PEST MANAGEMENT STRATEGIC PLAN FOR PROCESSING PEAS IN NEW YORK

Summary of a Workgroup Meeting
February 16, 2011
Canandaigua, New York
(Report completed June, 2012)

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EXECUTIVE SUMMARY

Processing green peas are an important crop in New York with an average of 17,689 acres planted annually (10 yr avg.). Currently, the pea crop is packed as a frozen product at facilities in Oakfield and Bergen, NY (Genesee County). Pea acreage declined nationally in 2010 and 2011 due to large inventories on hand and reduced demand. Compared to other processed vegetables, peas have the lowest yield per acre and the highest raw product cost, yet they are often sold at the same price. This results in low profit margins in mono-packs and added cost to vegetable blends. Hence, peas are becoming less desired by the industry. Historically, yields of peas in New York have been among the highest in the nation. The production outlook for peas in New York is uncertain because of changes in ownership of the processing plants. For pea acreage to be kept in New York, high quality, yield, and low cost production must be maintained.

A significant amount of research and extension has been conducted on processing peas in New York. A research fund is set up annually from grower and processor dollars set aside in contracts and managed via the New York State Vegetable Research Association and Council. Each December, a Processing Pea Advisory Meeting is held to review the previous growing season and hear updates on funded research. At the conclusion of the 2-hr meeting, research priorities are set for the ensuing Request for Proposals. Production guidelines are updated annually (Cornell Vegetable Guidelines http://www.nysaes.cornell.edu/recommends/). In past years, a portion of the pea crop was grown as an IPM labeled product, using the Cornell IPM Elements (http://nysipm.cornell.edu/elements/pea.asp), however, this product has been discontinued. Production Guidelines for Organic Peas for Processing were developed by Seaman et al. in 2009 due to interest from a processor. However, there are currently no organic peas grown for processing in New York that we are aware of.

A unique requirement of the processors is to document the needs (and the planning process) of the industry and farm management strategies in order to meet the requirements of Sustainability Audits from their customers. The industry also recognized the need to develop documentation that would support regulatory processes and the ability to attract research funds from other agencies. The previous crop profile was completed in 1999 and needed updating. A PMSP workgroup was formed of processors, growers, crop scouts, and researchers to discuss in-depth the critical pest management needs in the processing pea industry. The group met for an all-day meeting on February 16, 2011 in Canandaigua, NY. The report was finalized in early 2012 and contains the most up-to-date information as of that time.

The primary diseases identified as critical are Fusarium cortical rot and Fusarium wilt. These diseases can cause root rot and entire collapse of fields. Severity of these root diseases is increased by soil compaction and poor drainage. Foliar diseases are not a current concern for processing peas in New York.

Weeds were identified as the biggest problem overall in NY pea fields. Broadleaves such as lambsquarters, red root pigweed, and ragweed, and annual grasses such as fall panicum, foxtail sp., and barnyard grass not only reduce yields by competing with the crop, they can interfere with harvest by tangling around equipment. Buds of corn chamomile “daisy” and Canada thistle can be a contaminant at harvest because they are similar size and color as the shelled peas. Nightshade berries may also be a contaminant and may become more of a problem if warm spring weather, as occurred in 2010, becomes a more frequent pattern.

Seed corn maggots and aphids are generally only an occasional pest of peas in NY. Heavy aphid populations can attract lady beetles, which can be a contaminant at harvest. Colorado potato beetles feeding on volunteer potatoes or solanaceous weeds are also a contaminant. Slugs and snails are another contaminant when wet weather occurs at or near harvest.

The critical needs outlined on the following pages must be addressed in order to ensure the success of future processing pea production in New York.

PRIORITIES/SUMMARY OF MOST CRITICAL NEEDS

General Comments

Production of a high-yielding pea crop requires a whole-farm management plan in which field selection, crop rotation, cover cropping, and other practices are considered at least 3 to 4 years in advance. This schedule helps to reduce the populations of root rot pathogens, weed seeds, and perennial weeds and to maintain good soil health. Growers noted the need for profitable crops to grow in rotation with peas. The processors select the varieties and order seeds with select fungicide treatments one year in advance.

Research

- Integrated approach to weed management.
    - Develop practices to reduce weed seed banks and perennial weeds, including cover crops and crop rotation. How do these integrate with herbicide use?
    - Continue screening new herbicides for use in the pea crop.
    - Impact of pre-emergence herbicides on weed seeds. What is the window of effectiveness?
- Integrated approach to root rot management.
    - Screen varieties for tolerance to root rot pathogens in New York.
    - Cultural practices to reduce pathogen populations and plant stress.
- Basic research on the problem of slugs and snails as a contaminant at harvest; develop best management practices (BMPs).
- Management of Colorado potato beetle as a contaminant at harvest—how to control volunteer potatoes and solanaceous weeds; insecticides to knock down insect prior to harvest.

Regulatory

- Support new and continued registrations of herbicides, insecticides, and fungicides for use in peas in NY, including seed treatments
- Not many fungicides are registered if foliar diseases become more prevalent in NY; most current products are in group 11.

Education

- Develop and implement an educational program on overall farm management for optimal pea production. Includes crop rotation, cover crops, soil health, reducing weed populations, etc.
- Scouting and identification of weeds at early stages of growth. Special emphasis on nightshades if there is a warm spring.
- Develop expertise on slugs and snails. Become involved in slug working group in the eastern U.S.

PRODUCTION (AND CULTURAL PRACTICES)

Peas are a cool-season crop and thrive in the humid continental climate of western New York. The plains south of Lake Ontario and Lake Erie have relatively large acreages of fertile soils that were deposited and mixed by glaciers. The Lake plain is generally flat with gentle rolling hills. Genesee, Monroe, Wyoming, and Orleans Counties typically lead in the production of processing green peas. New York has a long history of processing pea production and typically boasts some of the highest yields in the nation.

According to the 2007 Census of Agriculture, peas were harvested from a total of 17,598 acres on 118 farms in New York. Nineteen percent of the farms harvested fewer than 50 acres, 65% harvested from 50 to 249 acres, and 16% harvested more than 250 acres. Much of the acreage is grown on large farms that also produce other processing vegetables such as snap beans, sweet corn, beets, and carrots. Depending on the year, additional contracts are made with farms that are more focused on dairy and field crops.

The general cropping plan is provided in Appendix A. Processors select the varieties to be grown and order the seed one year in advance. Preparation for the pea crop begins the previous year with perennial and winter annual weed control, soil testing and zone building, and planting cover crops. Spring tasks include field and seedbed preparation followed by planting. Planting can begin in late March for the earliest varieties and can continue until the 25^{th}-28^{th} of May. Some growers inoculate the seed with symbiotic bacteria that fix nitrogen and/or apply a pre-emergence herbicide at planting. Seedlings begin to emerge about 10 days after planting, depending on the weather. Soon after, field scouting begins in order to evaluate emergence and pest issues. Post-emergence applications of herbicides are common to control weed escapes. Irrigation is applied if needed and available. After the crop flowers and sets pods, the fields are monitored for harvest readiness. When the tenderometer readings reach 70 units, then fields are monitored daily. Harvest usually begins in mid-June and continues through late-July. Processing peas are harvested by machines that strip the pods from the plants and then remove the peas from the pods. Once harvested, peas are transported within a few hours to the processing plant.

DISEASES

SEED/SEEDLING STAGE

Several soilborne pathogens can infect pea seeds and seedlings. Seeds of poor quality and vigor as well as those planted in suboptimal soil conditions germinate rather slowly, and thus are most prone to attack. Infected seeds often become discolored, exhibit soft rot, and eventually decay. Seeds may not germinate or seedlings may die before reaching the soil surface or die shortly afterwards, resulting in poor emergence and stand establishment.

<u>Seed Decay and Damping-off (pre- and post-emergence) Diseases</u>

In New York, *Pythium ultimum* and *Rhizoctonia solani* are the principal pathogens causing seed decay and/or seedling damping-off diseases of peas grown throughout the production regions in the state. In heavily infested soils and under favorable disease development conditions, unprotected seeds may be infected shortly after planting or the developing young roots and stem tissues become infected. Both pathogens are capable of rapidly colonizing, advancing upwards and downwards, and causing complete collapse of infected tissues and death of seedlings. The stems of emerged infected seedlings usually exhibit lesions at the soil line that often coalesce, weaken the stem, and result in collapse of the seedling (post-emergence damping-off stage of the disease).

Controls for Seedling Stage Diseases:
The first and most important management option against these diseases is the use of seeds that are of high quality, pathogen-free, and treated with effective products, where possible. Several fungicide seed-treatment products for peas are available and discussed below.

CULTURAL
- See section on root diseases below
- No resistant varieties are available

CHEMICAL
- Captan is the current industry standard; however, other treatments are available per Table 1 below:

Table 1. Comparison of fungicides available for seed/seedling stage diseases for peas in New York.

	Pythium species	*Rhizoctonia* species	*Fusarium* species	Pros	Cons
Captan seed trt	Fair	Fair	Fair	Good for seed rots; cheap	Not for root rot
Thiram seed trt	Fair	Fair	Fair	Used for seed rots	Not for root rot
Apron seed trt	Best	No	No	Seed decay and damping-off diseases	More expensive than Captan
Maxim seed trt	No	Best	Best	Seed decay and damping-off diseases	More expensive than Captan
Ridomil Gold SL or OLF	Good	No	No	Soil treatment	At planting. Difficult to apply

ROOT ROT

Several fungal pathogens are known to attack pea roots and lower stem tissues. Each pathogen is capable of infecting peas singly and causes distinct and diagnostic symptoms. However, pea root pathogens often interact with each other, with other fungal and nematode root pathogens, and with saprophytic soil organisms in causing root disease complexes. The latter results in the expression of general root disease symptoms, making the diagnosis of involved pathogen(s) difficult. Roots of severely infected plants are generally reduced in size and may exhibit various stages of decay as well as diagnostic lesions and discolorations that are characteristic of the involved pathogen(s). The degree of damage often depends on other stress factors that reduce plant and root growth, including soil compaction, extremes in soil temperature and moisture, poor seed vigor, nematodes, and herbicide injury. Severely infected roots are inefficient in absorbing water and nutrients, thus often contributing to wilting, yellowing, and poor plant growth that may eventually result in premature defoliation and plant death. Thus, severe incidence and damage of root rot diseases will often result in significant reduction in marketable yield and quality.

Fusarium Cortical Wilt (*Fusarium solani* f. sp. *pisi*)

Recently, Fusarium Cortical Wilt has become the **primary disease problem in NY** pea fields. Infection first begins at the area of cotyledonary attachment, the below-ground epicotyl, hypocotyl, or upper taproot. The infection then spreads upward to the soil line and downward into the root system, causing narrow, long, and reddish-brown lesions/streaks. As the disease progresses, the streaks coalesce and become darker in color. The diagnostic red discoloration of the vascular system is revealed by scraping away the outer layers of the root cortex. Infection of the stem tissues by this pathogen generally does not progress above the soil line. Foliar symptoms on severely infected plants include stunted growth, yellowing, and necrosis of the basal foliage. The disease will develop at 64°F, but optimal growth is 77° to 86°F. No resistance occurs, but several pea varieties and promising lines appear to be tolerant and perform well under high disease pressure (Abawi, et al., 2011).

Fusarium Wilt and Near Wilt (*Fusarium oxysporum* f. sp. *pisi*)

Fusarium wilt and near wilt root diseases are also common in NY. The pathogen involved has several host-specific strains, although it is not certain which races occur in New York. It is known, however, that races 1, 5, and 6 cause the typical wilt symptoms, while race 2 produces the near wilt disease symptoms. Also, it is known that races 1 and 2 are widely distributed in North America and most processing pea varieties are resistant to race 1 (see Appendix B). However, the pathogen still reproduces and survives in the soil on resistant plants. The fungus penetrates the cortical tissues of fibrous roots of pea plants and in susceptible varieties it infects the vascular system tissues which then exhibit a yellow to orange color. In near wilt, the vascular system is a brick red color. Foliage of infected plants becomes discolored and the leaves and stipules curl downward. Yellowing of leaves starts at the base of the plant and progresses upwards. The optimum temperature for disease development is 68° to 72°F.

Black Root Rot (*Thielaviopsis basicola*)
Black root rot is also a widely distributed disease on peas in New York and the pathogen host range includes carrots, bean, and other plants. It can be severe during periods of high soil moisture and high temperature 82°F. The fungus infects the roots, initially causing dark brown to black elongated lesions. As the disease progresses, the lesions coalesce to form characteristic large, black lesions on the roots and lower stem. Plants are stunted and chlorotic and may senesce prematurely.

Pythium Rot (*Pythium* spp.)
Pythium rot is a later phase of the disease caused by the same pathogen as described under seed rots above. After seedling emergence, infection in roots tends to be restricted to feeder root tips, where the fungus attaches and destroys juvenile root tissue, resulting in root pruning. Infected roots are tan to light brown. Often the diseased plant is stunted and chlorotic because of the lack of root development.

Rhizoctonia Root Rot (*Rhizoctonia solani*)
Rhizoctonia root rot is another fungus with a wide host range that is common on vegetable farms. It can survive for long periods of time in the form of sclerotia and hyphae in the soil or in association with organic matter. Infection is favored by high soil moisture, high organic matter, and warm soil temperatures (70° to 77°F). Infection occurs primarily on the hypocotyls and epicotyls of pea seedlings. Water-soaked lesions that appear soon become sunken and reddish brown to brown. The shoot tip may die, with later-forming secondary shoots also becoming infected. Seedlings become more resistant with age. However, on older seedlings, large reddish brown sunken lesions may occur on the epicotyl, sometimes causing girdling and stunting.

Ascochyta Root and Stem Rots (*Ascochyta* spp.)
Ascochyta root and stem rots have always been of **minor importance** on peas grown in NY. They are usually introduced on contaminated or infected seeds. Infections results in discoloration of the cotyledon, hypocotyl, and root areas.

Aphanomyces Root Rot (*Aphanomyces euteiches*)
This major disease of peas in many other production regions in the U.S. and elsewhere has **rarely been observed in New York** and has not been observed to cause yield or quality problems in NY.

Management of Root Rot

Damage caused by root disease pathogens is greatest in poor quality soils. Thus, improving soil health status will directly or indirectly improve root health and reduce damage of root pathogens. It has been shown that assessing root health is a highly correlated biological indicator of soil health in general. Roots growing in healthy soils generally are of larger size, firm, have large numbers of fibrous rootlets, penetrate deeper into the soil profile, and exhibit limited or no symptoms of infections by root pathogens. Such roots are more tolerant to environmental stress conditions and more efficient in absorbing water and nutrients. In addition, it is known that all soil health management practices (various modifications of tillage systems, cropping sequences, cover crops and soil amendments) directly or indirectly affect the populations of root pathogens and their damage to vegetable crops.

ROOT ROT CONTROL GUIDELINES

- Avoid fields with a history of severe root rot occurrence – (a simple soil indexing procedure is available; see http://soilhealth.cals.cornell.edu/).
- Avoid spreading root pathogens by limiting movement of infested soil from field to field on equipment, surface run-off, etc.
- Use high quality and pathogen-free seeds that have been treated with fungicidal or biological seed protectants. (The combination of Apron plus Maxim is a highly effective seed treatment).
- Select tolerant varieties where possible (see Appendix B)
- Practice crop rotation: plant peas only once every 4 years; the two *Fusarium* spp. will only infect peas (rotate out of vegetables and plant peas preferably after a grain crop, if possible).
- Use grain crops and other disease-suppressing cover crops in the cropping system as much as possible.
- Improve soil health; increase drainage, reduce compaction, increase soil organic matter content, etc.

CHEMICAL SOIL TREATMENT

- Soil application of chemical fungicides for the control of root rot is not economically feasible at the present time, nor are there adequate products with broad efficacy against all the major root pathogens.

FOLIAR DISEASES

Although peas are susceptible to many foliar diseases (Kraft and Pfleger, 2001) these are uncommon and to date have not caused obvious losses in NY. The foliar fungicides Quadris F and Heritage (azoxystrobin), Endura (boscalid), and Headline EC (pyraclostrobin) are labeled, but are currently not being applied in processing peas in NY. There is concern that if one or more of these diseases, such as powdery mildew, becomes more prevalent, most labeled fungicides are in the same class (strobilurin) (Group 11). Some varieties of peas used for processing have resistance to powdery mildew (see Appendix B).

DISEASE PRIORTIES

RESEARCH:

- Resistant varieties—variety screening to NY problems/pathogens
- Races of Fusarium wilt (lower priority)
- Seed treatments—biological, new
- Cultural practices for control—rotation, etc.

REGULATORY:

- Seed treatments are very effective; maintain availability
- Not many foliar treatments registered
    - o New diseases (we are weak on products)
    - o Most current products are group 11

EDUCATION:

- Overall management plan
- Cultural practices for control

WEEDS

Weed management has been the highest research priority for processing-pea growers in New York for the past several years. Weeds are a detriment to crop fields because they reduce yields, interfere with harvest equipment, may harbor insects that can become contaminants in peas (e.g. Colorado potato beetles), and can contaminate the pea crop directly (e.g., thistle and daisy buds, nightshade berries). At recent processing-pea advisory meetings, growers and crop consultants complained that annual grasses have become more problematic in pea fields. New weeds such as white cockle and jimsonweed are also a concern. Proper weed ID is crucial to the selection of suitable herbicides and other management strategies. Injury to pea fields may occur if herbicide applications are not timed properly.

Peas are sensitive to residues of several herbicides. It is recommended that peas not be planted in fields where more than one pound of atrazine was applied the previous year. There is an 18-month restriction for planting into fields where mesotrione (Callisto, Camix, Lexar, Lumax) and clopyralid (Hornet, Stinger) have been applied.

Current Herbicide Use Patterns

Fields planted in March and early April are less likely to receive herbicides at or before planting because the seeds of many annual weeds germinate later in the spring as temperatures warm. A small percentage of later planted fields (mid-April through the end of May) receive either a pre-plant incorporated herbicide or a pre-emergence herbicide (Appendix C). Post-emergence herbicides are used on most fields, the most common being Basagran (95% of fields) and Thistrol (90% of fields), usually applied as a tank mix. Growers must wait to apply Basagran after the peas have 3 nodes with true leaves. Thistrol must be applied no later than 3 nodes before flowering. Ideally, fields are scouted for weed emergence and herbicides are selected based on the weed species present. The Basagran + Thistrol tank mix is effective against a wide range of broadleaf species (Appendix D), but neither product provides control of the eastern black nightshade, corn chamomile or galinsoga. Herbicides for annual grass control are applied to roughly 10-15% of pea fields annually (Appendix C).

Weed Escapes

Kikkert (2010) surveyed 57 commercial pea fields on 22 farms in western New York after the application of post-emergence herbicides was complete. A total of 16 grass species and 45 broadleaf species were found (Table 2). Common lambsquarter, common ragweed, and pigweed were the most abundant broadleaf species, while yellow nutsedge, fall panicum, and yellow foxtail were the 3 most common grass/sedge species. Overall, 64% of the fields were considered moderate to heavily weedy, despite applications of Basagran and Thistrol to the majority of fields. Grass herbicides (pre- or post-) were used on 30% of the surveyed fields. Of those fields, only one had significant grass escapes. This suggests that the herbicides did work on the species present. In fields where no grass herbicides were applied, 14% of the April planted fields had grass escapes; while 50% of the May planted fields had grass escapes. Annual grasses germinate after soils warm significantly and are more problematic later in the season. The effectiveness of herbicide applications may vary with weed species, size of weeds, application equipment, herbicide rate, use of an adjuvant, and soil and climatic conditions.

Table 2. The most common weeds identified in processing pea fields.
There were a total of 57 fields surveyed. From Kikkert (2010).

Broadleaf Species	No. Fields	Grass/Sedge Species	No. Fields
Lambsquarter	49	Yellow Nutsedge	26
Ragweed	47	Fall panicum	22
Pigweed	29	Yellow foxtail	20
Chickweed	28	Annual bluegrass	20
Shepherd’s Purse	24	Barnyard grass	17
Prostrate Knotweed	23	Green foxtail	15
Smartweed	22	Large crabgrass	9
Bindweed	17	Witchgrass	8
Dandelion	15	Smooth crabgrass	7
Black Nightshade	14	Annual rye	7
Milkweed	13	Quackgrass	6
Velvetleaf	12	Giant foxtail	2
Wood Sorrel	11	Johnson grass	1
Clover	10	Wild proso millet	1
Canada Thistle	10	Tall fescue	1
Henbit	10	Wild oats	1
Volunteer Corn	8		
Wild Mustard	7		
Daisy	3		
White Cockle	3		
Jimsonweed	2		
24 other occasional spp.	---		

WEEDS OF CONCERN

CONTAMINANTS

Nightshades

Nightshade berries are a potential contaminant in peas and processors have a zero tolerance policy. Furthermore, nightshade is attractive to Colorado potato beetles, which also contaminate peas if they are present in fields at harvest. Hairy nightshade (*Solanum sarrachoides*) and Eastern black nightshade (*Solanum ptycanthum*) are the two common species in New York (Bellinder and Kikkert, 2011). They are annual broadleaf weeds. Being able to distinguish between the two species is important in their control. In the seedling stage, leaves of black nightshade are purple on the underside. As its name implies, foliage of hairy nightshade contains many small “hairs”, especially as the plant grows past the seedling stage. Nightshade berries may not have time to form in early planted and early maturing pea fields and thus are more of a concern in later harvested fields. The warm spring of 2010 created ideal conditions for early germination of nightshade, resulting in early berry formation and rejection of several fields. Climate change that results in a pattern of more frequent warm spring weather will cause nightshade to become a more regular problem in New York pea fields.

Eastern black and hairy nightshade seeds germinate in the field, at soil temperatures between 68° and 115°F with 86°F being optimum. They generally will not germinate below 68°F. Seeds may be viable, on the plant, 2-4 wks (Eastern Black) or 4-5 wks (Hairy) after pollination. A germination rate of 91%, 8 wks after pollination has been reported for Eastern black nightshade. However, most seeds become dormant shortly after berry ripening. Species differ in their emergence patterns. Eastern black nightshade appears to emerge early and then cease by late June to early July. Hairy nightshade, on the other hand, has several emergence peaks throughout the season. Shallow tillage enhances germination and emergence of Eastern black but has little effect on emergence of Hairy nightshade. Neither species will generally emerge from depths greater than 2.5 inches. Maximum emergence occurs in the top 1-2 inches of soil.

Those plants that emerge in the late spring produce the greatest biomass, and the most berries and seeds. All nightshades are, however, very sensitive to shading. Plants that emerge in the early spring begin flowering 7-9 wks later; those that emerge in July flower at 5-7 wks, but when not competing with a crop may begin flowering 1-3 wks after the 5-leaf stage. Nightshades are not killed by light frosts and seeds in existing berries continue to ripen after plant senescence. Eastern black is more frost tolerant than Hairy nightshade.

CULTURAL CONTROL

- Good planting practices to obtain dense, uniform crop stands
- Prevent formation and ripening of berries (clean up fields after harvest)
- Use of small grains as a smother crop in the crop rotation sequence

CHEMICAL CONTROL

- Species are differentially sensitive to herbicides.
- Hairy nightshade appears to be controlled by typical applications of Basagran. See Table 3 for herbicide options.

Table 3. Herbicides labeled for peas in New York that have activity against nightshade species.

Herbicide	Timing	Eastern Black	Hairy	Pros	Cons
Optill	PP, PPI or PreE	Yes	Yes		Lack of grower experience with this newly registered product
Dual Magnum	PreE	Yes	No		Needs adequate soil moisture to activate
Basagran	PostE	No	Yes	Routinely applied to pea fields; 10 d PHI	
Raptor	PostE	Yes	Yes		Cost; 30 d PHI; grower concern over delay in flowering – must be tank mixed with Basagran
Pursuit	PPI, PreE or PostE	Yes	Yes		30 d PHI; Not commonly used in NY

Canada Thistle

Canada thistle (*Cirsium arvense*) is of special concern to pea growers because the flower buds can be a contaminant in the harvested crop. Canada thistle is a perennial broadleaf weed that often grows in patches. It is difficult to control because of the perennial root system that commonly extends to depths of 3 ft or more.

CULTURAL CONTROL

- Small patches can be hand pulled
- Harvesters can go around small patches
- The only way to really control this weed is to exhaust the storage roots. Begin first removal of shoots in late spring. Continue to remove shoots before they attain several leaves. After 2 years of shoot removal the weed will be killed.

CHEMICAL CONTROL

- Thistrol and Basagran will inhibit bud formation, but neither will provide long-term control. The typical application of these herbicides in pea production is at a time when the thistle is not growing or is very small and thus is not effective. Need to scout for this weed and make later applications as noted below.
- For small patches, Thistrol applied when the thistle is 4 to 10 inches tall at a rate of 3 to 4 pints/acre will prevent the thistle from forming flower buds that can contaminate the pea product. However, the thistle will not be killed. Thistrol cannot be applied to peas that are later than 3 nodes before flowering. In early peas, those at nodes 9-11, the timing of this post-emergence application is critical. Late applications in early peas cause non-uniform flowering, resulting in uneven maturity.
- Canada thistle management is best done in rotational crops or in the fall. Stinger is the most effective herbicide, because it moves to the roots. There is an 18-month restriction before peas can be planted in a field where Stinger has been applied. Stinger is labeled for field corn, sweet corn, cabbage, beets and spinach, and pasture/forage crops. The optimal time for application is in April and May before the thistle buds open. Later in the season, 2,4-D can be used in labeled crops (not peas). In the fall, Roundup + Banvel can be used.

<u>Corn Chamomile (aka Daisy)</u>

Corn chamomile (*Anthesis arvensis*), also known by pea growers as daisy, is a winter or summer annual which often grows in clumps. It is of special concern to pea growers because the flower buds and seed heads can become contaminants at pea harvest. Reproduction is by seed which germinates in late summer, early autumn, or early spring. Research by Dr. Bellinder's group at Cornell has shown that the fall cohorts cause the most problem because they bloom at the time the pea crop is in the field.

CULTURAL CONTROL

- Limiting the production of seed is very important to keeping this weed from spreading
- Crop rotation, with smothering crops and/or cover crops

CHEMICAL CONTROL

- None of the herbicides registered on peas will control this species
- Burn down with Gramoxone (paraquat dichloride) in the spring may be helpful
- An application of Harmony Extra with TotalSol 50 SG (thifensulfuron methyl) as a fallow application in the fall to infested fields is very effective. Use 0.45 to 0.9 oz product per acre and include a non-ionic surfactant. There is a 45 day rotation restriction before planting peas.
- Wheat and barley growers should note that Harmony Extra and Buctril will control corn chamomile when applied to young, actively growing seedlings in the fall.

BROADLEAF WEEDS

Pigweed (*Amaranthus* sp.), common lambsquarters (*Chenopodium album*) and common ragweed (*Ambrosia artemisiifolia*) are annual broadleaf weeds commonly found in pea fields in NY. They are particularly troublesome because they grow taller than the peas and compete for light, water and nutrients. These weeds can significantly reduce pea yields. These species produce copious amounts of seeds. The seeds of common lambsquarters and common ragweed tend to germinate earlier in the spring than pigweed. The peak emergence of these two species generally occurs by mid-June, however, some seedlings will continue to emerge throughout the growing season, making control with non-residual post-emergence herbicides difficult.

Jimsonweed (*Datura stramonium*)

Jimsonweed is a large summer annual that is becoming more problematic in pea fields. It is a solanaceous weed, which makes it attractive to Colorado potato beetle, a contaminant in peas. Seeds germinate between 68°F and 95°F. Seedlings emerge between mid-May and mid-June and throughout the growing season if moisture is available. All parts of the plant are poisonous, but toxic effects on humans occur after seeds are ingested (Uva, et al 1997). Basagran is the only herbicide labeled for jimsonweed in the pea crop, however, its effectiveness in NY pea fields is unknown. Jimsonweed responds strongly to nitrogen. It is commonly found in nutrient-rich sites, like manure and compost piles.

White cockle or white campion (*Silene alba*)

A winter or summer annual, biennial, or short-lived perennial, white cockle reproduces primarily by seed. However, fragments of the roots can also produce new plants (Uva, et al 1997). Seeds germinate in mid- to late spring and again in late summer.

GRASSES AND SEDGES

Grasses and sedges are also very competitive with peas. Annual grasses that grow tall shade out peas, reducing yields and wrap around harvest equipment. Below are some of the most common species:

ANNUAL GRASSES:

Most of these species are controlled by grass herbicides labeled for peas (Appendix D).

Fall panicum (*Panicum dichotomiflorum*)

A summer annual, 20 inches to 3.3 ft tall.

Yellow foxtail (*Setaria glauca*)

Seeds germinate from late spring to mid-summer (50°- 85°F). Grows to 3.3 ft tall. Foxtails can be successfully managed with tillage before and at planting. The relatively large seeds are attractive to birds, rodents and insects and leaving them on the surface of the soil over the winter greatly decreases the population. Shallow cultivation in late spring, followed by a short fallow period will further decrease the population. The seedlings can then be killed by tillage for seedbed preparation. Moldboard plowing in the spring can also be used to bury the seeds too deep for germination. Seeds are relatively short lived and will die before being brought to the surface in future years (Mohler and DiTommaso, 1997).

Annual bluegrass (*Poa annua*)
A winter annual or perennial (different subspecies), annual bluegrass can grow to 12 inches tall. Seeds germinate at temps of 36° to 86°F - in late summer, early autumn and spring. Clumps spread by aggressive tillering. Can be competitive at high densities. High populations in the spring can be buried by moldboard plowing, followed by shallow secondary tillage with disks or a harrow (Mohler and DiTommaso, 1997).

Barnyard grass (*Echinochloa crus-galli*)
A summer annual with clump-forming stems that can grow to 4.9 ft tall. Seeds germinate between 60° to 100°F. Seedlings begin emerging in mid-spring, reach peak emergence in early summer and continue sporadically until early fall.

Green foxtail (*Setaria viridis*)
Similar to yellow foxtail.

Large crabgrass (*Digitaria sanguinalis*)
A summer annual that can grow prostrate or upright to 3.3 ft in height. Seeds germinate from mid-spring to late summer. Can reproduce vegetatively. Seeds do not survive more than 1-3 years. Rotation into sod can reduce the seed bank. Cultivated fallow periods during the first 4-6 weeks of warm weather will also reduce the population. Tine weeding or rotary hoeing readily kills newly emerged seedlings (Mohler and DiTommaso, 1997).

Wild proso millet (*Panicum miliaceum*)
A summer annual that can grow to 6.6 ft tall. Seeds shatter early in the season and are spread by harvest equipment. Germinates throughout the season, making chemical control difficult.

SEDGES:
Yellow Nutsedge (*Cyperus esculentus*)
Reproduces primarily by tubers, but seeds can also be produced. Dormant tubers sprout beginning in mid-May. Since most of the tubers are in the top 6 inches of the soil, yellow nutsedge is sensitive to tillage in early June, before new tubers have formed. Using this strategy in rotational crops will reduce nutsedge populations (Mohler and DiTommaso, 1997). Although Basagran is labeled for yellow nutsedge, the rate used in peas (1.0 – 2.0 pt/A) is too low to kill nutsedge, however, it may suppress weed growth. Dual Magnum applied pre-emergence in pea fields is very effective against nutsedge.

GENERAL WEED MANAGEMENT STRATEGIES

Ideally, weed control in peas should start several years before planting the crop. The best results are obtained by using good crop rotation, cover crops and other practices that suppress weeds. This is especially true for weeds that are problematic in peas such as corn chamomile ("daisy"), nightshades, and Canada thistle. Ideally, fall applications of herbicides would have been applied to control any daisy or thistle problems for the coming year.

CULTURAL CONTROL

- Select fields without serious weed problems.
- Standard peas provide more shading and competition with weeds than do afila (semi-leafless) varieties.
- Tillage may help to control perennial weed species and certain grass species
- Cultivation is generally impractical in processing pea fields due to the narrow row spacing. Rotary hoes and tine weeders are effective on germinating weeds, but may also pull stones onto the soil surface. Small stones become a contaminant problem in harvested peas, and larger stones directly interfere with harvesting equipment.
- Scout for weed species throughout the season

CHEMICAL CONTROL

- Herbicides are needed in nearly all processing pea fields. Herbicides labeled for use in peas include pre-plant, pre-plant incorporated, pre-emergence, and post-emergence products. Herbicide choice should be based on the weed species, crop growth stage, weather, and pre-harvest interval. The relative effectiveness of pea herbicides on different weed species is given in Appendix D.

Pre-Planting

For peas that haven't yet been planted, there are pre-plant (PP), pre-plant incorporated (PPI), or pre-emergence (PreE) herbicides that can be used.

- Optill can be used PP, PPI or PreE. At the rate used in peas, it will control lambsquarters, pigweed, mustards, and both eastern black and hairy nightshades.
- Pursuit can be used PPI or PreE. Its strengths are redroot pigweed, mustards and nightshades. When used PPI, it also has good activity against common lambsquarters.
- Treflan HFP and Prowl 3.3EC or H_20 are applied PPI and have good annual grass activity. In addition, Prowl is effective against lambsquarters, purslane, pigweed and velvetleaf.
- Command 3ME (PreE) has good activity against annual grasses and some broadleaves (esp. Velvetleaf). Peas will turn white in areas where the herbicide is overlapped. The peas will grow out of this and usually not be harmed.
- Dual Magnum – applied only pre-emergence after planting. If soils are wet and cold during emergence, Dual Magnum may delay maturity and/or reduce yields. Dual provides excellent control of annual grasses and yellow nutsedge. It is also good on several broadleaves including lambsquarters, purslane, pigweed, galinsoga, and eastern black nightshade. Dual is an excellent choice when there is adequate soil moisture.

- Sharpen can be used PPI or PreE. At the rates used in peas, the label only states suppression of lambsquarters, pigweed, eastern black nightshade and velvetleaf.

Post-Emergence:

- Basagran and Thistrol are typically tank-mixed and applied after the peas have at least 3 nodes with true leaves. They don’t have any soil residual, so the best time to spray is when the majority of weeds have emerged. Ideally, the first flush of weeds would have one or two leaves and the next flush would be in the cotyledon stage. Rain will stimulate new flushes of weeds.
- Raptor or Pursuit may be a better choice if nightshades, pigweed or mustards are present. Basagran will only control hairy nightshade, whereas Raptor and Pursuit will control both hairy and eastern black nightshade.
- Poast, Assure II/Targa and Select Max all provide good to excellent control of the most prevalent annual grasses in NY.

WEED PRIORITIES

RESEARCH:

- Cover crops
  - Impact on weed seeds, weed growth
  - Integration with herbicides
- Better understand the timing of pre-emergence herbicides and the impact on weed seed mortality.
- Monitor for weed resistance to herbicides and develop management tools as needed

REGULATORY

- Maintain registration of current herbicides. Basagran and Thistrol are used on the majority of fields.
- Support registration of new herbicides
- Where do applications of burndown and fallow field herbicides get reported? We don’t know how much these are being used in conjunction with pea production.

EDUCATION:

- Whole farm weed management plan; how to reduce seed banks
- Nightshade biology and management
- More effective weed scouting
  - Grasses
  - Thistle and nightshades

INSECT PESTS (ARTHROPOD)

SEEDLING STAGE

Seedcorn Maggot (*Delia platura*) – Occasional Pest
Larvae feed on and burrow into the seed. Seed fails to germinate. Damaged plants are weak and may not develop. Favored by cold, wet weather where germination is delayed. Fresh organic matter attracts adults for egg-laying. Growers noted this is a problem when a pea crop follows sod production.

CULTURAL CONTROL

- Use high quality seed and planting conditions which favor rapid germination and emergence.
- Incorporate crop residues well before planting.
- Do not spread manure directly before planting.

CHEMICAL CONTROL

- None currently being used
- Crusier 5FS, Capture, and Lorsban are labeled, but the industry does not feel the cost is justified due to sporadic nature of this pest in processing pea fields.

FOLIAR

Pea Aphid (*Acyrthosiphon pisum*) – Occasional Pest
Pea aphids are generally not a problem on processing peas in NY, but populations can increase rapidly during hot weather. Peas near alfalfa fields that are being cut may be particularly vulnerable. During vegetative growth of peas, aphid infestations usually do not cause economic damage. Aphid feeding on flowers and pods can reduce the number of seeds produced, particularly if aphid numbers are very high.

CULTURAL CONTROL

- Scout fields at flowering, early pod-set, and especially during early pod filling.
- Monitor pea aphid populations using a sweep net. After checking with several other states, we have determined an average threshold: if you find 25 to 35 aphids per sweep and the peas are more than ten days from harvest, insecticide treatment is recommended.

CHEMICAL CONTROL

- Asana and Mustang Max have been used in processing pea fields on a small number of acres in recent years. However, there are numerous products labeled (Appendix E). Processors should consult the PHI and the environmental impact quotient (Kovach, et al. and Appendix F) when selecting a product.

Brown Marmorated Stink Bug (*Halyomorpha halys*) – Potential Pest
An invasive insect that is of potential concern, BMSB is present throughout NY, but currently not at economic levels. It has a wide host range including green peas. BMSB may not become problematic on peas due to early season harvest dates. However, this pest should be kept on the radar screen. Various BMSB working groups are putting together a list of potential materials for control. Effectiveness of insecticides is questionable. Currently there is a 2(ee) label for Lorsban Advanced and Danitol 2.4 EC which includes BMSB on peas.

INSECT CONTAMINANTS AT HARVEST

Lady Bugs (*various species in the family Coccinellidae)* - Occasional Problem
Occasionally found in processing pea fields, especially when pea aphids are present. Are a problem at high populations because they are picked up by harvesting machines and their size makes them difficult to separate from peas during the initial cleaning process.

Colorado Potato Beetle (*Leptinotarsa decemlineata*) – Occasional Problem
Feed on volunteer potatoes or solanaceous weeds (nightshades, jimsonweed, horsenettle, smooth groundcherry) that may be found in processing pea fields. Especially a concern when potatoes are grown in rotation.

Adults overwinter in woods and brush that border last year's infested fields. In June, they begin to move back into fields to feed and lay eggs. The edges of a field will be affected first, but if the beetles do not find host plants they will fly in search of food.

CULTURAL CONTROL
- Plant at least 200 yards away from last year's infested fields. Barriers between fields such as woods, rivers, and roads will also help.
- CPB are attracted to potato tubers; you must bury them
- Hand rogue volunteer potatoes

CHEMICAL CONTROL
- Raptor herbicide will reduce growth of volunteer potatoes.
- Manage solanaceous weeds:
    - Eastern black nightshade – Raptor (3 oz), Pursuit (3 oz rate and when the weeds are less than 2 inches tall; disadvantage 30 d PHI)
    - Hairy nightshade – Raptor (3 oz), Pursuit, Basagran (2 pt rate, before weeds reach 2-6 leaf stage)
    - Jimsonweed – Basagran is the only post-emergence herbicide labeled for this weed in peas.
- Knock-down insecticides may be used prior to harvest; however, even though many insecticides are labeled for Colorado potato beetle control, most are not labeled for use in peas. The only currently labeled products in NY that are legal to use are:

Mustang Max (zeta-cypermethrin)
Respect (zeta-cypermethrin)
Assail 30 SC and Assail 70 WP (acetamiprid) – NYS 2(ee) recommendation
Pyganic (pyrethrins)—efficacy is currently unknown.

INSECT PRIORITES

RESEARCH:

- Thresholds and management in peas if any insects become more frequently problematic in peas due to climate change, etc.

REGULATORY:

- Maintain products for control of seed corn maggot, aphids, and Colorado potato beetle. It will be difficult to get new products registered for CPB in peas since they do not feed directly on peas.

EDUCATION:

- Awareness of Brown Marmorated Stink Bug

NEMATODES

Lesion nematode (*Pratylenchus penetrans*) – Minor pest
The only nematode that really feeds on peas, lesion nematode is currently not causing economic damage in NY, but the industry needs to monitor its occurrence.

Although plant parasitic nematodes feed only on and/or in the roots of plants, above-ground symptoms include poor plant vigor, stunting, yellowing, wilting and browning of leaf margins. Initial infestation occurs in patches in production fields, but it will spread by tillage and other practices. General root symptoms include: poor root development, pruning, discoloration and lack of fibrous roots.

SLUGS AND SNAILS

Slugs and Snails – various spp. – Regular pest, serious in wet years
Although slugs and snails feed directly on pea plants, causing reduced yield and damage to pods, contamination of the harvested crop is the main concern. Intact or partial slugs/snails stick to peas and are very difficult to remove at the processing facility. Thus fields with serious slug/snail populations may be rejected. Feeding is more problematic in a lush crop under cool moist conditions. Reduced tillage also provides a more favorable habitat for slugs and snails (Hammond, et al. 2009).

Eggs hatch in mid- to late-May. Feeding occurs 1 to 2 weeks after egg hatch (hence significant feeding will begin in early to mid-June, with late-June to early-July experiencing heavy feeding. Pea planting starts in late March and continues until the third week of May. Harvest begins around June 10th and can last through July. In 2010 slugs were a serious problem in early-July, following a period of heavy rain.

CULTURAL CONTROL

- Monitoring; scout in late May to early June and then possibly treat (but would have to be pre-bloom)
- Reduced trash in fields; tillage on a regular basis will help to reduce slug populations.

CHEMICAL CONTROL

- Bait materials are limited to pre-bloom
- Deadline (metaldehyde) is the only material labeled for control

SLUG/SNAIL PRIORITIES

RESEARCH

- Need to develop a basic understanding of the biology of slugs and snails in New York crop fields
- How best to apply baits
- Processors would like to have a treatment they could apply within a week of harvest. Are sprays of salt solutions or concentrated liquid fertilizers effective? Will the dead slugs still stick to the plant material, thus causing contamination problems?

REGULATORY

EDUCATION

- Become involved with Eastern U.S. slug workgroup led by Joanne Whalen

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APPENDIX A

Worker Activities for Processing Peas in New York

	Month											
ACTIVITY	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
PREPLANT- FALL PREPARATIONS												
Weed assessment									XX			
Weed control (e.g. corn chamomile, thistle)									XX			
Soil health testing/root rot bioassays			XX						XXXX	XXXX		
Zone building for reduced tillage (if used)									XXXX	XXXX		
Plant cover crop						XXXX	XXXX	XXXX	XXXX	XXXX		
Soil nutrient testing			XX							XXXX		
Bush hog									XXXX	XXXX		
PREPLANT (Spring tasks)												
Order treated seed for following year (processor)				XXXX								
Crop rotation plan (3-4 year advanced plan)		XXXX										
Field Selection (3-4 year advanced plan)		XXXX										
Plow (moldboard or chisel, based on trash in field)			X	XXXX	XXXX							
Cultivate			X	XXXX	XXXX							
Culti-pack			X	XXXX	XXXX							
Rock removal			X	XXXX	XXXX							
Rolling/Level Seedbed			X	XXXX	XXXX							
Herbicide Application (PPI)			X	XXXX	XXXX							
Fertilizer (broadcast) ~30-50 lbs/A Nitrogen			X	XXXX	XXXX							

	J	F	M	A	M	J	J	A	S	O	N	D
PLANTING			X	XXXX	XXXX							
Inoculate Seed, if used			X	XXXX	XXXX							
Herbicide application following planter(Dual)			X	XXXX	XXXX							
POST PLANTING												
Rotary hoe to break up soil crusting			X	XXXX	XXXX							
Flex-tine weeding (organic production)			X	XXXX	XXXX							
POST EMERGENCE												
Plant emergence (~10 days after planting)				XXXX	XXXX	X						
Scouting for crop emergence, weeds, pests				XXXX	XXXX	XXXX						
Herbicide Application				XXXX	XXXX	XXXX						
Irrigation (if needed)				XXXX	XXXX	XXXX	XXXX					
Foliar feed application (micronutrients) (optional)				XXXX	XXXX	XXXX	XXXX					
Pre-harvest monitoring (around tenderometer reading of 70 units, then daily)						XXXX	XXXX					
HARVEST						XX	XXXX					
POST HARVEST												
Weed management (reduce seed production/bank)						X	XXXX	X				
Plant cover crop (if used)						X	XXXX	XXXX	XXXX	XXXX		
Plant second crop (if used)						X	XXXX	X				

APPENDIX B

Pea Varieties Commonly Grown for Processing in New York

Variety	Vine type	1st node to flower	Disease Resistance
Early Season Varieties			
Early Sweet 414	Standard	10	Fusarium wilt (race 1) Bean yellow mosaic virus
Ice Pack	Afila	9-10	Fusarium wilt (race 1) Bean yellow mosaic virus
Jumpstart	Standard	9	Fusarium wilt (race 1)
Premium	Standard	9	Fusarium wilt (race 1)
Spring	Standard	9	Fusarium wilt (race 1)
Mid-Season Varieties			
Bolero	Standard	14-15	Fusarium wilt (race 1)
Cosima	Standard	10	Fusarium wilt (race 1)
Gallant	Afila	14	Fusarium wilt (race 1, 2)
Genie	Afila	16-17	Fusarium wilt (race 1) Powdery mildew
Legacy	Standard	14	Fusarium wilt (race 1) Powdery mildew Pea enation mosaic virus
Lil' Mo	Standard	10-11	Fusarium wilt (race 1, 2)
Tonic	Standard	10-11	Fusarium wilt (race 1, 2) Bean leafroll virus
Late-Season Varieties			
Ashton	Standard	14-15	Fusarium wilt (race 1) Powdery mildew Downy mildew Bean yellow mosaic virus
Boogie	Afila	14-15	Fusarium wilt (race 1) Powdery mildew Downy mildew tolerant
Durango	Standard	14	Fusarium wilt (race 1) Powdery mildew Bean yellow mosaic virus
Grundy	Standard	16	Fusarium wilt (race 1, 2) Pea enation mosaic virus Powdery mildew
Ricco	Afila	16	Fusarium wilt (race 1,2) Bean leafroll virus Powdery mildew

APPENDIX C

Pesticide Use in Processing Peas in New York 2008-2010

	Active Ingredient	Product Name	Percent of Acres Treated			
			2008	2009	2010	3 yr Avg
Fungicides	Captan	Captan Seed Treatment	100	100	100	100
Herbicides	Sodium Bentazon	Basagran	97.25	96.02	93.46	95.58
	MCPB, sodium salt	Thistrol	93.75	88.75	86.80	89.76
	Quizalofop P-ethyl	Assure II Targa	6.50	12.11	7.72	8.78
	S-Metolachlor	Dual Magnum Dual II Magnum	2.33	9.08	3.34	4.92
	Clethodim	Select Max Intensity One	0.46	1.27	10.65	4.13
	Sethoxydim	Poast	4.22	6.30	1.23	3.92
	Imazethapyr	Pursuit	3.90	4.01	3.45	3.78
	Metalochlor	Parallel	0.00	2.31	2.48	1.60
	Pendimethalin	Prowl 3.3 EC Prowl H2O	0.59	1.01	2.53	1.37
	Imazamox	Raptor	1.58	0.93	0.46	0.99
	Trifluralin	Treflan	0.07	0.00	1.36	0.48
	Glyphosate	Round-Up Other labeled formulations	0.00	0.35	0.82	0.39
	Clomazone	Command 3E Clethodim 2EC	0.00	0.23	0.09	0.11
Insecticides	Zeta-Cypermethrin	Mustang Max	3.14	1.85	0.00	1.66
	Bifenthrin	Sniper	0.00	0.00	0.52	0.17
	Esfenvalerate	Asana	0.05	0.00	0.00	0.02

APPENDIX D

Relative Effectiveness of Herbicides Available for Use in Peas in New York for 2012[1]

(compiled by Julie Kikkert, CCE Regional Vegetable Program and Robin Bellinder, Cornell University)

Key[2] E=Excellent G=Good F=Fair P=Poor to None	Rate/A[3]	PHI	BROADLEAF ANNUALS												ANNUAL GRASSES				PERENNIALS		
			Lambsquarters	Purslane	Common Ragweed	Pigweed Smartweed	Galinsoga	Mustard	Eastern Black Nightshade	Hairy Nightshade	Velvetleaf Jimsonweed	Chamomile "daisy"			Barnyard grass	Crabgrass	Fall Panicum	Foxtail sp.	Quackgrass	Yellow Nutsedge	Canadian Thistle
Pre-Plant, PPI or PreE																					
Optill (saflufenacil + imazethapyr)	1.5 oz		G	P	P	E	P	P	E	E	E	P	P	P	P	P	P	P	P	P	P
Pre-Plant Incorporated (PPI)																					
Treflan HFP (trifluralin)	0.5-0.75 qt		F	F	P	P	P	P	P	P	P	P	P	P	E	E	G	E	P	P	P
Prowl 3.3EC (pendimethalin)	1.2-3.6 pt		G	G	P	G	F	P	F	P	P	G	P	P	E	E	E	E	P	P	P
Prowl H_20 (pendimethalin)	1.5-3.0 pt		G	G	P	G	F	P	F	P	P	G	P	P	E	E	E	E	P	P	P
Pre-Emergence (PreE)																					
Command 3ME (clomazone)	1.3 pt	45 d	F	F	F	P	F	F	P	P	P	G	P	P	G	G	G	G	P	P	P
Dual Magnum (s-metolachlor)	1.0-2.0 pt		G	G	P	E	P	E	P	G	P	P	P	P	E	E	E	E	P	E	P
PPI or PreE																					
Sharpen (saflufenacil)	0.75 fl oz		F	P	P	F	P	P	P	F	P	F	P	P	P	P	P	P	P	P	P
Post-Emergence																					
Basagran[4] (bentazon)	1.0-2.0 pt	10 d	G	F	G	F	G	P	G	P	G	G	G?	F	P	P	P	P	P	P	P
Thistrol 2S[5] (4-MCPB)	2.0 pt		G	P	P	G	G	P	P	P	P	P	P	P	P	P	P	P	P	P	F
Raptor[6] (imazamox)	3.0 fl oz	30 d	F	F	P	E	F	F	E	E	E	P	P	P	P	P	P	F	P	P	P
Poast (sethoxydim)	1.0-1.5 pt	15 d	P	P	P	P	P	P	P	P	P	P	P	P	G	F	G	G	F	P	P
Assure II/Targa (quizalofop P-ethyl)	0.375-0.75 pt	30 d	P	P	P	P	P	P	P	P	P	P	P	P	E	E	E	E	E	P	P
Select Max[7] (clethodim)	9.0-16.0 fl oz	21 d	P	P	P	P	P	P	P	P	P	P	P	P	E	G	E	E	G	P	P
PPI, Pre- or Post-Emergence																					
Pursuit (imazethapyr)	2.0-3.0 fl oz	30 d	G[8]	P	P	E	P	P	E	E	E	P	P	P	P	P	P	P	P	P	P

[1]For information only. Always read NYS approved product labels carefully before use.

[2]General comparison. Effectiveness may vary with method of application, rate, use of an adjuvant, size of weed, and soil and climatic factors. See label for specific information.

[3]Weed species controlled depends on rate. Lower rates than listed in this chart will result in poorer weed control.

[4]Peas must have 3 nodes with true leaves before application.

[5]Do not apply later than 3 nodes before flowering.

[6]Apply to peas at least 3 inches tall, but prior to 5 nodes before flowering. Basagran must be used with all Raptor applications.

[7]Must be applied before blossom

[8]Only the pre-plant incorporated application is effective.

APPENDIX E

Insecticides Labeled for Use in Succulent Peas in New York

Active Ingredient	Product	Seed Corn Maggot	Aphids	Brown Marmorated Stink Bug	Stink Bugs	Colorado Potato Beetle	Pre-Harvest Interval
Acetamiprid	Assail 30 SG		X			2(ee)	7 d
	Assail 70 WP		X			2(ee)	7 d
Bifenthrin	Bifenthrin 2EC		X		X		3 d
	Brigade 2EC, WSB		X		X		3 d
	Capture LFR	X					
	Sniper		X		X		3 d
Bifenthrin + imidacloprid	Brigadier		X				7 d
Bifenthrin + zeta-cypermethrin	Hero		X		X		3 d
Chlorpyrifos	Lorsban 4E	X					
	Lorsban Advanced	X		2(ee)			
Dimethoate	Dimethoate 4E		X				3 d
Esfenvalerate	Asana XL		X				3 d
Fenpropathrin	Danitol 2.4 EC			2(ee)			7 d
Imidacloprid	Provado 1.6		X				7 d
	Admire Pro		X				7 d
Lambda-cyhalothrin	Warrior II with Zeon Technology		X		X		7 d
Lambda-cyhalothrin + chlorantraniliprole	Voliam Express		X		X		7 d
Methomyl	Lannate LV		X	not for peas			1 d
Pyrethrins	Pyganic EC		X		X	X	0 d
Spirotetramat	Movento		X				1 d
Thiamethoxam	Crusier 5FS	X	X				
Zeta-cypermethrin	Mustang Max		X		X	X	1 d
	Respect		X		X	X	1 d

APPENDIX F

Pesticides Labeled for Use in Peas in New York

Active Ingredient	Product	Class	Rate/A Product	PHI (days)	REI (hours)	Field Use EIQ
FUNGICIDES						
Azoxystrobin	Quadris	Strobilurin FRAC[a] Group 11	6.2-15.4 fl oz	0	4	2.4-5.9
	Heritage	Strobilurin FRAC Group 11	3.2-8.0 oz	0	4	2.7-6.7
Boscalid	Endura	Anilene FRAC Group 7	8-11 oz	7	12	9.2-12.7
Pyraclostrobin	Headline EC	Strobilurin FRAC Group 11	6-9 fl oz	7	12	2.4-3.6
Mefenoxam	Ridomil Gold	Phenylamide, FRAC Group 4	0.5-1 pt	---	48	4.3-8.7
Captan	Captan 400 or 400-C seed treatment	Thiophthalimide, FRAC Group M4	2.5 fl oz per 100 lb seed	---	---	0.9 per 100 lb seed
Mefenoxam	Apron XL or Apron XL LS	Phenylamide, FRAC Group 4	0.16-0.64 fl oz/100 lb seed	---	48	0.1-0.3 per 100 lb seed
Fludioxonil	Maxim 4FS	Phenylpyrrole FRAC Group 12	0.08-0.16 fl. oz. per 100 lbs	---	12	0.0-0.1 per 100 lb seed
Thiram	42-S Thiram	Carbamate FRAC Group M3	3.0 fl oz/100 lbs seed	---	24	2.3 per 100 lb seed
HERBICIDES						
Bentazon	Basagran	Benzothiadiazinone; HRAC[b] Group C3; WSSA Group 6	1.0-2.0 pt	10 d	48	8.2-16.5
Clethodim	Select Max	Cyclohexanedione ‘DIMs’; HRAC Group A; WSSA Group 1	9.0-16.0 fl oz	21 d	24	1.2-2.1
Clomazone	Command 3ME	Isoxazolidinone; HRAC Group F3; WSSA Group 13	1.3 pt	45 d	12	8.0
Imazamox	Raptor	Imidazolinone; HRAC Group B; WSSA Group 2	3.0 fl oz	30 d	4	0.5
Imazethapyr	Pursuit	Imidazolinone; HRAC Group B; WSSA Group 2	2.0-3.0 fl oz	30 d	4	0.6-0.8

Active Ingredient	Product	Class	Rate/A Product	PHI (days)	REI (hours)	Field Use EIQ
4-MCPB	Thistrol 2S5	Phenoxy-carboxylic-acid; HRAC Group O; WSSA Group 4	2.0 pt	---	24	8.6
S-metolachlor	Dual Magnum	Chloroacetamide; HRAC Group K3; WSSA Group 15	1.0-2.0 pt	---	24	---
Pendimethalin	Prowl 3.3EC	Dinitroaniline; HRAC Group K1; WSSA Group 3	1.2-3.6 pt	---	24	13.6-40.7
Pendimethalin	Prowl H_20	Dinitroaniline; HRAC Group K1; WSSA Group 3	1.5-3.0 pt	---	24	17.5-35.1
Quizalofop P-ethyl	Assure II or Targa	Aryloxyphenoxy-propionate 'FOPs'; HRAC Group A; WSSA Group 1	0.375-0.75 pt	30 d	12	0.9-1.7
Saflufenacil	Sharpen	Pyrimidinedione; HRAC Group E; WSSA Group 14	0.75 fl oz	---	24	---
Saflufenacil + imazethapyr	Optill	See listing for individual active ingredients	1.5 oz	---	12	---
Sethoxydim	Poast	Cyclohexanedione 'DIMs'; HRAC Group A; WSSA Group 1	1.0-1.5 pt	15 d	12	3.8-5.6
Trifluralin	Treflan HFP	Dinitroaniline; HRAC Group K1; WSSA Group 3	0.5-0.75 qt	---	12	8.1-12.1
INSECTICIDES						
Acetamiprid	Assail 30 SG	Neonicotinoids; IRAC[c] Group 4A	2.5-5.3 oz	7 d	12	1.3-2.9
	Assail 70 WP	Neonicotinoids; IRAC Group 4A	1.0-2.3 oz	7 d	12	1.6-3.7
Bifenthrin	Bifenthrin 2EC	Pyrethroids Pyrethrins; IRAC Group 3A	2.1-6.4 fl oz	3 d	12	1.5-4.5
	Brigade 2EC	Pyrethroids Pyrethrins; IRAC Group 3A	2.1-6.4 fl oz	3 d	12	1.5-4.5
	Capture LFR	Pyrethroids Pyrethrins; IRAC Group 3A	3.4-6.8 fl oz	---	12	1.6-3.2
	Sniper	Pyrethroids Pyrethrins; IRAC Group 3A	2.1-6.4 fl oz	3 d	12	1.5-4.4

Active Ingredient	Product	Class	Rate/A Product	PHI (days)	REI (hours)	Field Use EIQ
Bifenthrin + imidacloprid	Brigadier	See individual active ingredients	3.8-5.5 fl oz	7 d	12	2.2-3.1
Bifenthrin + zeta-cypermethrin	Hero	See individual active ingredients	4.0-10.3 fl oz	3 d	12	1.5-4.1
Chlorpyrifos	Lorsban 4E	Organophosphates; IRAC Group 1B	2 pt broad-cast appl.	---	24	24.1
Dimethoate	Dimethoate 4E	Organophosphates; IRAC Group 1B	0.3-1.0 pt	0 d	48	4.4-14.6
Esfenvalerate	Asana XL	Pyrethroids Pyrethrins; IRAC Group 3A	2.9-5.8 fl oz	3 d	12	0.6-1.2
Fenpropathrin	Danitol 2.4 EC	Pyrethroids Pyrethrins; IRAC Group 3A	10.67 fl oz	7 d	24	5.2
Imidacloprid	Provado 1.6	Neonicotinoids; IRAC Group 4A	3.5 fl oz	7 d	12	1.4
	Admire Pro	Neonicotinoids; IRAC Group 4A	1.2 fl oz	7 d	12	1.2
Lambda-cyhalothrin	Warrior II with Zeon Technology	Pyrethroids Pyrethrins; IRAC Group 3A	1.28-1.92 fl oz	7 d	24	0.8-1.2
Lambda-cyhalothrin + chlorantraniliprole	Voliam Express	See individual active ingredients	6.9-9.0 fl oz	7 d	24	1.6-2.2
Methomyl	Lannate LV	Carbamates; IRAC Group 1A	1.5-3.0 pts	1 d	48	9.6-19.1
Pyrethrins	Pyganic EC	Pyrethroids Pyrethrins; IRAC Group 3A	1.0 pt – 2.0 qt	0 d	12	0.5-2.1
Spirotetramat	Movento	Tetronic and Tetramic acid derivatives; IRAC Group 23	4.0-5.0 fl oz	1 d	24	2.0-2.5
Thiamethoxam	Crusier 5FS	Neonicotinoids; IRAC Group 4A	1.28 fl oz per 100 lbs seed	---	12	1.3 per 100 lb of seed
Zeta-cypermethrin	Mustang Max	Pyrethroids Pyrethrins; IRAC Group 3A	3.2-4.0 fl oz	1 d	12	0.7-0.9
	Respect	Pyrethroids Pyrethrins; IRAC Group 3A	3.2-4.0 fl oz	1 d	12	0.7-0.9

Active Ingredient	Product	Class	Rate/A Product	PHI (days)	REI (hours)	Field Use EIQ
MOLLUSCICIDES						
Metaldehyde	Deadline Bullets	Aldehyde	20-40 lbs	---	12	9.4-18.8

[a]FRAC = Fungicide Resistance Action Committee, Fungicides sorted by mode of action: http://www.frac.info/frac/publication/anhang/FRAC%20Code%20List%202011-final.pdf

[b]HRAC = Herbicide Resistance Action Committee, Classification of Herbicides According to Site of Action: http://www.hracglobal.com/Publications/ClassificationofHerbicideSiteofAction/tabid/222/Default.aspx

[c]IRAC = Insecticide Resistance Action Committee, MoA Classification Scheme: http://www.irac-online.org/wp-content/uploads/MoA-classification.pdf