integrated Management of Field Crop Diseases....51
2.16 Managing Insects and Diseases with Seed Treatments....51

3 CORN GUIDELINES....55

3.1 Planting Techniques....55
3.2 Hybrid Selection....56
3.2.1 Corn Silage Hybrids....56
3.2.2 Corn Grain Hybrids....59
3.3 Fertilizers for Corn....59
3.3.1 Band Rates....60
3.3.2 Efficient Nitrogen Use....60
3.3.3 Nitrogen Status of the Corn Crop....62
3.3.4 Adaptive Management Process....64
3.4 Managing Field Corn Pest Problems in New York....64
3.5 Managing Diseases of Corn....66
3.5.1 Seed Treatment Fungicides....66
3.5.2 Selection of Disease-Resistant Varieties....66
3.5.3 Sound Crop Management....67
3.5.4 Foliar and Soil at-planting Fungicide Application....67
3.6 Managing Insects, Slugs, and Nematodes in Corn....70
3.6.1 European Corn Borer....70

3 CORN GUIDELINES *(continued)*

3.6 Managing Insects, Slugs, and Nematodes in Corn *(continued)*
3.6.2 Northern and Western Corn Rootworms ... 71
3.6.3 Seed Corn Maggot ... 73
3.6.4 Cutworms ... 73
3.6.4.2 Management ... 73
3.6.5 Armyworms ... 73
3.6.6 Wireworms and White Grubs ... 74
3.6.7 Potato Stem Borer and Hopvine Borer ... 74
3.6.8 Western Bean Cutworm ... 74
3.6.9 Slugs ... 74
3.6.10 Nematodes ... 74
3.7 Managing Weeds in Corn ... 75
3.7.1 Weed Management Methods ... 76
3.7.2 Factors Affecting Soil-Applied Herbicides ... 76
3.7.3 Herbicide Resistance Management ... 77
3.7.4 Weed Control in Zone/No-Tillage Corn ... 77
3.7.5 Prepackaged Herbicide Mixtures ... 78
3.7.6 Atrazine Application Rates ... 78

4 FORAGE CROPS GUIDELINES ... 89

4.1 Forage Varieties ... 89
4.1.1 Alfalfa ... 89
4.1.2 Birdsfoot Trefoil ... 89
4.1.3 Red Clover ... 90
4.1.4 Alsike Clover ... 90
4.1.5 Crownvetch ... 90
4.1.6 Results from Forage Trials Harvested in 2022 (Trials Sown in 2019, 2020, and 2021) ... 90
4.2 Perennial Grasses ... 94
4.2.1 Reed Canarygrass ... 94
4.2.2 Timothy ... 94
4.2.3 Smooth Bromegrass ... 94
4.2.4 Orchardgrass ... 94
4.2.5 Ryegrasses ... 95
4.2.6 Meadow Fescue ... 95
4.2.7 Tall Fescue ... 95
4.2.8 Festulolium ... 95
4.2.9 Perennial Forage Variety Selection ... 95
4.3 Annual Crops for Forage ... 101
4.3.1 Sudangrass and Forage Sorghums ... 101
4.3.2 BMR Sorghum-Sudangrass Hybrids ... 101
4.3.3 Anti-Quality Components ... 102
4.3.4 Millets ... 102
4.3.5 Oats and Spring Triticales ... 102
4.3.6 Winter Wheat, Barley, Rye, and Triticales ... 102
4.4 Planting Perennial Legumes and Grasses ... 103
4.4.1 Seedbed Preparation ... 103
4.4.2 Date of Seeding ... 103
4.4.3 Inoculation ... 103
4.4.4 Fertilizers and Lime for Legume Establishment ... 103
4.4.5 Companion Crops ... 103
4.4.6 Species Selection ... 103
4.5 Harvest Schedules ... 103
4.5.1 Alfalfa ... 103
4.5.2 Perennial Grasses ... 104
4.6 Forage Fertilization ... 104
4.6.1 Alfalfa/grass ... 104
4.6.2 Winter cereals grown as forage double crop ... 105

4 FORAGE CROPS GUIDELINES *(continued)*

4.6 Forage Fertilization *(continued)*
4.6.3 Considerations for Manure Use for Alfalfa-Grass Production....105
4.7 Forages for Conservation....107
4.8 Managing Alfalfa Pest Problems in New York....108
4.9 Managing Diseases of Perennial Forage Legumes....110
4.9.1 Vascular Wilts....110
4.9.2 Root, Crown, and Stem Rots....110
4.9.3 Leaf and Stem Blights....111
4.9.4 Seed Fungicides....111
4.9.5 Selection of Disease-Resistant Varieties....111
4.9.6 Sound Stand Management....111
4.10 Managing Insects in Forage Crops....112
4.10.1 Alfalfa Weevil....112
4.10.2 Potato Leafhopper....113
4.10.3 Alfalfa Snout Beetle....114
4.11 Weed Control in Forages....116
4.11.1 Herbicide Resistance Management....116
4.12 Minimum-Tillage Forage Seedings....120
4.12.1 Vegetation Control....120
4.12.2 Seeding Methods....120
4.12.3 Insect Control....120
4.13 Perennial Forages for Pasture....120
4.13.1 Ladino White Clover (*Trifolium repens* L.)....121
4.13.2 Kentucky Bluegrass (*Poa pratensis* L.)....121
4.13.3 Tall Fescue (*Festuca arundinacea* Schreb)....121
4.13.4 Use of Pastures....121
4.13.5 Grass-Legume Mixtures....121
4.14 Weed Control in Grass Pastures....122
4.14.1 Herbicide Resistance Management....122

5 SMALL GRAIN CROPS GUIDELINES....124

5.1 Planting Techniques....124
5.1.1 Winter Grains....124
5.1.2 Spring Grains....124
5.2 Variety Selection....124
5.2.1 Winter Wheat....124
5.2.2 Hybrid Winter Rye....125
5.2.3 Spring Oat....125
5.2.4 Winter Malting Barley....125
5.2.5 Spring Malting Barley....126
5.2.6 Triticale....126
5.2.7 Spelt....126
5.2.8 Buckwheat....126
5.2.9 Other Grain-Type Crops....126
5.3 Why We Recommend Certified Seed....130
5.4 Growth Stages in Small Grains....130
5.4.1 Winter Wheat....130
5.4.2 Spring Grains....131
5.5 Fertilizers for Small Grains....131
5.5.1 Lodging Control in Wheat or Barley....132
5.6 Managing Winter Wheat Pest Problems in New York....133
5.7 Managing Diseases of Small Grain Cereals....135
5.7.1 Selection of Disease-Resistant or Disease-Tolerant Varieties....135
5.7.2 Seed Treatment....135
5.7.3 Foliar Fungicides....135
5.7.4 Guidelines for Wheat Fungicide Decisions....136
5.7.5 Sound Agronomic Practices....136

5 SMALL GRAIN CROPS GUIDELINES *(continued)*

5.8 Managing Insects in Small Grains 140
5.8.1 Armyworms 140
5.8.2 Cereal Leaf Beetle 141
5.8.3 Hessian Fly 141
5.8.4 Stored Grain Insect Management 141
5.9 Weed Control in Small Grains 143
5.9.1 Herbicide Resistance Management 144

6 SOYBEAN GUIDELINES 146

6.1 Soybean Maturity Group Selection 146
6.2 Soybean Planting 146
6.3 Managing the Crop 146
6.4 Managing Soybean Pest Problems in New York 147
6.5 Managing Diseases of Soybeans 150
6.5.1 Fungicidal Seed Treatment 150
6.5.2 Foliar Fungicides 150
6.5.3 Soybean Rust 150
6.5.4 Soybean Cyst Nematode 151
6.6 Managing Insects in Soybeans 154
6.6.1 Seed Corn Maggot 154
6.6.2 Soybean Aphid 154
6.6.3 Two-spotted Spider Mites 155
6.7 Weed Control in Soybeans 156
6.7.1 Herbicide Resistance Management 156

7 TOTAL VEGETATION CONTROL 163

7.1 Total Vegetation Control 163

8 APPENDIX 164

8.1 Trade and Common Names of Field Crop Pesticides 164
8.2 Herbicide Site of Action Groups and Site of Action Information. 169

1 Pesticide Information

1.1 Pesticide Classification and Certification

Pesticides can be classified as general-use or restricted-use. **General-use pesticides** may be purchased and used by anyone. **Restricted-use pesticides** can only be purchased and used by a certified applicator or used by someone under a certified applicator's supervision. In some cases, the pesticide label may limit use of a restricted-use pesticide to only a certified applicator.

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. If a private applicator wants to use or supervise the use of restricted-use pesticides, they need to be a **certified private applicator**. Certified private applicators are also allowed to purchase restricted-use pesticides. Certification is not needed if a private applicator uses general-use pesticides.

In New York State, a **certified commercial applicator**, **certified commercial technician**, or **commercial apprentice** working under the supervision of a certified commercial applicator is allowed to apply any type of pesticide on property that is not a private application (described above) or is a residential application. (A residential application is the use of general-use pesticides on property owned or rented by the applicator, excluding establishments selling or processing food and residential structures other than where the applicator lives.) Certified commercial applicators are allowed to purchase restricted-use pesticides.

Information on 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 (www.cornellstore.com/books/cornell-cooperative-ext-pmep-manuals), or the Cornell Cooperative Extension Pesticide Safety Education Program (psep.cce.cornell.edu).

1.2 Use Pesticides Properly

Using pesticides requires the user to protect their health, the health of others, and the environment. Keep in mind "pesticide use" is more than just the application. It 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 also require you to comply with state and federal laws and regulations intended to protect human health and the environment from the adverse effects pesticides may cause.

1.2.1 Plan Ahead

Many safety precautions should be taken *before* you begin using pesticides. Most pesticide accidents can be prevented with informed and careful practices. **Always read the label on the pesticide container before using the pesticide.** Make sure you understand and can follow all label directions and precautions. 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

Transporting pesticides carelessly can result in broken containers, spills, and contamination of people and the environment. Accidents can occur even when transporting pesticides 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 (PPE) needs depend on the pesticide being handled. **Required PPE are listed on pesticide labels.** Any required PPE is based on the pesticide's toxicity, route(s) of exposure, and formulation. Label-listed PPE are the minimum that must be worn when using a pesticide. You can always use more than what's listed!

The type of PPE used depends on the type and duration of the activity, where pesticides are being used, and the user's exposure. For example, mixing/loading procedures often require more PPE than when applying a pesticide. Studies show you are at a greater risk of accidental poisoning when handling pesticide concentrates. Pouring pesticide concentrates is the most hazardous activity.

Engineering controls are devices that help reduce a pesticide user's exposure. An example is a closed transfer system that reduces the exposure risk when dispensing pesticide concentrates. 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 non-target areas, and harm the environment. Choose weather conditions, pesticides, application equipment, pressure, droplet size, formulations, and adjuvants to minimize drift and runoff potential. Product labels may have specific application and/or equipment requirements to reduce issues with drift and runoff.

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. For further information on any topic in this booklet, you may contact your local Cornell Cooperative Extension office.

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.

For example, if your locality averages 2200 growing degree days (as read from the map) but your field is in a pocket or is observed to be subject to early fall frosts, then choose a slightly earlier hybrid or variety, perhaps one that can mature with 2000 degree days.

2.5 Soil Health

Soil health is the capacity of the soil to function productively and sustainably without jeopardizing the environment. From its definition, soil health focuses on maintaining the soil in an optimally productive state while at the same time balancing the need for resource sustainability and environmental conservation.
Functions of a good soil in relation to crop production and environmental conservation include:

- good physical medium that can support healthy crop growth on sustained basis
- good nutrient retention and release for crops
- adequate moisture storage and release for crops
- good partitioning of surface water preventing erosion and runoff
- support of a healthy population of beneficial soil organisms to suppress harmful organisms and
- buffer against toxic substances and environmental pollutants

Soil health emphasizes the integration of the different aspects of the soil which is broadly classified into the physical, biological and chemical categories (Figure 2.5.1). However, these different aspects of the soil are interrelated and each aspect cannot be seen independent from the other.

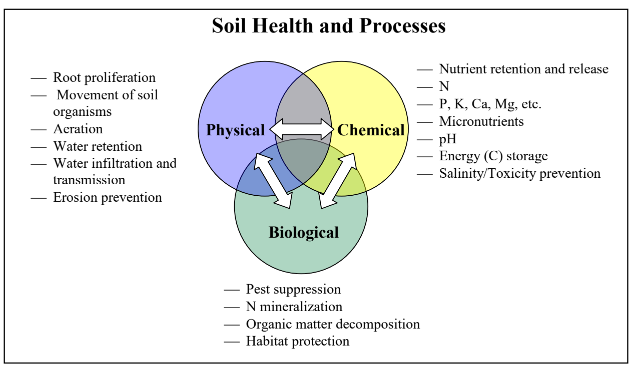


Figure 2.5.1. Processes affected by the physical, biological and chemical aspects of the soil.

Figure 2.5.1 shows the interdependence between the different soil aspects along with different soil processes belonging to each aspect. Understanding these inter-relationships and managing them for optimal soil performance are important to maintaining healthy soils. For example, aggregation in the surface soil is favored by organic matter, surface residue, and an absence of erosion and forces that cause compaction. A continuous supply of organic matter provides food for a variety of soil organisms. Large pieces of fresh organic material are used by macro-organisms such as spiders and ants that will pulverize the substrate and make it available for use by microorganisms. In the breakdown of the organic materials, substances are derived that can glue soil particles into aggregates. These organic compounds, mostly polysaccharides, are then used by other organisms and will decompose over time. Therefore, a continuous supply of fresh organic materials and roots of living plants as well as healthy and diverse soil organisms are needed to maintain good soil aggregation. Figure 2.5.2 shows the relationship between the aggregate stability and the total organic matter in some NY soils. The higher the soil organic matter in mineral soils, the higher the soil aggregate stability.

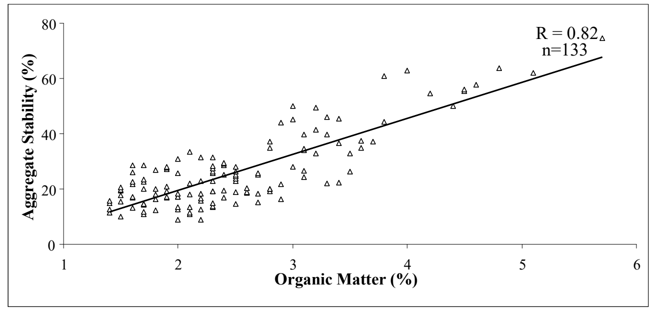


Figure 2.5.2. Relationship between aggregate stability and soil organic matter in some selected soils from the Cornell University research sites in NY.

For good soil health to be maintained, all the different aspects of the soil, physical, biological and chemical, must be well balanced and in good condition. Functionally, good soil health connotes that the soil can supply adequate amounts of nutrients but does not contain excessive levels, has appropriate pH levels, has high moisture availability, is well aerated, is penetrable to roots, has low erosion and runoff potential, and is biologically balanced. A soil's health is affected by inherent soil factors, such as texture, and management-related factors, such as fertility levels, compaction, and past erosion.

Soil health assessment relies on the measurement of carefully chosen soil indicators. From these, we can infer the health or the quality of the soil. The validity and the usefulness of any soil health assessment is as good as the set of indicators chosen. The criteria for choosing soil health indicators are often based on:

i. Sensitivity to management (does the soil measurement show distinct changes under contrasting management practices).
ii. How variable are the measured values of the indicator (is the measurement so variable that it becomes difficult to show distinct differences between management practices).
iii. How relevant is the measurement to soil processes (does the measurement integrate functional soil processes such as infiltration, aeration, nutrient cycling etc.).
iv. The cost and ease of sampling.
v. The cost of soil analysis.

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.

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.

Table 2.8.2. Estimated percent residue cover remaining on the soil surface after specific implements and field operations.

Implement	Nonfragile residue remaining
Plows:	
Moldboard plow	0–10
Disk plow	30–40
Machines that fracture soil:	
Paratill/paraplow	70–90
V ripper/subsoiler:	
12–14 in. deep, 20-in. spacing	60–80
Combination tools:	
Subsoil-chisel	50–70
Disk-subsoiler	30–50
Chisel plows with:	
Sweeps	70–85
Straight chisel spike points	60–80
Twisted points or shovels	40–70
Combination chisel plows:	
Coulter chisel plows with:	
Sweeps	60–80
Straight chisel spike points	50–70
Twisted points or shovels	30–60
Disk chisel plows with:	
Sweeps	60–70
Straight chisel spike points	40–60
Twisted points or shovels	20–50
Undercutters:	
Stubble-mulch sweep or blade plows with:	
Sweep/V-blade 30 in. wide	75–95
Sweeps 20–30 in. wide	70–90

2.15 Integrated Management of Field Crop Diseases

Efficient management of diseases affecting field crops in New York principally involves the sowing of seeds of disease-resistant crop varieties (where available and appropriate) and the employment of sound agronomic practices. Although the bulk of the following sections deal with chemical disease control tactics, it should be emphasized that in practice, chemical control is secondary to cultural control tactics and variety selection.

An attempt has been made to list all relevant fungicide products that satisfy three conditions: (1) they are effective in controlling some field crop disease(s) important in New York; (2) they have a federal (EPA) registration for use on a specific crop and target pest(s); and (3) they have a New York (DEC) registration for use on a specific crop and target pest(s).

Please be aware that many products that have a federal label for a crop use have not been registered for use in New York. Application of such materials in New York is illegal, even though the materials may be applied legally in adjacent states.

2.16 Managing Insects and Diseases with Seed Treatments

Seed treatments are an important tool for managing many pests and diseases of field crops. Nowadays, most commercial seed comes pre-treated with fungicide and insecticide seed treatments. But, there are also other treatments included in some commercial seed treatment packages, such as nematicides and plant growth regulators. It can be challenging to understand what is on the seed that you purchase, especially in some of the standard commercial seed treatment packages. Table 2.16.1 outlines some of the most common seed treatments and the individual treatments within seed treatment packages.

Pesticide registrations and availability of certain active ingredients can change at any time. It is the responsibility of the pesticide applicator to check on the current status of a particular product. The Bureau of Pesticides Management (New York State Department of Environmental Conservation), the Cornell Cooperative Extension Pesticide Safety Education Program (CCE-PSEP), or the chemical manufacturer or distributor can assist you in checking on a product's registration. Product label changes are available online from the NYS DEC at extapps.dec.ny.gov/nyspad/products.

Table 2.16.1 Commonly Available Seed Treatments

Type key: I = insecticide; F = fungicide; N = nematicide; P = plant growth regulator
Crop key: A = alfalfa; C = corn; S = soybean; SG = small grains; W = wheat

Type	Active Ingredient(s)	Product Name	Crop(s)
F	Azoxystrobin	Agri Star Azoxystrobin 100 ST	C, S, SG
		Dynasty	C, S, SG
F	*Bacillus amyloliquefaciens*, strain MBI 600	HiStick N/T Soybean[1]	S
		*L-2013 P	C
		*L-2012 R	C
F	carboxin	Vitavax-34	C, S, SG
F	copper hydroxide	Champ Formula 2	SG
		NU-COP 3L	SG
F	difenoconazole	*Difenoconazole 3L ST	SG
		Dyna-Shield Defuzed[1]	SG
		Salient 372 FS	SG
F	fludioxonil	Agri Star Fludioxonil 4L ST	C, S, SG, A
		Dyna-Shield Fludioxonil	C, S, SG, A
		Maxim 4FS	C, S, SG, A
		Spirato 480 FS	C, S, SG, A
F	fluopyram	*Ilevo	S
F	fluoxastrobin	†Fluoxastrobin ST	C, S, W
F	mancozeb	*Dithane F-45 Rainshield	C
		Dithane M45	C, SG
		*Manzate Max	C
		Manzate Pro-Stick	C, SG
		Penncozeb 75DF	C, SG
		*Penncozeb 80WP	C, SG
		STartUp MANZB	C, SG
F	mefenoxam	Apron XL	C, S, SG, A

Table continued on next page.

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.

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).

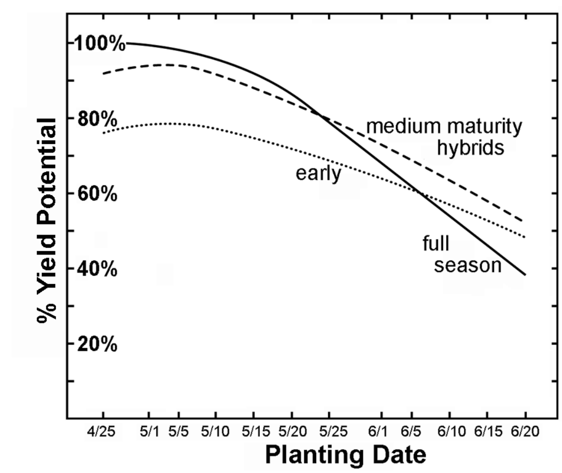


Figure 3.1.1. Effect of planting date on grain yields.

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).

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.

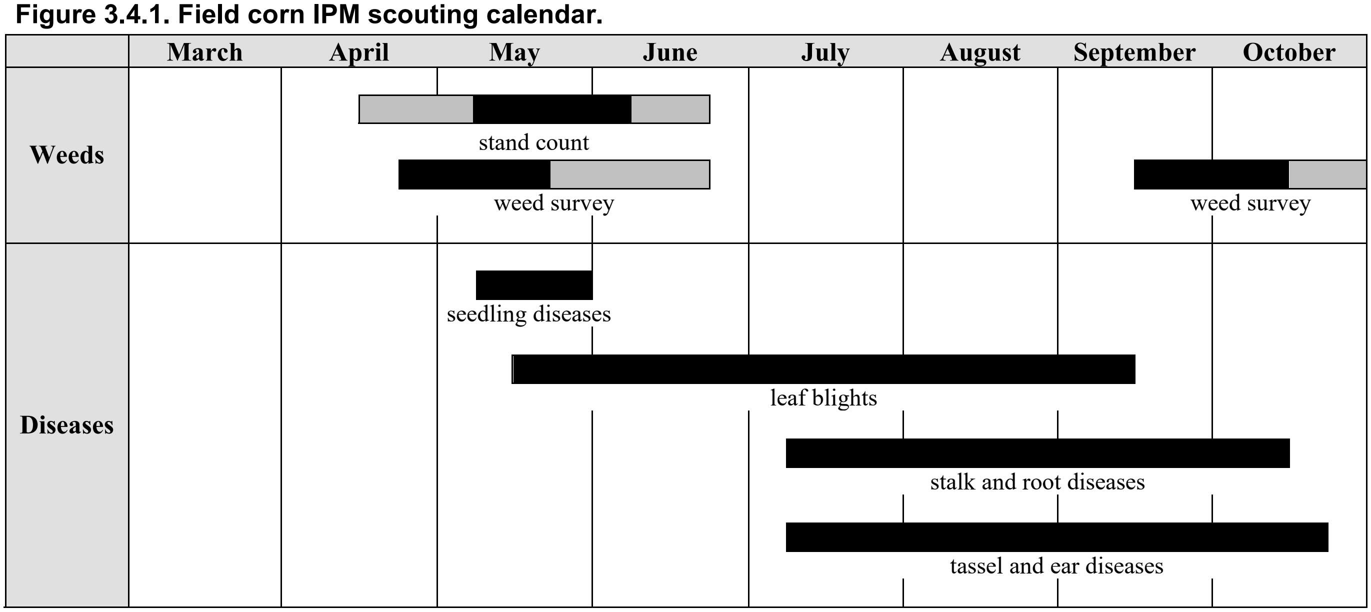
For the most current information on field crop pest activity during the growing season see the NYS IPM Weekly Field Crop Pest Report: (blogs.cornell.edu/ipmwpr).

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, wireworm, 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), western bean cutworm; watch for “occasional” pests	Weed escapes, common armyworm, European corn borer, 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, stalk rots, western bean cutworm; watch for “occasional” pests	European corn borer, vertebrate pests, nutrient deficiencies, environmental stress, hail
Late Season (harvest and postharvest)	
Ear mold and stalk rot assessment, yield checks, weed inventory survey, soil sampling	European corn borer, vertebrate pests, environmental stresses, lodging assessment

Figure 3.4.1. Field corn IPM scouting calendar.



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. Clover root curculios are unbiquitous in alfalfa growing regions. Larvae feed on alfalfa roots and reduce plant productivity. Check control guidelines in the section "Management of Insects in Forage Crops (section 4.10)."

New York alfalfa trials test yield of new varieties (Tables 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 to compare variety yields within trials. 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 and Seedway 9558 SBR (selected for resistance to alfalfa snout beetle).

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.

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 outlive alfalfa and 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 4.1.6: Alfalfa cultivar Features *(continued)*

For more information log on to blogs.cornell.edu/varietytrials/forage/

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***
SW4515	Alfalfa Partners	4	HR	HR	HR	HR	HR		
SW5509	Alfalfa Partners	5	HR	HR	HR	HR	HR		
SW5511	Alfalfa Partners	5	HR	HR	HR	HR	HR		
SW5520Y	Alfalfa Partners	5	HR	HR	HR	HR	HR		
SW5615	Alfalfa Partners	5	HR	HR	HR	HR	HR		
WL 349HQ	Seedway; Crop Prod. Services; W-L	4	HR	HR	HR	HR	HR	717-917-1609	www.wlresearch.com

*Disease ratings were provided by source companies, and from standard national tests.

Disease ratings code: HR = High resistance (50% or more of the plants resistant), R= Resistance (31-50% resistant), MR = Moderate resistance

FD = fall dormancy. Fall Dormancy ratings of 2,3 or 4 are recommended for New York State.

Cultivars rated R or HR to BW, VW, and Prr should have sufficient disease resistances to perform well in New York State.

*BW - bacterial wilt, VW-Verticillium wilt, FW-Fusarium wilt, An-Anthracnose, Prr-Phytophthora root rot

4.2 Perennial Grasses

Dairy management decisions are being affected more and more by environmental and manure management concerns. Grasses have several advantages over alfalfa: they do not fix atmospheric N to add to the N surplus on many dairy farms; they offer a much better option for manure management than does alfalfa; and they are a very good option when considering intensive grazing management. Grass production for high-quality dairy feed, however, requires a higher level of management than alfalfa production. Grass varieties that are being tested in Cornell forage trials are listed in Table 4.2.2 along with their heading dates and yield. Optimal first harvest yield and quality is at boot stage, just prior to seed head emergence. In the grass variety yield Table 4.2.2, heading date is the date when at least five grass seed heads were visible.

4.2.1 Reed Canarygrass

Reed canarygrass is a fast-recovering grass for intensive pasture programs as well as for hay or haylage. Reed canarygrass is a vigorous, tall-growing grass with the ability to adapt to diverse soil conditions. Until recently its primary uses were in waterways, ditch banks, and other areas where water stood for part of the year. However, reed canarygrass is also one of the most drought resistant of forage grasses. This adaptability helps this grass do well over a wide range of pasture conditions. Reed canarygrass grows fast in the spring and heads in late May. The first growth should be harvested early as pasture or hay to prevent it from becoming too stemmy. Reed canarygrass quality can be best maintained by frequent grazing or mowing throughout the season.

Reed canarygrass can be planted in a mixture with alfalfa. Reed canarygrass produces a very weak seedling, and until more research is done, establishing alfalfa-reed canarygrass with a companion crop (small grains or small grain-pea mixtures) is not recommended. Because no chemicals are cleared for weed control in alfalfa-reed canarygrass, a late summer seeding, when weed competition is less, may be better than a spring seeding.

Reed canarygrass varieties previously tested at Cornell have been bred for high palatability. They are low in alkaloids–chemicals found in common reed canarygrass that reduce animal intake and performance. These varieties are well adapted to New York and New England. Seed supplies of reed canarygrass are often short. Seed left over from last year should be tested by a certified seed testing laboratory. Reed canarygrass seed does not survive long-term storage, even under controlled-climate conditions.

4.2.2 Timothy

Timothy is the most popular grass with New York farmers, who routinely sow it in mixtures with alfalfa, red clover, and trefoil (Table 4.2.1). Timothy provides stand insurance when legumes die out and helps fend off weed encroachment. Timothy is a well-adapted crop in New York. A principal disadvantage is that timothy forage will always be 1-2 percentage units lower in protein than other perennial grasses. Farmers presently sow timothy-legume mixtures on more than two-thirds of New York's hay crop acreage.

4.2.3 Smooth Bromegrass

Smooth bromegrass has been a popular choice for mixtures with alfalfa (Table 4.2.1) but will not survive under intensive alfalfa management. Bromegrass will have difficulty persisting in alfalfa fields cut three to four times per year, particularly if the first cut is taken early. Because bromegrass produces more regrowth than timothy, it fits better where one or more harvests can be pastured. Bromegrass forms a strong sod and does well for hay, haylage, or silage. With supplemental nitrogen, bromegrass can maintain a high yield potential.

4.2.4 Orchardgrass

Orchardgrass can be established in either early spring, late summer, or as a frost seeding in late winter before the frost is out.

4.11 Weed Control in Forages

Glyphosate (Roundup PowerMax, Durango DMA, etc.) provides a means of controlling quackgrass before forage establishment. Spring seedings should be made before quackgrass reaches the four- to five-leaf stage, the recommended stage of development for treatment with glyphosate. As a result, fall applications are encouraged to control quackgrass and other perennial grasses before making spring seedings.

Fall applications of glyphosate are recommended between October 1 and November 15. Glyphosate should not be applied, however, if the average daily air temperature has dropped below 55°F for a seven-day period before application (glyphosate works best if soil temperature is 65° to 75°F). Spring applications can be made before late spring or summer seedings. Because glyphosate will not control weeds that germinate after application, this treatment should be used in combination with other weed control measures.

Scouting new legume seedlings for weeds should be done shortly after the seeding emerges because herbicides for annual broadleaf weeds must be applied when the legume is 1 to 3 inches tall and weeds have two to four true leaves. In established hayfields scouting can be done at the time of each harvest. This should provide adequate information for decisions on dormant or between-cuttings herbicide applications.

Though it is relatively easy to show the value of herbicides during legume establishment, it is more difficult to determine their value in established stands. To be economical, herbicide applications on established legumes must control the weeds, and the stand must have the potential for increased legume yields. If the legume stand is so poor that total forage yields decline when the weeds and/or grasses are controlled, the economics are questionable.

In a good stand, the removal of weed competition should increase the quantity and quality of the forage produced. Although the potential of a legume stand is difficult to evaluate, it is suggested that clear stands should have a minimum of five healthy crowns per square foot to justify herbicide application. Because grasses are sensitive to many of the herbicides available for use in established legumes, the guidelines given in Table 4.11.1 are for clear stands; in some cases, label restrictions limit their use to clear alfalfa. Roughstalk bluegrass is a perennial, cool season grass that heads in May and early June and then goes dormant in summer. This weedy grass is a problem in established alfalfa because it matures prior to first cutting harvest and the mature, somewhat woody stems of the bluegrass reduce palatability and quality of first cutting dry hay. Its presence in alfalfa that is harvested and preserved as haylage is perhaps of less concern than in dry hay. Research results show that seeding a perennial forage grass with alfalfa suppresses bluegrass and probably other weeds. The results show that the recommended seeding rate (4-6 lb. of seed per acre) for timothy or orchardgrass is adequate for this purpose.

4.11.1 Herbicide Resistance Management

Herbicide resistance management involves the use of crop rotation along with herbicide rotation and/or use of herbicide combinations that include herbicides with different sites of action (how they affect weeds). These practices will help manage existing herbicide resistant weed populations and delay development of new resistant weed populations.

To effectively utilize herbicides with different sites of action, everyone involved in decisions about weed management must have herbicide site of action classification readily available. The Weed Science Society of America (WSSA) has approved a numbering system to classify herbicides by their site of action (Mallory-Smith, C.A. and Retzinger, E.J. 2003. Revised classification of herbicides by site of action for weed resistance management strategies. Weed Technol. 17:605-619). A group number is given to all herbicides with the same site of action. These "GROUP NUMBERS" are included in the "Chemical weed control tables" in each crop section. Since herbicide resistance management is most effective when practiced across all crops in rotation, a list of all herbicides in this guide with their "**GROUP NUMBERS**" can be found in **Table 8.2.1** at the end of this book. Mode of action/site of action and chemical families for site of action GROUPS can be found in **Table 8.2.2** at the end of this book.

Table 4.11.1. Chemical weed control in forage crops.

Situation	Amount of Product(s) per Acre	Remarks and Limitations
Legume seedings without small grain companion crop		
Quackgrass	22-44 fl. oz. Roundup PowerMax **or** 20-40 fl. oz. Roundup PowerMax 3	**GROUP 9 HERBICIDES•** Apply these or other glyphosate products as preplant foliar sprays in the fall or spring when quackgrass is at least 8 in. tall (4- to 5-leaf stage) and actively growing. Fall applications should not be made in fields that have been tilled during the summer or mowed after August 15. Delay tillage for at least 3 days after spraying. Will not control weeds germinating after application. The low rates may not provide long-term quackgrass control. Labels include all forage grasses and forage legumes. Do not graze or harvest forage within 8 weeks after application.

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 5.7.3. Fungicides registered for control of important barley diseases in New York[a] *(continued)*

Fungicide(s)				Powdery mildew	Stagonospora blotch	Net blotch	Spot blotch	Scald	Rusts (*Puccinia* spp.)	Fusarium head blight[1]	Harvest restriction
Class	Active ingredient	Product	Rate/A (fl. oz)								
Mixed mode of action	fluapyroxad 2.8% pyraclostrobin 18.7% propiconazole 11.7%	*†Nexicor EC[2]	7.0-13.0	X	X	X	X	X	X	NL	Feekes 10.3
	fluxapyroxad 14.3% pyraclostrobin 28.6 %	*†Priaxor[3]	4.0 – 8.0	X	X	X	X	X	X	NL	Feekes 10.3
	prothioconazole 17.39% tebuconazole 8.7% fluopyram 8.7%	Prosaro Pro 400SC	10.3 – 13.6	X	NL	X	X	X	X	X	32 days
	propiconazole 11.7% azoxystrobin 13.5%	Quilt Xcel 2.2 SE Aframe Plus 2.2 SE	10.5-14.0	X	X	X	X	X	X	NL	Feekes 10.5.4
	prothioconazole 10.8% trifloxystrobin 32.3%	Stratego YLD[2]	2.3	X	X	X	X	X	X	NL	Feekes 8 (flag leaf ligule emergence) or 30 days
	benzovindiflupyr 2.9% azoxystrobin 10.5% propiconazole 11.9%	*Trivapro 2.21 SE[2]	9.4-13.7	X	X	NL	X	X	X	NL	Feekes 10.5.4
	metconazole 7.4% pyraclostrobin 12%	TwinLine 1.75 EC[3]	7.0-9.0	X	X	X	X	X	X	NL	Feekes 10.5

[a] *This information is provided as a guide for the convenience of barley producers in New York. Registrations are granted and withdrawn and labels are changed continuously. No endorsement is intended for products listed, nor is criticism meant for products not listed. It is the responsibility of the pesticide applicator by law to read and follow all current label directions and restrictions. An X indicates that control of a disease is included on the product label whereas NL indicates it is not a labeled use.*

* Restricted-use pesticide

† Not for sale or use in Nassau and Suffolk Counties.

[1] Statements of relative efficacy for suppression of Fusarium head blight severity and reduction of contamination of grain by the mycotoxin, deoxynivalenol, are based on consensus research observations by members of the USDA-NIFA Committee on Management of Small Grain Cereals (NCERA-184); members of NCERA-184 assume no liability resulting from use of these products.

[2]Aerial application not allowed in New York.

[3]Aerial application not allowed within 100 feet of aquatic habitats.

[4]Application of this product is not allowed within 100 feet of coastal marsh.

5.8 Managing Insects in Small Grains

Small grains - wheat, oats, barley, and rye - are usually fairly free of severe insect pest problems in New York. Three species have been of concern to farmers in recent years: the armyworm, the cereal leaf beetle, and the Hessian fly. Infestations of these insects are variable, occurring at irregular intervals or in localized areas of the state.

5.8.1 Armyworms

Armyworm outbreaks are sporadic with this insect occurring in very low numbers in some years and very numerous over a wide geographic area in other years. This insect does not overwinter in NYS or the Northeastern US but migrates into the area on the spring storm fronts from its southern overwintering area. Arriving migrant moths lay their eggs on available grassy areas which include small grains. While there are 2-3 generations of armyworm per season, it is the first generation which can cause economic losses in NY small grains.

The larvae are smooth cylindrical caterpillars, 1-1/2 to 2 inches long when fully grown. Their color ranges from tan to dark olive green, with a lighter stripe running along each side. They feed at night on the leaves of grasses and small grains but may "march" from badly infested fields during the day to other grain and corn. Look for chewed leaves, pellet-like frass on the ground, and larvae hidden during the day in the soil surface at the base of the plants. Armyworms may feed on the stem when most of the leaves are consumed and cause the grain head to drop off.

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

7 Total Vegetation Control

7.1 Total Vegetation Control

Weed control around farm buildings improves the appearance of the farm and reduces maintenance and labor costs. The chemicals available for this use include those listed in Table 7.1.

Table 7.1.1 Herbicides for total vegetation control.

Amount of Products per Acre	Remarks and Limitations
3-15 lb. Hyvar X IVM **or** 1-1/2-6 gal. Hyvar X-L IVM	**GROUP 5 HERBICIDES•** Apply before weed emergence or when weeds are young and actively growing. Do not apply when ground is frozen. Low rates are for annuals; high rates are for hard-to-control perennials.
4-30 lb. Krovar IVM	**GROUP 5 and 7 HERBICIDES•** Apply before weed emergence or when weeds are young and actively growing. Low rates are for annuals; high rates are for hard-to-control perennials.
5-10 gal. Pramitol 25E	**GROUP 5 HERBICIDE•** Apply before weed emergence or when weeds are young and actively growing. Low rates are for annuals; high rates are for biennials and perennials.
220-400 lb. Pramitol 5PS	**GROUP 5 HERBICIDES•** May be applied before or after plant growth begins. Low rates are for annuals; high rates are for biennials and perennials.
5-7.5 lb. *†Spike 80DF **or** 5-20 lb. *†Spike 20P	**GROUP 7 HERBICIDES•** Apply anytime except when the ground is frozen or the soil is saturated with moisture. For optimal results, applications should be made just before or just after emergence of plants in spring.

*Restricted-use pesticide

†Not for use in Nassau and Suffolk Counties

• Refer to Section 6.6.1 for information on herbicide resistance management and site of action groups.

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
Acropolis	60063-82	thiophanate-methyl + tetraconazole
Affiance SC	10163-332	tetraconazole + azoxystrobin
Aframe Plus 2.2 SE	100-1324	propiconazole + azoxystrobin
Alto 100 SL	100-1226	cyproconazole
*†Aproach SC	352-840	picoxystrobin
*†Aproach Prima 2.34 SC	352-883	cyproconazole + picoxystrobin
Avaris 200 SC	100-1178-5905	azoxystrobin + propiconazole
Caramba 0.75 SL	7969-246	metconazole
Delaro	264-1055	prothioconazole +trifloxystrobin
Domark 230 ME	80289-7	tetraconazole
Endura 0.7 DF	7969-197	boscalid
*†Evito 480 SC	66330-64	fuoxystrobin
*†Fortix	66330-409	flutriafol + fluoxastrobin
Headline AMP	7969-291	pyraclostrobin + metconazole
Headline EC	7969-186	pyroclostrobin
Headline SC	7969-289	pyraclostrobin
*Miravis Ace	100-1645	propiconazole + pydiflumetofen
*Miravis Neo	100-1605	pydiflumetofen + azoxystrobin + propiconazole
*Miravis Top	100-1602	pydiflumetofen + difenoconazole
*†Nexicor	7969-380	pyraclostrobin + propiconazole + fluxapyroxad
*Omega 500 DF	71512-1	fluazinam
*†Priaxor 4.17 SC	7969-311	pyraclostrobin + fluxapyroxad
Proline 480 SC	264-825	prothioconazole
*†Propulse	264-1084	fluopyram + prothioconazole
Prosaro 421 SC	264-862	prothioconazole + tebuconazole
†Prosaro Pro 400 SC	264-1209	prothioconazole + tebuconazole + fluopyram
Quadris Flowable 2.08 SC	100-1098	azoxystrobin
Quadris Top	100-1313	azoxystrobin + difenconazole
Quilt Xcel	100-1324	azoxystrobin + propiconazole
*†Revytek	7969-406	mefentrifluconazole + pyraclostrobin + fluxapyroxad
Sphaerex	7969-473	metconazole + prothioconazole
Stratego YLD	264-1093	trifloxystrobin + prothioconazole
Tilt 3.6E	100-617	propiconazole
†Topguard	279-3557	flutriafol
†Topguard EQ	279-3596	flutriafol + azoxystrobin
*Trivapro	100-1613	benzovindiflupyr + azoxystrobin + propiconazole
TwinLine 1.75 EC	7969-247	pyraclostrobin + metconazole
*†Veltyma	7969-409	mefentrifluconazole + pyraclostrobin
†Xyway LFR 1.92 SC	279-9658	flutriafol
†Xyway 3D 2.5 SC	279-9638	flutriafol
*†Zolera FX	66330-424	fluoxastrobin + tetraconazole

*Restricted-use pesticide

†Not for use in Nassau or Suffolk Counties.

[1]Trade names are given for convenience only. No endorsement of products is intended nor is criticism of unnamed products implied.

Table 8.2.1. Index of herbicide product names with active ingredients and site of action GROUPS. *(continued)*

Trade Name[1]	Active Ingredient(s)	Site of action GROUP(S)
Valor SX	flumioxazin	14
Valor XLT	flumioxazin + chlorimuron ethyl	14 + 2
Varisto	imazamox + bentazon	2 + 6
*†Verdict	saflufenacil + dimethenamid-P	14 + 15
*†Warrant	acetochlor	15
*†Warrant Ultra	acetochlor + fomesafen	15 + 14
Yukon	halosulfuron + dicamba	2 + 4

*Restricted-use pesticide

†Not for use in Nassau and Suffolk Counties

[1]Trade names are given for convenience only. No endorsement of products is intended nor is criticism of unnamed products implied.

[2] Not classified