Cole Crops

Tuesday afternoon 2:00 pm

Where: Grand Gallery (lower level) Room A-B

Recertification credits: 1 (1B, PRIV CORE)
CCA Credits: PM(1.5) CM(0.5)

Moderator: Jim Breinling, Regional Vegetable ICM Educator, MSU Extension

2:00 p.m. The ABC's of Cole Cropping in New York State

- Stephen Reiners, Horticultural Science Dept., Cornell Univ.

2:30 p.m. Cole Crop Insect Pest Management

- Beth Bishop, Entomology Dept., MSU

3:00 p.m. Weed Control in Cabbage and Broccoli

- Bernard Zandstra, Horticulture Dept., MSU

3:30 p.m. Controlling Black Rot of Cole Crops

- Christine Smart, Plant Pathology Dept., Cornell Univ.

THE ABC'S OF COLE CROPPING IN NEW YORK STATE

Stephen Reiners, Associate Professor
Cornell University, Department of Horticultural Sciences
NYS Agricultural Experiment Station, Geneva, NY 14456

Cabbage is king! At least that's true in New York State. In fact, all cole crops are big in New York, as you can see from Table 1. New York consistently is number 2 or 3 in the US for cabbage acres, and is the only vegetable crop in the state worth more than $100 million. Probably about half of the cabbage grown in the state is used fresh while the rest will go into storage (some common but more and more refrigerated and even a few controlled atmosphere), providing cabbage, when stored under the best of conditions, throughout the spring. Storage allows growers to sell their product when prices are high, and hold the product when prices dip. New York is also a major producer of kraut cabbage, second only to Wisconsin. Typical heads grown for kraut are much larger than those grown for fresh and storage, often weighing more than 10 pounds each.

Table 1. Acreage of cole crops in New York, 2007.

Crop	**NY Acres, 2007**	**Crop**	**NY Acres, 2007**
Cabbage, fresh and storage	13,000	Kale	100*
Cabbage, kraut	2,800	Collards	80*
Broccoli	400*	Mustard	70*
Cauliflower	366	Brussels sprouts	60*
Chinese cabbage	350*	Radishes	700*

*Estimate, based on 2002 Ag Census

Cabbage consumption among American consumers had been relatively stable from about 1970 through the mid-90's, at about 8.5 pounds per capita. This is far from the high of 22 pounds in the 1920's, but there seems to be some good news. In the mid-90's consumption increased to more than 10 pounds per capita as consumers, looking for convenience, began to purchase fresh cut salad mixes, which often include at least a small amount of shredded cabbage. In addition, cabbage and other cole crops have been featured in recent medical literature as an anti-cancer food. A challenge for the cabbage industry is that even though consumption is growing, by far the biggest consumers of cabbage are people older than 59. There is a need to market to the next generation.

Perhaps the most exciting marketing effort has occurred, surprisingly, with sauerkraut. The recipe for kraut has been the same for hundreds of years – take cabbage, shred, mix with salt, put in a large vat, cover, and wait. Research in the Department of Food Science at Cornell, has tested recipes that included garlic, onions, hot peppers, and dill. Most encouraging was that taste test showed that younger consumers preferred the flavored kraut more than older consumers.

Over the past 25 years we have seen a trend away from direct seeding and a greater use of transplants. There are a couple of reasons for this. First, the price of seed (and availability of labor) increased to a level where overseeding and thinning became prohibitive. Also, weed control options for direct seeding were more limited as compared to transplants. And growers know that a weedy field early in the season

will impact yield later. We still use transplants from producers in the south but production of locally grown has increased significantly in recent years.

Broccoli and cauliflower are grown in a limited quantity in NY, most of it for farm stands and retail. Crops can be grown for both spring and fall, but fall harvest is usually more consistent. Growers run the risk of buttoning or premature flowering with spring crops. This occurs when plants with more than 5 true leaves are exposed to low temperatures in spring (<60F daytime temps for 7-10 days). Smaller transplants are not affected by the cool temperatures. Another problem for summer production is the lack of heat tolerant varieties, especially in broccoli. Heads are distorted as the flower buds differentiate at different times.

With the exception of kraut cabbage, all NY cole crops are hand-harvested. At one time, kraut was harvested by cutting in the field and, using a pitchfork, lifting the head into a truck. This back breaking chore was replaced by a harvester in the 1960's that cuts the head and lifts them by belts into a waiting wagon. Since this is a one-time harvest, fields must be of uniform maturity for harvesting. Kraut cabbage is often harvested very late in the season to ensure the highest yield, which may be more that 30 tons per acre. Fresh cabbage is harvested from mid-July through late November. Storage cabbage is harvested late, especially those put in common (non-regrigerated) storage. One of the biggest challenges with cabbage in storage is bruising. Bruises will open cabbage up to secondary rots and reduce storage time significantly. Garbage in…garbage out!

By far the biggest cost in production for non-kraut cabbage is labor. New York, like other states, faces a limited Ag labor supply. New York, seemingly more than other states, is faced with INS raids or at least the threat of a raid. Many cabbage growers have awakened to find their labor force has seemingly disappeared overnight when INS agents are rumored to be in the region.

High quality cabbage, cauliflower and broccoli begins with a soil test, something that should be done on all fields at least every three years. Growing any crop without reliable soil test results is risky and just not worth it. For under $20 a soil test can give you the pH, organic matter content, cation exchange capacity, and the levels of most of the nutrients needed for plants. A soil test may be even more important for cole crops as imbalances in phosphorus, potassium, calcium, boron, and nitrogen will result in visible problems that will reduce your marketable yield.

Let's start with the pH. Cole crops, like most vegetable crops, do best in a slightly acid soil, from 6.0 to 6.5. If the pH is below 5.5, it's best to apply limestone in the fall so that it has time to react with the entire plow layer (at least two plowings). If a fall application is not possible or more than four tons per acre need to be added, a split application is recommended. Plow down half and apply the rest to the surface and disk in. This will provide a pH favorable for seedling development.

Many cole crop growers will raise their pH to levels above 7 where clubroot is known to be a problem. Clubroot is a fungus disease that will live in the soil for many years, even if no cabbage has been grown there. It can survive quite nicely on crucifer weeds like yellow rocket. Infected plants will first wilt on bright, sunny days and recover at night. Eventually, the plants will not recover and when dug up, knobby, clubbed roots are present rather than a normal root system. Control of this disease is difficult with chemicals but when pH is raised to 7.2 and above, the fungus cannot infect plants. If you are using a high pH to control Clubroot, be aware that at pH 7 and above, some elements will become less available. These include zinc, copper and boron. These elements, needed in very small amounts, may be blended with the banded fertilizer (preferred) or added in a foliar spray later in the season.

Once you have the pH adjusted, it's time to plan your fertilizer program. In New York, we recommend the following;

Table 2. Recommended rate of nutrients to apply to cole crops based on soil tests.

N	P_2O_5			K_2O			
pounds/Acre	**pounds/acre**			**pounds/acre**			**Comments**
	Soil Test Level			**Soil Test Level**			
	low	**med.**	**high**	**low**	**med.**	**high**	
100-120	**120**	**80**	**40**	**160**	**120**	**60**	**Total Recommended**
Application for direct seeding							
40	80	40	0	120	80	20	Broadcast and disk in[1]
40	40	40	40	40	40	40	Band place with planter
20-40	0	0	0	0	0	0	Sidedress four weeks after seeding
Application for transplants							
40	80	40	0	120	80	20	Broadcast and disk in[1]
40	40	40	40[2]	40	40	40	Band place with planter or broadcast before transplanting
20-40	0	0	0	0	0	0	Sidedress 2-3 weeks after seeding

[1]Growers with leachable soils may split the necessary nitrogen between planting and sidedressing and eliminate broadcast applications.

[2]If phosphorus level is high, starter solution may provide adequate phosphorus with no additional P_2O_5 needed.

Cool soils will tie-up some of the nutrients needed for plant growth. Nitrogen, normally slowly released from soil organic matter, becomes available only as the soil warms up. Phosphorus too is bound in the soil at temperatures 60F and below. Only about 1/3 is available at 60F compared to 70F. We can see early season P deficiencies even in soils that are very high in P.

Like all vegetables, to get plants off to a good start, a starter fertilizer is recommended. Typically, a banded fertilizer is placed no closer than two inches to the side and two inches below the seed furrow as it is planted. The fertilizer should stay far enough from the seed to avoid burning but close enough to provide nutrients. Never apply more than 100 pounds of the combined N and potassium (K) in the band or you risk burning the seedlings. The level of P in the band is not as critical as P is normally less likely to burn. For transplanted crops, a starter solution that is relatively high in P_2O_5 is recommended, especially on early planted crops when the soil is cool.

Cole crops are attacked by numerous insects and diseases. In NY, probably the biggest insect problem is onion thrips. Old timers say that 30 years ago this pest was minor but today can cause major losses. Growers have had some success with tolerant varieties and the use of Assail. Swede midge is a new pest in NY, found for the first time five years ago. More of a problem on broccoli, the midge lays eggs on the growing tip. When these hatch, the tiny larvae feeding causes leaf galls and misshapened growing points. Other problems include root maggots, flea beetles, the worm complex (Diamondback, Cabbageworm, and looper), aphids, especially in dry years.

The bacterial disease black rot, has resulted in significant losses in recent years. The disease is often seed borne. Hot water treatments of seeds will help control the problem but may result in loss of seed vigor if the treatment temperatures are too high. Dr. Chris Smart at Cornell has an ongoing project that is developing DNA fingerprinting of the strains in NY. Other disease problems include clubroot, downy mildew, root rots, and white mold. Besides chemical treatments, cole crops benefit from a long rotation (at least 3 years) to minimize disease problems.

There are several problems that affect cole crops that are caused by nutrient deficiencies or imbalances. These include;

Tipburn. This disorders is familiar to most and affects all leafy cole crops. The leaves half an inch to an inch under the top of the head dry out.

Tipburn is caused by water movement going from the roots to the outside of the head, without carrying enough calcium to the center. Moist soils and high transpiration are especially bad conditions. Calcium levels are usually adequate in the soil but conditions prevent uptake.

Black Midrib (or black petiole). The outside of the midrib near the attachment point turns dark first. The outer leaves are most affected. The dark areas are in the fleshy part of the midrib, not associated with the surface or with the veins.

Dr. Nathan Peck of Geneva studied this disorder in the 1970's and attributed it to a deficiency of K in soils that have abundant P. Additional K fertilizer has been effective at reducing the incidence.

Pepperspot (or black speck). There is also a viral disorder with the same name. This disorder starts with a blackening of the cells surrounding stomata. The lesions grow with time.

Pepperspot is the result of salts or toxic metals that accumulate at the stomata after high transpiration. Either a salty soil, or a low pH soil that has high nickel and copper available will predispose plants to pepperspot when weather is dry and warm. Over maturity will also favor development of the disorder.

COLE CROP INSECT PEST MANAGEMENT

Beth A. Bishop
Department of Entomology, Michigan State University
(517) 432-6520, bishopb@msu.edu

Managing insect pests in Cole crops presents unique challenges both because of the variety of pests involved and the diversity of the crops themselves. This presentation will discuss how to manage each of the major insect pests of Cole crops. Pests will be addressed in the approximate order they appear during the growing season. Emphasis will be placed on integrated management principles and will include a discussion of pest life cycle (knowledge of life cycle is critical for management), scouting and thresholds, and management practices.

Early Season Pests: include cabbage maggot and flea beetles (Table 1). Cabbage Maggots are flies as adults and spend the winter as pupae in the soil. They adapted to cool weather and begin development very early in the spring. Adult cabbage maggot flies lay eggs at the base of plants. Upon hatching the larvae (maggots) burrow into the developing roots, disrupting water transport to the plant, causing wilting stunted plants, and death. Later in the season subsequent generations can cause cosmetic damage to root crops (turnips, radishes, etc.).

Flea beetles overwinter as adults in plant debris and become active when weather warms. They are efficient movers, and can migrate into a crop field very quickly. Adults feed on foliage and large populations can severely damage seedlings. Later in the season adult feeding can reduce the quality of greens (mustard greens, collards, kale, etc.). Adults lay eggs in the soil and the tiny larvae feed on roots. Larvae do not cause economic damage to most Cole crops, but larval feeding can cause cosmetic damage to root crops such as radish and turnips.

Mid-Season Pests: include imported cabbageworm (a.k.a. cabbage butterfly) and diamondback moth. Imported cabbageworm adults are small white butterflies with black spots that are seen flitting over plants throughout the growing season. The year's first adults begin flying early (April), before any Cole crops are planted, but they lay eggs on and the first generation caterpillars feed on wild mustard species. Subsequent generations of adults lay eggs on Cole crops. Imported cabbageworm caterpillars are dark green, up to 1 ¼ inch long, with a velvety-appearance and have a very thin yellow line down their back. They feed on foliage, creating plants with large, irregular holes and contaminating crops with their frass.

Diamondback adults are very small (1/2 inch) brown moths. Some diamondbacks overwinter in the Great Lakes region. Others migrate into the area each year. Others may be transported to fields on infested transplants. Adult moths lay eggs on all Cole crops, although they prefer collards to other varieties. The small caterpillars (up to 1/3 inch long) are pale green with pointed ends. When disturbed, they fall off plant and dangle from silken threads. Diamondback caterpillars feed on foliage producing many small holes. Very small caterpillars may mine the leave, creating a "windowpane" effect. Their silken cocoons cause contamination at harvest. Diamondback moths can develop resistance to insecticides very quickly.

Late-Season Pests: include cabbage loopers, aphids and thrips. Unlike cabbageworms and diamondback moths, cabbage loopers are unable to survive the Michigan winter. New individuals migrate into the state each growing season. Cabbage looper adults are large (1 ¼ inch), brown, nondescript moths that are active at night. They may migrate into Michigan anytime during the growing season, depending on weather patterns, but they are most likely to appear in July. Cabbage looper caterpillars are, large (1 ¾ inch), green caterpillars with white stripes along their sides. They have a characteristic "inchworm" type movement, and alternating arching and straightening their bodies (thus their name "loopers"). They feed on foliage creating large, irregular holes. Because of their size they can severely damage crops and their frass causes major contamination. Large caterpillars are difficult to control.

Aphids, also called "plant lice", are small (1/12 inch or less), oval-shaped insects. Both adults and immatures feed by sucking sap from the plant. Aphids are the reproduction champions of the insect world. Their numbers can increase very quickly. Populations often build up quickly in hot, dry or when broad-spectrum insecticides are applied (this kills many of their natural enemies). Cabbage aphids are bluish-gray and form very dense colonies. Their feeding can cause distorted foliage, but they are mainly a contaminant at harvest. Aphids in the heads of cabbage, cauliflower, Brussels sprouts, or broccoli are almost impossible to remove. Brussels sprouts are particularly susceptible to aphid infestations.

Onion thrips are sometimes a late season pest of cabbage. Both adults and immatures live on and feed on the plant. These very small insects feed by rasping the plant surface and sucking the juice. Their feeding causes brownish rough areas on cabbage leaves,. They are also adapted to living in very tight places, which means they hide in the heads where they are protected from rain, pesticides, etc. and can also be a contaminant at harvest. Cabbage plants located near onion fields will often experience an influx of onion thrips as the onion plants mature and die down.

Table 1. Insect Pests of Cole Crops

Pest	Type	Overwintering Stage	Attacks
Early Season Pests			
Cabbage Maggot	Adult: Fly Larva: Maggot	Pupae in soil	Larvae feed on roots
Flea Beetles	Adult: Beetle Larva: Very small beetle larva	Adults in grass and leaf litter	Adults feed on foliage Larvae feed on roots
Mid Season Pests			
Imported Cabbageworm	Adult: Butterfly Larva: Caterpillar	Pupae on plant debris	Larvae feed on foliage
Diamondback Moth	Adult: Small moth Larva: Caterpillar	Some overwinter as adults Some migratory Carried in on transplants	Larvae feed on foliage
Later Season Pests			
Cabbage Looper	Adult: Moth Larva: Caterpillar	Migratory	Larvae feed on foliage
Cabbage Aphids	Adult and immature similar. Winged and wingless	Eggs in crop residue	All stages suck plant juices. Brussels Sprouts most susceptible
Onion Thrips	Adult and immature similar	Adults and nymphs on grains, clover, alfalfa	All stages rasping, sucking on cabbage foliage.

A key to effective pest management is regular scouting of the crop to determine pest presence and abundance (Table 2). At least five different areas of the field should be chosen, and 10 to 20 plants inspected for pests and/or damage. In addition, yellow sticky traps placed in and around Cole crop fields early in the growing season can alert growers to the presence of cabbage maggot flies and flea beetles. Traps should be changed at least weekly. Another valuable scouting tool is pheromone trapping. Pheromones are scents produced by female moths that attract males for mating. Synthetically produced pheromones can be purchased and used in traps to assess presence of and abundance of diamondback moths and cabbage looper. Yellow, sticky traps and pheromone traps and lures may be purchased through several sources, including Great Lakes IPM (http://www.greatlakesipm.com/), Gemplers (http://www.gemplers.com), or others.

Regular scouting helps growers determine when pests are at threshold. The treatment threshold is the pest population level at which control measures must be initiated to prevent economic damage. Treatment threshold usually varies with crop type and growth stage. Thresholds have not been determined for every pest, for example, there are no treatment thresholds for flea beetles or onion thrips. In these cases growers can use their judgment when evaluating crops.

Table 2. Scouting and threshold Summary of Insect Pests of Cole Crops

Pest	Scouting	Threshold
Early Season Pests		
Cabbage Maggot	Phenology Yellow Sticky Traps Yellow Dish Pans	Adults flying and laying eggs
Flea Beetles	Yellow Sticky Traps Whole plant Observation	Undetermined. Depends on crop stage and crop type. Most damaging to seedlings and edible greens. Larvae may damage radishes/turnips.
Mid Season Pests		
Imported Cabbageworm	Whole plant sampling	Depends on crop stage **Percent Infestation (WI)** In seed bed: 10% infestation Transplant-> cupping (Cabbage): 30% Cupping -> early heading (Cabbage): 20% Transplant->curd (broccoli, cauliflower) 50% Heading or curds to harvest (all): 10% **Cabbage Looper Equivalents (CL)** 1 CL =1 cabbage looper, 1.5 cabbageworm or 20 diamondback moths **NY: Cabbage** Prior to heading: 2-3 CL Equivalents After heading: 0.5 CL equivalents
Diamondback Moth	Pheromone traps Whole plant Sampling	
Later Season Pests		
Cabbage Looper	Pheromone Trap Whole Plant Sampling	
Cabbage Aphids	Whole Plant Sampling	Broccoli and Cauliflower, Prior to heading 100 aphids per plant After heading: aphids present Cabbage, Brussels Sprouts: 1-2% of plants infested
Onion Thrips	Whole Plant Sampling	Undetermined. Presence of damage or thrips

An integrated approach to insect pest control makes use of all effective control strategies in a complementary way (Table 3). Cultural control methods (crop rotation, resistant varieties, trap cropping, etc.) can reduce pest numbers and reduce or eliminate the need for insecticide application. When necessary, insecticides should be chosen carefully, so as not to impact biological control agents.

Table 3. Control measures for Insect Pests of Cole Crops

Pest	Cultural Control	Biological Control	Insecticide
Early Season Pests			
Cabbage Maggot	Crop Rotation Avoid planting when adults are flying Delay planting till soil warms		Apply soil insecticide at planting or transplanting. Insecticides against flies ineffective
Flea Beetles	Trap crop or perimeter crop. Collards preferred.		Foliar insecticides for adults. Soil insecticides for larvae. Spot treat problem areas
Mid Season Pests			
Imported Cabbageworm	Do not prefer red and savoy cabbage	Lots of natural enemies (diseases, parasites and predators).	Bacillus Thuriengiensis effective (does not impact natural enemies)
Diamondback Moth	Inspect transplants for larvae Collards as trap crop	Lots of diseases, parasites and predators. As many as 90% of larvae may be parasitized.	Bacillus Thuriengiensis effective (does not impact natural enemies) Spinosad (SpinTor, Entrust) May develop insecticide resistance
Later Season Pests			
Cabbage Looper		Lots of diseases, parasites and predators.	Target small larvae May develop insecticide resistance
Cabbage Aphids	Crop rotation	Often effectively controlled by natural enemies. Lots of diseases, parasites and predators.	Avoid over-application of broad-spectrum insecticides (kills natural enemies). May develop insecticide resistance
Onion Thrips	Prefer tighter headed varieties		May develop insecticide resistance

Cole Crop Weed Control

Bernard Zandstra
Michigan State University

Preemergence Herbicides Currently Registered for Cole Crops

- **Treflan** (trifluralin)
- **Devrinol** (napropamide)
- **Dual Magnum** (s-metolachlor)
- **Command** (clomazone)
- **Goaltender** (oxyfluorfen)
- **Spartan** (sulfentrazone)

Postmergence Herbicides Currently Registered for Cole Crops

- **Stinger** (clopyralid)
- **Poast** (sethoxydim)
- **Select Max** (clethodim)
- **Roundup** (glyphosate)
- **Gramoxone** (paraquat)
- **Aim** (carfentrazone)

Preemergence Weed Control

Treflan 4 EC (trifluralin)

- 1. Use rate: 1-2 pt/acre
- 2. Must be incorporated soon after application.
- 3. 4-6 weeks suppression of most annual grasses, lambsquarters, pigweed, and purslane.
- 4. No control of mustards or composites.
- 5. Inexpensive.

Devrinol 50 DF (napropamide)

- 1. Use rate: 2-4 lb product/acre.
- 2. May be PPI or applied after transplanting.
- 3. 4 week suppression of annual grasses and Redroot pigweed.
- 4. No root stunting in cold soil; good for early season use.
- 5. Expensive.

Dual Magnum 7.62 EC (s-metolachlor)

- 1. Cabbage only; indemnified 24C label.
- 2. Use rate: 0.5-1.3 pt/acre.
- 3. Apply before transplanting or within 48 hrs after transplanting.
- 4. 4-5 weeks control of annual grasses, pigweeds, nightshades; some nutsedge suppression.
- 5. Poor-fair control of mustards, lambsquarters, composites.
- 6. Do not tank mix with **GOAL** (label restriction)

Command 3 ME (clomazone)

- 1. Cabbage only.
- 2. Use rate: 0.7-1.3 pt/acre.
- 3. Apply before transplanting.
- 4. Controls annual grasses, lambsquarters, velvetleaf, ragweed.
- 5. May bleach or stunt cabbage.

Goaltender 4 SC (oxyfluorfen)

- 1. Use rate 0.5-1 pt/acre.
- 2. Apply to soil before transplanting.
- 3. Not for use on Brussels sprouts.
- 4. Controls most annual broadleaves and grasses.
- 5. Irrigate after application and transplanting.

Spartan 4 F (sulfentrazone)

- 1. Processing cabbage only.
- 2. Use rate: 2.3-6 fl. oz/acre.
- 3. Apply before transplanting or directed between rows after transplanting.
- 4. Controls annual grasses, lambsquarters, pigweeds.

Postemergence Herbicides

Stinger 3 L (clopyralid)

- 1. Use rate: 4-8 fl. oz/acre.
- 2. May be applied anytime during the season. 30 day PHI.
- 3. Controls composites, legumes, nightshade. Stunts smartweeds.
- 4. Maximum of 2 applications/season.
- 5. Expensive ($20-30/acre/application).
- 6. 30 day PHI.

Poast 1.5 E (sethoxydim)
Select Max 0.97 E (clethodim)

- 1. **POAST** 1 pt/acre;
  SELECT MAX 12 fl. oz/acre.
- 2. Controls most annual grasses postemergence.
- 3. 30 day PHI.

Aim 1.9 EW (carfentrazone)

- 1. Use rate: 6.1 fl. oz/acre.
- 2. Apply as a shielded spray only.
- 3. Controls most small annual broadleaves.
- 4. Drift to crop plants will cause serious injury and yield reduction.

Potential New Labels for Cole Crops

- **PROWL H20**(pendimethalin)
- **OUTLOOK**(dimethenamid-p)
- **GOALTENDER**(oxyfluorfen) POSTEMERGENCE

Weed Control Recommendation for 2009

Early Season

- 1. Apply **GOAL** to soil surface; transplant cabbage; broadcast **DEVRINOL** over the field.
- 2.Cultivate and sidedress 4-6 weeks after transplanting.
- 3. Apply **POAST** or **SELECT MAX** for POST grass control.
- 4. Apply **STINGER** for composite, nightshade, and smartweed control.

Transplanting After May 15th (soil temp >55˚F)

- 1. PPI **TREFLAN**; apply **GOAL**; transplant crops.
- 2. Cultivate and sidedress.
- 3. **POAST** or **SELECT MAX** for grasses.
- 4. **STINGER** as needed.

Special Problems

- 1. Velvetleaf – use **COMMAND** PRE transplant.
- 2. Nightshade or yellow nutsedge – use **DUAL MAGNUM**.
- 3. Mustards, wild radish – **GOAL** PRE transplant, cultivation, hoeing, weed removal, crop rotation.

Cole Crop Weed Control Summary

- 1. Use at least 2 PRE herbicides; either before or after transplant.
- 2. All the PRE herbicides require some moisture for activation.
- 3. Stay ahead of the weeds.
- 4. Disk fields after harvest to kill weeds before they set seed.

CONTROLLING BLACK ROT OF COLE CROPS

Chris Smart and Holly Lange
Assistant Professor and Research Technician
Department of Plant Pathology and Plant-Microbe Biology
Cornell University, New York State Ag Experiment Station
Geneva, NY 14456

Black rot, caused by the bacterium *Xanthomonas campestris* pv. *campestris* (*Xcc*), is a significant disease of cabbage, and other crucifer crops world-wide. This disease has been a serious problem in New York and is listed as a high priority for the industry. The pathogen can be spread through infected seeds or from plant-to-plant through water droplets, and can spread rapidly in transplant greenhouses and seed beds. In other locations where black rot is prevalent, the disease has been shown to spread from weeds, and debris in the soil. The relative role of weeds and soil debris as a source of the pathogen, compared with infected seed is unknown. The overall goal of this project is to gain a better understanding of the potential sources of inoculum of black rot, and the severity of disease from different sources. This information will allow the development of management strategies for control of this disease, and ensure that new varieties are tested against the most aggressive strains of the pathogen.

Since 2004, our program has been using DNA fingerprinting to identify strains of the pathogen. We have surveyed black rot pathogen isolates annually from both cole crop and weed hosts using selective media, ELISA, pathogenicity, and DNA fingerprinting. Our studies have shown that while it is possible for the pathogen to over-winter in NY, this has not been the most common source of inoculum. Fingerprinting results have identified new strains of *Xcc* in NY each year of the study (2004-2008).

To better understand the role of weeds as a source of inoculum, we performed two studies. First, we collected weed samples in the spring, from 5 fields that had severe black rot the previous fall. From each field, 15-20 weed samples were collected, and we attempted to isolate Xcc. The pathogen was isolated (based on molecular data) only from cruciferous weeds, however none of the bacteria isolated produced symptoms on cabbage plants when inoculated in our greenhouse assay. Additionally, the DNA fingerprint patters of the isolates obtained from weeds did not match any of the DNA fingerprint patterns from isolates obtained from cole crops. This means that the isolates we collected from weeds did not come from the severely infected cabbage that were in the same field the previous year.

In the second study performed to better understand the role of weeds in spreading black rot, 51 weed samples were collected between April and October 2007. Yellow bacteria (potentially *Xanthomonas)* were isolated from 18 of the 51 samples. Seven of the 18 were *Xanthomonas campestirs* based on selective media tests (however these media can not specifically identify pv. *campestris)*. Two of the 7 were pathogenic on cabbage in our greenhouse. Both of these isolates were from the same farm, isolated on May 10, 2007 from shepherds' purse. One isolate was collected from a field that had been in cabbage in 2006, while the other had been planted in snap beans in 2006. Thus, while strains of *Xcc* that are pathogenic to cole crops can be harbored and

detected in weeds in New York, this does not seem to have been the predominant source of inoculum over the past 4 seasons.

We have also completed testing 9 cabbage varieties to determine the susceptibility of each variety to strains of the black rot pathogen collected in New York. The 8 varieties included; Superstar, Fresco, Gonzales, Bobcat, Vitaton, Kaitlin, Megaton and Thunderhead. Each cabbage variety was inoculated with each of 7 *Xanthomonas campestris* pv. *campestris* isolates, plus one water inoculated control. Varieties respond differently to different isolates of *Xcc*. Vitaton, Thunderhead and Superstar were tolerant to some (but not all) strains. However, Kaitlin, Fresco, Bobcat, Gonzales, and Megaton were consistently quite susceptible.

Finally, a field trial was conducted to look at efficacy of various compounds to control black rot and downy mildew. Copper is still the best choice for control of black rot, as we have not identified any resistance to copper in the black rot pathogen in New York. Downy mildew is not as common as black rot, but can be very severe. This disease frequently appears in the fall when temperatures are cool and there are long periods of morning dew.

Table 1. Black Rot control using weekly sprays of various compounds for 6 weeks.

Treatment	Rate	Incidence (%)						Disease severity (%)			
		7 Aug[y]		12 Aug		17 Aug		12 Aug		17 Aug	
Unsprayed control ……	NA	29.1	ab	100	a	100	a	25.00	a	31.30	a
Actigard 50 WG……....	1 oz/A	62.5	a	100	a	100	a	9.50	b	23.75	a
Kocide 3000 WG……..	1lb/A	13.6	b	100	a	100	a	4.75	b	8.25	c
Manex SC…….……...	1.6 qt/A	23.4	b	100	a	100	a	13.75	ab	18.75	b
Manex SC +……..	1.6 qt/A	12.3	b	100	a	100	a	10.00	ab	11.75	bc
Kocide 3000 WG……..	1lb/A										
Tanos 50DF[z] +……..	8oz/A	10.0	b	100	a	100	a	8.75	ab	12.75	bc
Manex SC ……..	1.6 qt/A										
Tanos 50DF[z] +……..…	8oz/A	20.9	b	95.5	a	100	a	10.75	ab	16.25	b
Manex SC +……...…	1.6 qt/A										
Kocide 3000 WG ……..	1lb/A										

[z] Tanos applied every other week

[y] Column numbers followed by the same letter are not significantly different at *P*=0.05 as determined by Fisher's LSD.

Table 2. Downy mildew control using weekly sprays of various compounds.

Product	**Rate**	**Incidence (%)[z]**
ActiGard 50WD	1oz/A	93.25 ab
Unsprayed	NA	100.0 a
Kocide 3000WG	1lb/A	79.50 abc
Manex SC	1.6qt/A	48.75 cd
Manex+Kocide	1.6qt+1lb/A	66.25 bcd
Tanos+Manex[y]	8oz+1.6qt/A	51.50 cd
Tanos+Manex+Kocide[y]	8oz+1.6qt +1lb/A	28.50 d

[y]Tanos applied every other week

[z] Column numbers followed by the same letter are not significantly different at *P*=0.05 as determined by Fisher's LSD.