PEST MANAGEMENT STRATEGIC PLAN FOR CUCUMBERS (PICKLING) IN DELAWARE AND EASTERN SHORE MARYLAND

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Executive Summary

Research Needs
Numbers after items = priority rank on scale of 0 (lowest) – 24 (highest)

1. Research needed on races of Downy Mildew and disease resistant varieties of cucumber and effect of environment on resistance. 24
2. Forecasting and Predicting for Downy Mildew. 24
3. Need research for efficacy on seed treatments for Cucumber Beetles: Platinum, Fipronil,(no soil activity for Assail – so that is why I deleted it), Imidacloprid. 17
4. Need more materials for belly rot, scab and cottony leak that have only one registered product. 13
5. Redroot and Prostrate Pigweed control. 7
6. Phytophthora Blight pesticide resistance management. 7
7. Suppressive crops to reduce Root-Knot nematodes (planted fall before). 4
8. Monitoring techniques for pickleworm. 3
9. Determine the occurrence and distribution of *P.capsici* populations resistant to mefanoxam. 1
10. Pesticide resistance management for Downy Mildew. 1
11. Is Downy Mildew spread by Cucumber Beetles? 1

12. Efficacy of Flonicamid for aphids (seed treatment). 0
13. Soil insecticides for seed corn maggot needed to replace Lindane and Diazinon 0
14. Belly Rot prediction. 0
15. Efficacy of Tanos on Phytophthora Blight. 0

Regulatory Needs

1. Submit Project Clearance Request forms to IR-4 in order for them to initiate work on clearances for seed applied treatment (commercially applied) in pickles to control cucumber beetle. Potential projects to request include, but are not limited to: imidaclorprid, thiomethoxam, and clothianidin.

Education Needs

1. Consumer education: pickle worm tolerance
2. Education of growers in disease identification; may include scouting/ ID guide

Production Information (Fournier, A. and A. Brown, 2000)

Cucumbers thrive in light textured, well-drained soils high in organic matter, with a pH between 6 and 6.8. These prostrate, annual vines require adequate moisture. Two or three crops of pickling cucumbers are often produced from a single field during a single growing season, but are generally rotated with other crops from season to season. Conventional tillage is used during bed preparation. Flat beds are used to enhance cucumber pick up to minimize field loss. Prior to planting, fields are moldboard plowed. This practice reduces weed seed populations by redistributing a high proportion of seeds below the upper soil layer to prevent germination. This practice also buries plant residue and reduces pathogen levels in the soil. A high seeding rate produces dense plantings which provide a competitive stand and reduce weed seed germination after the canopy closes. After planting, 90% of fields are cultivated. Of these, about 25% are cultivated twice.

Pickling cucumbers are direct-seeded into bare ground, initially between mid-April and early May in the mid-Atlantic, with successive plantings continuing through early August. The growing season of about 180 days allows double cropping of pickling cucumbers or multiple cropping of pickling cucumbers with other vegetables. 19% of Maryland and Delaware pickling cucumbers were double cropped in 1998. Successive plantings are made to provide continuous harvests of pickling cucumbers for processors. All pickling cucumbers on the Delmarva are machine harvested. They are planted 2 to 3 inches apart with 20 to 28 inches between rows, and 3 rows per bed. The seeding rate of 4 to 5 pounds per acre produces the optimal density of 65,000 plants per acre for harvesting. Pickling cucumbers are in the field 38-42 days from seeding to harvest. Overhead, center pivot irrigation systems are used to provide adequate moisture throughout the growing season. Growers require honeybee colonies to

assure adequate pollination. Fields are always tilled after harvest to prevent late summer and fall weed seed production.

Timeline
April- May: ground preparation
May through early August: sequential plantings
June 25 – First harvest; harvest continues on sequential plantings until 9/25.
Perhaps 60% of the acreage is planted as a double-crop, following peas, small grains, green beans, and the first pickle planting.

Worker Exposure
Because pickling cucumbers are mechanically harvested, worker exposure to pesticides is greatly reduced.

Representative Variable Costs for Processing Cucumbers in Delaware

Operating Inputs	***Rate/Acre***	***Price***	***Cost/Acre***	***Cost/Bu.*** ***180 BU/A***
Cucumber Seed-thousand	58	$1.48	$85.84	$0.48
Nitrogen – lbs	100	$0.21	$21.00	$0.12
Phosphorus - lbs	30	$0.16	$4.80	$0.03
Potassium – lbs	150	$0.12	$18.00	$0.10
Lime (pro rated over 2 years)	1	$14.40	$14.40	$0.08
Fungicide (Amistar) – oz	5	$5.60	$28.00	$0.16
Fungicide (Acrobat) – oz	6	$1.38	$8.28	$0.05
Herbicide (Command) – oz	4	$0.45	$1.81	$0.01
Herbicide (Curbit) – pt	1.33	$5.55	$7.38	$0.04
Bee Rental – per hive	1	$40.00	$40.00	$0.22
Irrigation fuel (per Acre in.)	7	$2.20	$15.40	$0.09
TOTAL			**$244.91**	**$1.36**

Total Costs of Pickle Production

	Per Acre	***Per Bu.***
Variable Costs	$244.91	$1.36
Equipment Costs	$69.94	$0.39
Land Costs	$75.00	$0.42
Taxes & Ins.	$25.00	$0.14
Total Exc. Harvest	**$414.85**	**$2.31**
Harvesting Wilde	$69.34	$0.39
Total w/Wilde	**$484.19**	**$2.70**
Harvesting Pik Rite	$110.21	$0.61
Total w/Pik Rite	**$525.06**	**$2.92**

CRITICAL PEST INFORMATION

Insects

There are 3 major insect pests of pickling cucumbers: the cucumber beetle (striped and spotted), green peach aphid and melon aphid. Cucumber beetle can cause direct feeding damage and vector bacterial wilt, a disease which causes up to 10% losses in pickling cucumbers. Aphids can cause direct damage and vector viruses. Minor insect and mite pests are Seed corn Maggots, Cabbage Looper, Pickleworm, Two-spotted Spider Mite and Beet Armyworms.

Diseases

Downey Mildew was the major disease of pickling cucumbers in 2004. No control measures were effective. Cottony Leak can cause high post harvest losses. Some diseases are vectored by insects: Bacterial Wilt and viral diseases. Control measures should be directed towards the insect vector or host plant resistance. Other diseases on the Delmarva are: Belly Rot, Phytophthora Blight, Damping-Off, Angular leaf spot, Gummy stem blight/ black rot, Scab, Powdery Mildew, Anthracnose, and Root Knot Nematode.

Weeds

Primary weeds in cucumbers include annual grasses, common ragweed, pigweed species, lambsquarters, jimsonweed, morningglory species, common purslane and common cocklebur. Secondary pests are yellow nutsedge, johnsongrass, bermudagrass, nightshades, velvetleaf, spurred anoda, horsenettle, common milkweed, bindweed, Canada thistle, pokeweed and groundcherry.

CRITICAL PESTICIDE INFORMATION

Insecticides

Organophosphates used in pickling cucumbers are: lindane (30% of acreage) and chlorpyrifos (Lorsban SL; 70% of acreage) as a commercial seed treatment only. Guthion is no longer labeled for pickling cucumbers. Carbamates used in pickling cucumbers are: carbofuran, methomyl, and carbaryl. There are no B2 carcinogens used. Pipe line materials are: lambdacyhalothrin, indoxacarb, methoxyfenozide, etoxazole, thiamethoxam, acetamiprid, and flonicamid.

Fungicides

One organophosphate is used in pickling cucumbers: ethoprop for nematode control. Carbamates used are: propamocarb hydrochloride, thiophanate-methyl, and oxamyl. B2 possible carcinogens used in pickling cucumbers are: chlorothalonil, mancozeb, zoxamide, and metam-sodium. There are no pipe line materials.

Herbicides

Bensulide (Prefar) is the only organophosphate herbicide used in pickling cucumbers. There are no carbamates or B2 possible carcinogens. There are no pipe line materials.

INSECT PESTS

Striped and spotted cucumber beetles

Damage and Life Cycle: Striped cucumber beetles, *Acalymma vittata* (Fabricius), and spotted cucumber beetles, *Diabrotica undecimpunctata howardi* (Barber), are the most destructive insect pests of pickling cucumbers in the mid-Atlantic area. Both cucumber beetles share a similar life cycle, and inflict similar damage to host plants. Both species overwinter as adults in neighboring woodlands or other protected areas and move onto cucurbit crops in May, just after plant emergence. The major feeding injury and disease transmission takes place from the time cucumbers are emerging until they form runners. Beetle feeding on the young seedlings often kills the plants or greatly retards their growth. Beetles also burrow into the soil to feed on seedlings below the surface. Female cucumber beetles deposit eggs in the soil at the base of host plants or on the underside of leaves. Larvae feed on the roots of the plants for 2 to 3 weeks before they pupate in the soil. A second generation of beetles appears later in the summer and will attack the fruit. Both species of cucumber beetles feed on the roots, stems, foliage and fruit of cucumbers. Cucumber beetles vector bacterial wilt disease to cucumbers and certain other cucurbits. Cucumber beetles also can transmit another important disease, cucumber mosaic virus.

Monitoring: Cucumber beetles can transmit bacterial wilt; however, losses from this disease vary greatly from field to field and among different varieties. On farms with a history of bacterial wilt infections, insecticides are used to control adult beetles before they feed extensively on the cotyledons and first true leaves.

If foliar insecticides are used, sprays are applied shortly after plant emergence and repeat applications are made if new beetles continue to invade fields.

The action threshold for treatment in machine-harvested pickling cucumbers is when 5% of plants are infested with beetles and/or showing fresh feeding injury. Cucumber beetle populations exceeding this threshold are typically treated with one to four insecticide applications.

IPM issues: In recent conversations with producers, they have indicated that they are finding an increase in the incidence of bacterial wilt vectored by cucumber beetles. After the 2004 season, there may also be concern regarding the role cucumber beetles could play in increasing entry sites for downy mildew. These 2 issues could result in the need for refined thresholds and/or an increase in foliar and at planting insecticide use.

Resistance management issues: None

Consumer education issues: None

Export/Import issues: None

Organo-phosphates currently used to manage this pest: None (Guthion no longer labeled).

Carbamates currently used to manage this pest:

Furadan-- 4F – This is labeled as a Special Local-Needs Label 24(c) – 3.8 fl oz/1000 ft of row; One application per season applied at planting; applied to 10% of the acres; provides good control ; REI – 48 hours; PHI – at planting material

Lannate--1.5-3 pt LV/A ; One application per season; applied to 0% of the acreage; poor - fair control; REI- 48 hours; PHI – 3 days

Sevin--1.25 lb 80S/A; One – two applications per season ; applied to less than 2% of the acreage; bee issues; good control; REI – 12 hours; PHI – 3 days

B2 carcinogens currently used to manage this pest: None

Other pesticides currently used (including biologicals) to manage this pest:

Admire--16-24 fl oz 2F/A (neonicotinoid) – One application per season at planting; Applied to 0% of the acres because of cost; good control; REI – 12 hours; PHI – 21 days

Asana XL--5.8-9.6 fl oz 0.66EC/A (pyrethroid) ;One to two applications per season; applied to 10% of the acreage; fair-good control; REI – 12 hours; PHI – 3 days

Capture--2.6-6.4 fl oz 2EC/A (pyrethroid); One to two applications per season; applied to 20% of the acreage; good control; REI – 12 hours; PHI – 3 days

Permethrin -- 4-8 fl oz 3.2EC /A (pyrethroid); One to two applications; applied to

30% of the acreage; fair - good control; REI – 12 hours; PHI – 0 days

Thionex – 0.67-1.33 qts 3EC/A (organochlorine); One application per season; applied to 20% of the acreage; safer on bees; good resistance management tool; fair-good control; REI – 24 hours; PHI – 2 days

Non-Chemical methods: None
Biological: None
Cultural: Row covers can be used in small fresh market plantings to screen out adult beetles during the critical period of disease susceptibility, and trap crops of squash can be used as an early planting to lure beetles away from cucumbers. However, these practices are not practical or effective in commercial pickling cucumber fields. Bacterial wilt resistant cultivars are not available

Non-registered (Pipe line materials) pest management tools:
Thiamethoxam (Platinum - labeled on crop but not for cucumber beetle); Acetamiprid (Assail)

Melon aphid (*Aphis gossypii*) and **Green Peach aphid** (*Myzus persicae*)

Damage and Life Cycle: Aphids are found primarily on the underside of the leaves, where they suck sap from the plant and cause a reduction in the quality and quantity of the fruit. Infested leaves curl downward and may turn brown and die. The melon aphid is also one of the primary vectors of cucumber mosaic virus. Aphid species identification is critical, since available chemical controls are not equally effective against all aphid species.

Monitoring: An insecticide treatment is recommended if more than 20% of the plants have 5 or more aphids, natural enemy populations are low, and humidity is low to moderate.

IPM issues: None

Resistance management issues: The Melon aphid, also known as the cotton aphid, can quickly develop resistance to insecticides.. Although the green peach can be easier to control, it has also developed resistance to labeled materials on other vegetable crops in the Mid-Atlantic region.

Consumer education issues: None

Export/Import issues: None

Organo-phosphates currently used to manage this pest:

Metasystox –R—1.5 – 2 pt 2SC/A: One application per season; applied to less than 2% of the acreage; fair control of green peach aphid; more commonly used

on fresh market cucumbers; poor control of melon aphids; REI – 48 hours; PHI – 3 days

Carbamates currently used to manage this pest:
Lannate--1.5-3 pt LV/A ; One application per season; applied to 10 % of the acreage; fair control of melon aphid; poor control of green peach aphid; better control at higher rates; REI- 48 hours; PHI – 3 days

B2 carcinogens currently used to manage this pest: none

Other pesticides currently used (including biologicals) to manage this pest:
Admire--16-24 fl oz 2F/A (neonicotinoid); One application per season at planting; Applied to 0% of the acres due to cost; good control; REI – 12 hours; PHI – 21 days

Fulfill--2.75 oz 50WP/A ; One application per season; Applied to less than 2% of the acres; fair - good control if penetrating surfactant used; REI – 12 hours; PHI – 0 days

Platinum -- 5-8 oz 2SG/A (neonicotinoid); One application per season at planting; Applied to 0% of the acres due to cost; good control; REI – 12 hours; PHI – 30 days

Thionex – 0.67-1.33 qts 3EC/A (organochlorine); One application per season; applied to 20% of the acreage; good control; REI – 24 hours; PHI – 2 days

Non-Chemical methods:

Biological: When making a treatment decision, natural enemy populations are considered. Aphids may be controlled by parasitic wasps and a variety of predators, including lady beetles and their larvae, lacewing larvae, and syrphid fly larvae. During periods of high humidity, fungal diseases may also help reduce aphid populations. Natural enemies are important to a certain extent but do not always keep pest populations in check. There is no manipulated attempt to enhance natural enemy populations, nor are any alternate or biological controls used to manage aphids in pickling cucumbers.

Cultural: None

Non-registered (Pipe line materials) pest management tools:
Acetamiprid (Assail)**;** Flonicamid

Minor Insect and Mite Pests

Seedcorn maggot (*Delia platura*)

Damage and Life Cycle: Seedcorn maggot is a common insect throughout the Northeast . Adults emerge from overwintering puparia during spring planting time and females lay eggs just below the surface of the soil. Eggs hatch in 4 to 7

days, and emerging larvae feed on decaying organic matter. Maggots may burrow into the seed and consume the germ, preventing germination. Larvae feed for 21 days, then pupate in the soil. There are 4 to 5 generations per season.

Monitoring: There are no monitoring techniques or thresholds for seedcorn maggot. Currently, no at planting soil insecticides are labeled on cucumbers for seed corn maggot control.. If damage is extensive enough to warrant replanting, a seed treatment should be used to prevent re-infestation. .. .

IPM issues: Only one seed treatment is currently labeled on cucumbers. Diazinon is no longer labeled on cucumbers as a pre-plant broadcast applied insecticide. Although Admire and Platinum applied at planting may help to reduce problems, limited research data is available to support this use so they are not labeled for maggots. In addition, there are no rescue treatments for this insect pest.

Resistance management issues: None
Consumer education issues: None

Export/Import issues: None

Organo-phosphates currently used to manage this pest:
LorsbanSL – 2 oz/100 lbs of seed; Commercial seed treatment only; applied before planting; Applied to 70% of the acreage; good control

Carbamates currently used to manage this pest: None

B2 carcinogens currently used to manage this pest: None

Other pesticides currently used (including biologicals) to manage this pest:
None labeled

Non-Chemical methods: None
Biological: None
Cultural: A variety of cultural control measures can help to reduce problems from this pest. Late plantings during cool springs and shallow placement of seed may speed germination times and reduce injury levels, but these are not practical options for commercial growers. Fields with cover crops or those high in organic matter are generally plowed prior to fly emergence in early spring. Removal of plant debris is also an important practice.

Non-registered (Pipe line materials) pest management tools: None

Cabbage Looper

Damage and Life Cycle: The cabbage looper is a migratory pest reaching the Mid-Atlantic in early July. In general, it can be a problem in later plantings of pickling cucumbers. Adults are nocturnal laying their eggs on the undersides of leaves. Larvae generally feed on the undersides of leaves. They are often observed feeding between the veins of leaves making ragged holes in the foliage.

Monitoring: There are no thresholds available for this pest on pickling cucumbers. Sprays are applied when numbers are increasing and defoliation is observed.

IPM issues : None

Resistance management issues: None

Consumer education issues : None

Export/Import issues: None

Organo-phosphates currently used to manage this pest: none

Carbamates currently used to manage this pest:

Lannate--1.5-3 pt LV/A ; One application per season; applied to less than 2% of the acreage; good control; REI- 48 hours; PHI – 3 days

B2 carcinogens currently used to manage this pest: None

Other pesticides currently used (including biologicals) to manage this pest:
Asana XL--5.8-9.6 fl oz 0.66EC/A (pyrethroid); One applications per season; applied to less than 2% of the acreage; fair - good control; REI – 12 hours; PHI – 3 days

Bacillus thuringiensis (various formulations) – One application per season; applied to
less than 1% of the acreage; good control, but must be applied to small larvae; REI – 4 hours; PHI – 0 days

Capture--2.6-6.4 fl oz 2EC/A (pyrethroid); One application per season; applied to less than 1% of the acreage; fair - good control; REI – 12 hours; PHI – 3 days

permethrin-- 4-8 fl oz 3.2EC/A (pyrethroid); One application per season; applied to less than 2% of the acreage; fair-good control; REI – 12 hours; PHI – 0 days

SpinTor--4-8 fl oz 2SC/A (macrocyclic lactone) ; One application per season; applied to less than 1% of the acreage; fair – good control (need high rate for good control); REI – 4 hours; PHI – 1 day

Non-Chemical methods: None
Biological: None

Cultural: None

Non-registered (Pipe line materials) pest management tools: lambda-cyhalothrin (Warrior)

Pickleworm

Damage and life cycle: Pickleworm moths migrate to the mid-Atlantic region by late July. Eggs are deposited on hairy plant parts, such as the blossoms and young leaves. Young larvae usually feed among small leaves at the growing tips of vines, or within blossoms. When about half grown, they may bore into fruits and continue to feed there, causing internal damage to the fruit. Larvae are seen feeding in plant terminals in late August, but they have very rarely been detected in the fruit.

Monitoring: There are no effective monitoring techniques for pickleworm. There is zero tolerance for larvae found feeding in the fruit.; therefore, processors can reject any field identified with fruit infestation from pickleworm. Due to the zero tolerance for this pest and the fact that it does migrate to our area, some growers use a preventative approach to treatment for pickleworm.

IPM issues: Currently, we lack effective treatment thresholds as well as a method to monitor moth migration into our area. Although the use of pheromone traps has been evaluated, this method has been ineffective due to difficulties in identifying the active isomers to produce a lure that attracts moths.

Resistance management issues: None

Consumer issues: A combination of zero tolerance by the consumers in the finished product and difficulty in detection can result in precautionary foliar applications.

Export/Import issues: None

Organo-phosphates currently used to manage this pest: none

Carbamates currently used to manage this pest:

Lannate--1.5-3 pt LV/A ; One application per season; applied to less than 2 % of the acreage; good control; REI- 48 hours; PHI – 3 days

Sevin--1.25 lb 80S/A ; One applications per season ; not used to control this pest; poor control; REI – 12 hours; PHI – 3 days

B2 carcinogens currently used to manage this pest: None

Other pesticides currently used (including biologicals) to manage this pest: Asana XL--5.8-9.6 fl oz 0.66EC/A (pyrethroid); One applications per season; applied to less than 2% of the acreage; good control; REI – 12 hours; PHI – 3 days

Capture--2.6-6.4 fl oz 2EC/A (pyrethroid); One application per season; applied to less than 1% of the acreage; good control; REI – 12 hours; PHI – 3 days

permethrin-- 4-8 fl oz 3.2EC/A (pyrethroid); One application per season; applied to less than 2% of the acreage; good control; REI – 12 hours; PHI – 0 days

SpinTor--4-8 fl oz 2SC/A (macrocyclic lactone) ; One application per season; not used for this pest; good control; REI – 4 hours; PHI – 1 day

Thionex—0.67 – 1.33 qts 3EC/A (organochlorine); One application per season; applied to less than 5% of the acreage; good control; REI – 24 hours; PHI – 2 days

Non-Chemical methods: None
Biological: None
Cultural: Pickleworm problems can be avoided by planting early, but commercial growers growing for a processor use successive plantings, since a steady supply of pickling cucumbers is needed throughout the season. For this reason, early planting to avoid pickleworm damage is not viable management option.

Non-registered (Pipe line materials) pest management tools: lambda-cyhalothrin (Warrior); indoxacarb (Avaunt) ; methoxyfenozide (Intrepid)

Two-Spotted Spider mites

Damage and Life Cycle: Pickling cucumbers are not generally seriously damaged by mites, due to the short growing season. Some damage can occur in the most extreme drought conditions, but treatment for this pest is extremely rare. Mite infestations generally begin around near overwintering areas such as field margins and grassy areas.

Monitoring: Localized infestations can be spot-treated. Begin treatment when 10 to 15 percent of the crown leaves are infested early in the season, or when 50 percent of the terminal leaves are infested later in the season.

IPM issues : None.

Resistance management issues : None

Consumer education issues: None

Export/Import issues: None

Organo-phosphates currently used to manage this pest: none

Carbamates currently used to manage this pest: none

B2 carcinogens currently used to manage this pest: none

Other pesticides currently used (including biologicals) to manage this pest: Acramite – 0.75-1.0 lb 50WS/A (carboxylic acid ester.); One application per season; labeled in 2004 but not used yet; good control; REI – 12 hours; PHI – 3 days

Agri-Mek--8-16 fl oz 0.15EC/A (macrocyclic lactone) – One application per season; not used on pickling cucumbers; good control; REI – 12 hours; PHI – 7 days

Capture--5.12-6.4 fl oz 2EC/A (pyrethroid); One - two applications per season; Used on less than 2 % of the acreage; good control; REI – 12 hours; PHI – 3 days

Danitol--10.66 fl oz 2.4 EC/A (pyrethroid); One-two applications per season; used on less than 1% of the acres; good control; REI – 24 hours; PHI – 7 days

Kelthane (See restrictions.)--1.67 lb 35WP/A (organochlorine); One application per season; Used on less than 1% of the acreage; fair control; REI – 12 hours; PHI – 2 days

Non-Chemical methods: None

Biological: None

Cultural: Mite infestations generally begin around field margins and grassy areas. Therefore, avoiding mowing or maintaining these areas after midsummer reduces mite movement into fields.

Non-registered (Pipe line materials) pest management tools: Etoxazole (Zeal)

Beet Army Worm

Damage and Life Cycle: This insect migrates from the south and arrives in the Mid-Atlantic region in late July. Peak populations generally occur in late August. Early instar larvae usually feed in groups, skeletonizing leaves and spin silk over the feeding sites. Later instars have been found feeding on the surface of pickles.

Monitoring: No thresholds are available for beet armyworm on cucumbers. In addition, early detection can be difficult.

IPM Issues: None

Resistance Management Issues: This insect is difficult to control and has developed resistance to organophosphate, carbamate and pyrethroid chemistry in the south.

Consumer Issues: None

Export/Import Issues: None

Organo-phosphates currently used: None

Carbamates currently used to manage this pest:

Lannate--1.5-3 pt LV/A ; None used due to resistance issues and the fact that it is only affective on small larvae; REI- 48 hours; PHI – 3 days

B2 carcinogens currently used to manage this pest: None

Other pesticides currently used (including biologicals) to manage this pest:

Capture--2.6-6.4 fl oz 2EC/A (pyrethroid); None used due to resistance issues poor control; REI – 12 hours; PHI – 3 days

SpinTor--4-8 fl oz 2SC/A (macrocyclic lactone) ; One application per season; used on less than 5 % of the acres; good control; REI – 4 hours; PHI – 1 day

Non-Chemical methods: None
Biological: None
Cultural: None
Non-registered (Pipe line materials) pest management tools: indoxacarb (Avaunt) ; methoxyfenozide (Intrepid)

Insect Control Efficacy Table

	Striped and spotted cucumber beetles	Melon Aphid Green Peach Aphid	Seedcorn maggot	Cabbage Looper	Pickleworm	Two-Spotted Spider Mite	Beet Army Worm
Furadan 4F	G						
Lannate	P-F	P- F		G	G		P
Sevin	G				P		
Acramite						G	
Admire	G	G					
Agri-Mek						G	
Asana XL	F-G			F-G	G		

Capture	G			F-G	G	G	P
Danitol						G	
Kelthane						F	
Permethrin	F-G			F	G		
Thionex	F-G	G			G		
Thiamethoxam (Platinum)		G					
LorsbanSL			G				
Lindane			P				
Bacillus thuringiensis				F- G			
SpinTor				F-G	G		G
Fulfill		F-G					
Row covers	NU						
trap crops	NU						
Resistant cultivars	Not available						
Natural enemy populations	NU	NU	NU				
Late plantings	NU	NU					
planting early	NU	NU			NU		
shallow placement of seed			NU				
plowing prior to fly emergence			F				
Removal of plant debris			F				
avoid mowing field margins						P-F	

E = excellent
G = good
F = fair
P = poor
? = more research needed
Var = variable
NU = not used

- = used, but not necessarily a stand along management tool.

DISEASES

Infectious diseases of cucumbers are caused by fungi, bacteria, viruses, and nematodes, and some are vectored by insects. Most diseases are controlled through host plant resistance. Two varieties that exhibit resistance to a combination of diseases account for 86% of acres grown in Maryland and Delaware. Other common varieties offer disease resistance as well. The prevalence of excellent host plant resistance in this crop eliminates the need for fungicide applications for foliar diseases in most years. 100% of pickling cucumber acres are moldboard plowed prior to planting to bury plant residue and reduce pathogen levels in the soil. Fields are generally rotated into non-cucurbit crops following harvest, but some growers double crop pickling cucumbers, increasing the risk of yield loss to soil-borne diseases or nematodes. The 2004 growing season, however, was an extremely unusual year with excessive rain. Many fungicides did not control Downy Mildew. In a normal year, growers seldom spray for Downy Mildew. In 2004, however, Downy Mildew was a severe problem.

Several diseases are not adequately controlled by resistance and cultural techniques. For these, seed treatments and soil applications of fungicides are necessary. The soil-borne diseases belly rot and phytophthora blight cause sporadic but severe yield and quality losses in pickling cucumbers. Damping off and Pythium cottony leak also cause economic losses and are of concern for growers. Damage from bacterial wilt is less common, but yield losses do occur in some fields in some years.

Downy Mildew (Everts, 2005)

Resistance is available in most modern cultivars to the races that have been previously documented in the Mid-Atlantic. Use resistant varieties when possible. However, use of resistant varieties did not work in 2004. The disease generally does not occur until mid-August, however, scout fields for disease incidence beginning in mid-July. Refer to the Cucurbit Downy Mildew Forecasting website (http://www.ces.ncsu.edu/depts/pp/cucurbit/) for current status of the disease. Begin sprays when vines run or if disease occurrence is predicted for the region.

Preventative applications are much more effective than applications made after disease is detected. The following are the most effective materials.

IPM issues: forecasting and prediction

	Before 2004		During 2004	
Products	Level of control	Percent of acres treated	Level of control	Percent of acres treated
Ridomil Gold Bravo	n/a	0 acres	No control	75%
Previcur	n/a	0 acres	No control	70%
Cabrio	n/a	0 acres	No control	25%
Pristine	n/a	0 acres	No control	2%
Tanos	n/a	0 acres	No control	65%
Gavel	n/a	0 acres	No control	65%
Bravo, Echo, Equus	n/a	0 acres	No control	75%
Hero/ Ranman	n/a	n/a	n/a	n/a
Curzate	n/a	0 acres	No control	45%
Quadris	n/a	0 acres	No control	5%
Prevam	n/a	0 acres	No control	3%
Copper	n/a	0 acres	No control	65%

Carbamates currently used to manage this pest:
Propamocarb hydrochloride (Previcur Flex) --1.2 pt 6F/A; not effective in 2004

B2 carcinogens currently used to manage this pest:
mefenoxam *plus* chlorothalonil (Flouronil, Ridomil Gold Bravo)--2 lb 76WP/A; not effective in 2004
chlorothalonil (Bravo, Echo, Equus)--1.5-2 pt 6F/A or OLF; not effective in 2004
Cymoxanil + mancozeb (Curzate) 60 DF—3.2oz/A; not effective in 2004.
Zoxamide (Gavel)--1.5-2 lb 75 DF/A; not effective in 2004

Other pesticides currently used (including biologicals) to manage this pest:
Pyraclostrobin (Cabrio) --8-12 oz 20WG/A; not effective in 2004
Pyraclostrobin + boscalid (Pristine)--12.5-18.5 oz 38WG/A; not effective in 2004
Famoxodone + cymoxanil (Tanos)--8 oz 50WDG/A (must be tank mixed with either chlorothalonil, mancozeb or copper); not effective in 2004
Bacillus subtilis (Serenade)- not effective
cyazofamid (Hero, Ranman) – New product on cucumbers 9/2004.

Sprays should be applied on a 7-day schedule. Cabrio, Pristine and Tanos should not be alternated or used consecutively. Under severe disease conditions spray interval may be reduced if label allows.

Belly rot

Damage and Life Cycle:
Belly rot is caused by *Rhizoctonia solani*, a common soil-borne fungus. The disease develops on the portion of the cucumber fruit which is in contact with the soil. The disease proceeds rapidly when temperatures exceed 82^{o}F (23).

IPM issues- difficult disease to predict, mechanical pick system with close rows and dense canopy favor disease when environmental conditions are favorable for infection especially in pickling cucumbers following pickling cucumbers.

Organo-phosphates currently used to manage this pest: none

Carbamates currently used to manage this pest: none

B2 carcinogens currently used to manage this pest: none

Other pesticides currently used (including biologicals) to manage this pest:
Azoxystrobin (Amistar) – 3.5-5 oz. normally one application, occasionally two; good control;

Non-Chemical methods:
Biological: none
Cultural: rotation, deep plowing

Non-registered (Pipe line materials) pest management tools: none

Phytophthora blight

Damage and Life Cycle:
The fungus that causes Phytophthora blight, *Phytophthora capsici*, is primarily soil-borne, has a number of hosts, and can remain in the soil for years. All above-ground plant parts can be affected, but cucumber fruit is the main plant part infected. A white mold and spores develop on the affected area, and later appear as a yeast-like growth. Fruits that develop are undersized and distorted. The disease is promoted by warm, wet weather and frequently appears first in the wettest part of the field.

IPM issues- need to rotate, heavy rain showers that saturate the soil or leave fields flooded are problematic, need to allow for water to run off or drain quickly, fungicides alone will not control Phytophtora blight.

Resistance management issues. Fungicide resistance in P. capsici has been documented in Delaware for mefanoxam.

Comment [MSOffice1]: Added this section

Organo-phosphates currently used to manage this pest: none

Carbamates currently used to manage this pest: none

B2 carcinogens currently used to manage this pest:
Zoxamide (Gavel)-- 1.5 – 2 lb 75DF/A; used on less than 2% acreage; some efficacy

Other pesticides currently used (including biologicals) to manage this pest:
mefanoxam (Ridomil) (Ultra Flourish) – 2-4 pt/A; used on 60% acreage; good efficacy. Needs rotation partners to limit development of resistance;
dimethomorph (Acrobat) - 6.4 oz 50WP/A; used on 25% acreage;
Copper- 1.5 – 2.0 lbs/A; used on 40% acreage; tank mixed partner for Acrobat and Gavel.

Non-Chemical methods:
Biological: none
Cultural: rotation, water management**,** sanitation of equipment, timing and method of application to ensure good coverage, 99% of acreage moldboard plowed

Non-registered (Pipe line materials) pest management tools: none

<u>Damping-off</u>

Damping-off refers to diseases caused by several species of *Pythium* that cause seeds to rot before they germinate, shoots to decay before they emerge, or seedlings to collapse. More prevalent in second crop pickling cucumbers (pickles after pickles).

IPM issues: More prevalent in second crop pickling cucumbers (pickles after pickles, spinach, green peas or other vegetables).

Resistance management issues: excessive use of mefanoxam could lead to resistance development not likely though

Organo-phosphates currently used to manage this pest: none

Carbamates currently used to manage this pest: none

B2 carcinogens currently used to manage this pest: none

Other pesticides currently used (including biologicals) to manage this pest:
Metalaxyl (Apron TL) or Allegiance seed treatment – 2-4 fl oz/100# of seed; used on 100% acreage
mefanoxam (Ridomil Gold) (Ultra Flourish) – 1-2 pt Ridomil Gold 4E/A or 2-4 pt Ultra Flourish 2E/A; rescue treatment on seedling on less than 2%; fair control

Non-Chemical methods:
Biological: none
Cultural: plowing, selection of well-drained fields, rotation

Non-registered (Pipe line materials) pest management tools: none

Cottony leak (Pythium)

Damage and Life Cycle:
Cottony leak is caused by the fungal pathogen *Pythium aphanidermatum*. In an unusually wet season, it can cause damping-off or vine cankers, but the most typical symptom is fruit rot. The fungus penetrates wounds in the fruit as well as old flower parts and plant parts in contact with the soil. Narrow rows and dense plant canopy (necessary for mechanical harvest pickling cucumbers) enhance potential for disease. Post harvest losses can be great because of fruit to fruit contact prior to processing. Disease occurrence depends on wet conditions favorable for infection.

IPM issues: scouting is difficult, disease prediction is difficult

Resistance management issues: Pythium has developed resistance to mefanoxam in other cropping systems in other areas.

Organo-phosphates currently used to manage this pest: none

Carbamates currently used to manage this pest: none

B2 carcinogens currently used to manage this pest: none

Other pesticides currently used (including biologicals) to manage this pest:
mefanoxam (Ridomil Gold) (Ultra Flourish) - 1-2 pints; used on 60% acreage; fair control;

Non-Chemical methods:
Biological: none
Cultural: rotation

Non-registered (Pipe line materials) pest management tools: none

Bacterial wilt

Damage and Life Cycle:
Erwinia tracheiphila, the bacterium that causes bacterial wilt, overwinters in the digestive tract of cucumber beetles (primarily striped) and is transmitted by beetles feeding on the leaves. Once a plant has been infected with bacterial wilt, it cannot be saved. Control of the beetle vector is the primary control strategy for the disease.

Chemical Controls:
There are no chemical controls that work directly on bacterial-wilt infected plants. The disease is managed by chemical control of the cucumber beetle vector. (See cucumber beetle section.)

Non-Chemical methods: refer to Cucumber beetles section

Non-registered (Pipe line materials) pest management tools: none

Angular leaf spot

Damage and Life Cycle:
Angular leaf spot is caused by the bacterium *Pseudomonas syringae* pv. *lachrymans* and occurs in squash, cucumber and pumpkin. The bacterium overwinters in seed and crop residue from infected plants, and can survive for at least one year in the field. Occurs in DE mostly in the fall crop and causes little to no damage. Control rarely necessary.

Organo-phosphates currently used to manage this pest: none

Carbamates currently used to manage this pest:
Mancozeb plus copper- 1lb per acre; used on less than 2% acreage;

B2 carcinogens currently used to manage this pest: none

Other pesticides currently used (including biologicals) to manage this pest:
none

Non-Chemical methods:
Biological: none
Cultural: disease free seed, moderate levels of host plant resistance in many varieties

Non-registered (Pipe line materials) pest management tools: none

Viral Diseases

Four distinct viruses have the potential to cause disease problems on pickling cucumbers in DE/Maryland: cucumber mosaic virus, watermelon mosaic virus, papaya ring spot virus and zucchini yellow mosaic virus. All these viruses have been identified on cucurbits on Delmarva. The relative occurrence of each of these viruses is uncertain. This is because specific viral identification is costly and time consuming and virus symptoms and management are similar regardless of the species involved. There is generally no yield loss in pickling cucumbers due to viral disease. All four of these viruses are transmitted by aphids, and Cucumber mosaic virus may also be spread by cucumber beetles. Control of these diseases, if necessary, is brought about through control of their insect vectors (see insect sections for control measures).

Organo-phosphates currently used to manage this pest: none
Carbamates currently used to manage this pest: none

B2 carcinogens currently used to manage this pest: none
Other pesticides currently used (including biologicals) to manage this pest: none

Non-Chemical methods:
Biological: none
Cultural: high level of host plant resistance for some viruses, planting the crop away from an existing cucurbit crop will help reduce spread of disease.

Non-registered (Pipe line materials) pest management tools: none

Gummy stem blight

Damage and Life Cycle:
Gummy stem blight is caused by the fungus, *Didymella bryoniae*, and refers to the foliar and stem-infecting phase of the disease. Control measures are rarely directed specifically at this pathogen.

Resistance management issues: Some populations of the pathogen in the Mid-Atlantic are resistant to Qoi fungicides and Topsin M.

Organo-phosphates currently used to manage this pest: none

Carbamates currently used to manage this pest:
mancozeb- 2-3lbs; 10% of crop treated
thiophanate-methyl (Topsin M) - .25 to half lb; 10% of crop treated

B2 carcinogens currently used to manage this pest:
chlorothalonil (Bravo)- 2 pints; 10% of crop treated

Other pesticides currently used (including biologicals) to manage this pest:
azoxystrobin (Amistar) - 3.5 -5 oz.; 10% of crop treated
pyraclostrobin (Cabrio) - 12-16 oz. 0% of crop treated
pyraclostrobin + boscalid (Pristine) - 12.5-18.5 oz. 0% of crop treated

Non-Chemical methods:
Biological: none
Cultural: rotation, clean plowing,

Non-registered (Pipe line materials) pest management tools: none

Scab

Damage and Life Cycle:
Scab is caused by a fungus called *Cladosporium cucumerinum,* which overwinters in seeds and on residue from diseased plants. The fungus can attack

any above-ground portion of the plant, including leaves, petioles, stems and fruits. The disease is most damaging because of the unsightly scab lesions that develop on fruit, usually making them unmarketable. Usually occurs under cool wet conditions.

Organo-phosphates currently used to manage this pest: none

Carbamates currently used to manage this pest: none

B2 carcinogens currently used to manage this pest:
Chlorothalonil (Bravo)- 2-3 pints; used on less than 2% acreage;

Other pesticides currently used (including biologicals) to manage this pest:
none

Non-Chemical methods: good host plant resistance is widely available
Biological: none
Cultural: rotation, clean plowing

Non-registered (Pipe line materials) pest management tools: none

Powdery Mildew

Damage and Life Cycle:
Powdery mildew, caused by the fungus *Podosphaera xanthii* and to a lesser extent by *Erisiphe cichoracearum,* occurs on cucumber, muskmelon and pumpkin, as well as squash. High temperatures promote the development of the disease. A powdery white growth first appears as spots on the leaves and young stems. The crown leaves are usually the first to be affected. Plants infected early tend to produce smaller fruit if left untreated. The pathogens are obligate parasites and must be reintroduced into the region every year.

IPM issues: scouting threshold has been developed,

Resistance management issues: widespread resistance in the pathogen to QOI and DMI fungicides

Organo-phosphates currently used to manage this pest: none

Carbamates currently used to manage this pest: none

B2 carcinogens currently used to manage this pest:
Chlorothalonil- 2-3 pints; used on less than 2% acreage;

Other pesticides currently used (including biologicals) to manage this pest:
Pristine- 12.5 – 18.5 oz 38WG/A

Recommended to be tank mixed with chlorothalonil
myclobutanil (Nova) - 2.5-5oz 40WP/A; used on less than 2% acreage
triflumizole (Procure)- 4-8 oz 50WS/A; used on less than 2% acreage
trifloxystrobin (Flint)- 1.5-2 oz 50 WDG/A; used on less than 2% acreage
pyraclostrobin (Cabrio) - 12-16 oz 20 EG/A; used on less than 2% acreage
azoxystrobin (Quadris)- 3.5-5 oz 80WDG/A; used on less than 2% acreage
Serenade- not effective

Non-Chemical methods: host plant resistance widely available
Biological: none
Cultural: use resistant cultivars

Non-registered (Pipe line materials) pest management tools: none

Anthracnose

Damage and Life Cycle:
Anthracnose is caused by the fungus *Colletotrichum orbiculare*, and occurs on a number of cucurbits. The causal fungus overwinters in seed and in residues from diseased plants, and can survive for up to 2 years in the absence of a host. Humid conditions and wet weather promote disease development.

Organo-phosphates currently used to manage this pest: none

Carbamates currently used to manage this pest:
Thiophanate-methyl (Topsin M) - .5 lb; usually added to chlorothalanil to increase efficacy;

B2 carcinogens currently used to manage this pest:
Mancozeb- 1.5–3 lbs; used on 5% of acreage; fair control
Chlorothalonil plus Topsin M- 1.5-3 pints; used on 5% of acreage; very good control

Other pesticides currently used (including biologicals) to manage this pest:
azoxystrobin (Amistar)- 3.5-5 oz; used on 5% of acreage; very good control
pyraclostrobin (Cabrio) -12-16 oz; used on 5% of acreage; very good control
pyraclostrobin + boscalid (Pristine) - 18.5 oz; used on 5% of acreage; very good control

Non-Chemical methods:
Biological: none
Cultural: rotation, good host resistance, disease free seed

Non-registered (Pipe line materials) pest management tools: none

NEMATODES

Root knot nematode

The most important nematode pest of pickling cucumbers in Maryland/ DE is the Southern Root Knot Nematode (*Meloidogyne incognita*). Like most nematodes, root knot nematodes have a broad host range, and feed on a variety of crops and weeds. Above-ground symptoms of root knot nematode infestation include erratic stands, stunted and wilted plants, and chlorosis. Nematode feeding produces the most severe symptoms under drought conditions, when plants are under increased stress. Yield reductions are highly variable, but can be significant. Yield reductions are much worse when following double crop pickling cucumbers or other vegetable crop.

IPM issues- can be a serious problem when winters are not cold enough to reduce the resident population. Can be very expensive to control chemically if necessary. Soil testing in the fall would be very helpful to identify damaging levels of nematodes.

Organo-phosphates currently used to manage this pest:
ethoprop (Mocap) - difficult to use

Carbamates currently used to manage this pest:
oxamyl (Vydate) -1-2 gallons; used on less than 20% acreage; good control;

B2 carcinogens currently used to manage this pest:
Metam-sodium (Vapam) - 37.5 -75 gallons; used on less than 3% acreage

Other pesticides currently used (including biologicals) to manage this pest:
Fumigants:
dichloropropene + chloropicrin (Telone) - 9-12 gallons; used on less than 10% acreage
metam potassium (K-pam) - 30-60 gallons; used on less than 10% acreage

Non-Chemical methods:
Biological: none
Cultural: rotation, suppressive crop (practice must be frequently repeated to be effective), increasing organic matter,

Non-registered (Pipe line materials) pest management tools: none

Plant Disease Control Efficacy Table

	Belly rot	Phytophthora blight	Damping-Off	Cottony leak	Angular leaf spot	Viral Diseases	Gummy stem blight/ black rot	Scab	Powdery mildew	Downy mildew ***	Anthracnose	Root knot nematode
Ridomil (Ultra Flourish; Ridomil Gold EC) mefenozam		G	F-G	F								
chlorothalonil (Bravo, Terranil)	P						G	G	P	***	P-F	
azoxystrobin (Quadris, Amistar)	F-G						G	G	P-F?	P-F	G-VG	
mefenoxam (Ridomil Bravo) & Flouranil		P-F					F-G		P	***	P-F	
thiram + metalaxyl (Apron)			F-G									
fixed copper + mancozeb												
mancozeb							F		P		F	
metam-sodium (Vapam)												VG
dichloropropene (Telone)												VG
oxaml (Vydate)												VG
Ethoprop (Mocap)												G
Metam potassium (K-Pam)												VG

famoxodone+ cymoxanil (Tanos)		?								*** G		
pyraclostrobin + boscalid (Pristine)							V G	G	G	***	F	
propamocarb HCl (PrevicurFlex)		P-F								G ***		
zoxamide +mancozeb (Gavel)		P-F					P-F		P	G ***	P-F	
pyraclostrobin (Cabrio)	?	P-F							G	***	VG	
dimethomorph (Acrobat)		F								F		
Copper		?					P		P	P	P	
thiophanate-methyl (Topsin M)	P						P-F	F	F		P-F	
Myclobuanil (Nova)									VG			
Chlorothalanil plus Topsin M							G	G	F		VG	
Triflumizole (Procure)									VG			
Trifloxystrobin (Flint)												
Cymoxanil + mancozeb (Curzate)										***		
Bacillus subtilis (Serenade)									Not effective	***		
rotate	E	E	E	E	E	E	E	E	VG	NE	E	E
plowing	E	NE	E	NE	E	NE	E	E	VG	NE	E	VG (1)

Water Management	VG	VG		VG						VG		
Timing & Method of Application to ensure good coverage	G	*		*	NU	NU	VG	NU	E	E	E	
well-drained fields	E	E	E	E						VG		
resistant varieties					NE	NE	VG	G	G	***	G	
Plant away from existing cucurbit crop						*				G		
disease-free or fungicide-treated seed			E-VG		G		VG					
incorporate organic matter into soil	?	?		?								?
Sanitation of equipment	VG	VG	NE	VG	NE	VG	NE	NE	NE	NE	NE	VG
Suppressive Crop	?	?	?	?								?

***Downy Mildew: No treatments (including host plant resistance) were effective in 2004

E= excellent
VG = very good
G= good
F= fair
P= poor
?= more research needed
NU= not used
*= used, but not necessarily a stand alone management tool
NE= Not Effective
(1) if planting can be delayed after tillage

WEEDS

Primary weeds (mostly in terms of acres) include:
Annual grasses (foxtails, fall panicum, crabgrass, barnyardgrass, and others)

Common ragweed
Pigweed species
Lambsquarters
Jimsonweed
Morningglory species
Common purslane
Common cocklebur

Secondary pests (defined as not as wide-spread of a problem in pickling cucumbers):
Yellow nutsedge
Johnsongrass
Bermudagrass
Summer annual weeds:
- Nightshades
- Velvetleaf
- Spurred anoda

Perennial weeds
- Horsenettle
- Common milkweed
- Bindweed
- Canada thistle
- Pokeweed
- Groundcherry

HERBICIDE FOR PICKLING CUCUMBERS

Pre-Planting Decisions: Use information obtained from the past season's scouting in planning weed control programs for the current year. Match preplant incorporated and preemergence herbicide rates to soil type and percent organic matter in each field. Since all pickles are planted after spring tillage, there is need for a no need for a non-selective herbicide prior to planting.

Labeled Herbicides for Pickling cucumbers:
Soil-applied herbicides:

Alanap (naptalam) 2SC: 1 gal/A - Alanap must be applied pre-plant incorporated only. Alanap will control a limited number of grass and broadleaf weeds. Weed control is reduced on sandy soils with less than 1% organic matter. Alanap provides good to fair control of pigweed and common purslane. Alanap is always used in combination with other herbicides (Prefar). Used on 0-5% acreage

Prefar (bensulide) 4E: 5 to 6 pts/A - Prefar can be applied pre-plant incorporated or preemergence. Prefar will control some annual grasses (barnyardgrass, large crabgrass, fall panicum, giant foxtail, and johnsongrass seedlings) but

only suppression of certain broadleaves, such as common lambsquarters, common purslane, and pigweed species. Risk of crop injury is less with Prefar than with Curbit. Used on less than 5% acreage.

Sandea (halosulfuron) 75DF: 0.5 to 1 oz/A - Preemergence application only. Sandea provides fair to good control of common ragweed, common lambsquarters, pigweed, cocklebur, jimsonweed, smartweed, galinsoga and yellow nutsedge. Yellow nutsedge control is better when applied as a postemergence herbicides. Sandea was recently labeled and limited historical use data available. Sandea does not control grass species. Used on 50-75% acreage.

Curbit (ethalfluralin) 3E: 1.5 to 2 pts/A - Preemergence application only. Curbit controls a number of annual grasses but only a few broadleaf weeds (pigweed and carpetweed). Curbit is often applied in combination with another herbicide (Command and/or Sandea). Curbit provides better weed control than Prefar, yet it has a slightly higher risk of crop injury. Curbit is seldom used with early planted pickling cucumbers due to this reason. Lower rates reduce the risk of crop injury; higher rates cause damage on sandy soils, especially in cold weather. Used on 90-100% acreage.

Command (clomazone) 3ME formulation: 4-8 oz./A - Preemergence application only. (Previously there was crop injury concern with another formulation of Command). Used predominately for annual grass, velvetleaf, jimsonweed, purslane, and common lambsquarters control. Used on 90-100% acreage.

Strategy (pre-packaged mixture of clomazone and ethalfluralin) at the following rates:

Strategy Rates (pints/A)	Equivalent rates of Curbit (oz/A)	Equivalent rates of Command (oz/A)
1.5	13	4
2	17	5
3	25	8
4	34	11

Used on 25% acreage; good control

<u>Postemergence herbicides</u>:

Alanap (naptalam) 2SC: 2 qts/A - Alanap will control a limited number of broadleaf weeds. Alanap provides good to fair control of pigweed and common purslane. Avoid use early in the season due to increase risk of

crop injury. Used on 5% acreage. No carry over restrictions with this product.

Sandea (halosulfuron) 75DF: 0.5 to 1 oz/A - Sandea provides good to excellent control common ragweed, pigweed, cocklebur, smartweed, galinsoga and yellow nutsedge. Yellow nutsedge control is better when applied as a postemergence herbicides. Common lambsquarters and jimsonweed control is much better when Sandea is applied preemergence. Sandea was recently labeled and limited historical use data available. Sandea does not control grass species. Sandea should be applied with a non-ionic surfactant. Carry over can be an issue. Used on 50% acreage.

Poast (sethoxydim) - 1 to 1.5 pints/A - Used exclusively for grass control. Will control annual grasses and certain perennial grasses. Use with crop oil concentrate at 1 percent solution (1 gallon/100 gallons of spray solution). Grass control will be best when the plants are treated while actively growing. Used on 25% acreage. Good to excellent control.

Select (clethodim) - 6 to 8 oz/A - Used exclusively for grass control. Will control annual grasses and certain perennial grasses, although not as effective on goosegrass as Poast. Use with crop oil concentrate at 1 percent solution (1 gallon/100 gallons of spray solution). Grass control will be best when the plants are treated while actively growing. Used on 10% acreage. Good to excellent control.

Herbicide	Under plastic	Soil between rows of plastic	Broadcast for bareground production	POST for row middles	Broadcast POST treatments
Alanap			**XXX**	**XXX**	**XXX**
Command		**XXX**	**XXX**		
Curbit		**XXX**	**XXX**		
Prefar	**XXX**	**XXX**	**XXX**		
Sandea		**XXX**	**XXX**	**XXX**	**XXX**
Strategy		**XXX**	**XXX**		
Poast				**XXX**	**XXX**
Select				**XXX**	**XXX**

For pickling cucumbers grown under plastic-culture, Gramaxone Max (paraquat) is used with shielded sprayers to control emerged weeds. A residual herbicide is included with paraquat.

Weed control is critical to the success of pickle production because of mechanical harvest.

All the herbicides have a PHI, however it is not an issue since the herbicides are typically sprayed well in advance of harvest and the REI is 24 hrs.

No problems with water quality or worker related problems for all herbicides beyond standard safe use information.

Herbicide-resistant weeds:

Imidazolinone-resistant pigweeds have been identified in DE. These plants have been selected for by repeated Pursuit applications in vegetables. It is suspected that Pursuit-resistant pigweed will not be adequately controlled by Sandea, although at this time, this has not been confirmed. Common ragweed resistant to imidazolinone have been identified in DE. Preliminary research indicates this common ragweed biotype is resistant to Sandea as well.

Organo-phosphates currently used to manage weeds: bensulide (Prefar)

Comment [MSOffice2]: What is this sentence in relation to.

Carbamates currently used to manage weeds: None

B2 carcinogens currently used to manage weeds: None

Non-chemical methods currently used to help manage weeds: All pickle fields are cultivated at least once for weed control. The rapid growth and vining growth habit of pickling cucumbers, makes it difficult to cultivate more than once. Cultivation is an important IPM component. Whether weeds are within the row or between the rows determines if cultivation will be an effective control. No biological control agents are currently being used for weed control.

Non-registered pest management tools:

University of Delaware's Weed Science Program has evaluated some herbicides for weed control between the rows of plastic. This work is extremely preliminary.

TABLE 1: RELATIVE EFFECTIVENESS OF SOIL-APPLIED PICKLE HERBICIDES FOR INDIVIDUAL GRASS AND GRASS-LIKE WEED SPECIES

Legend - based on adequate moisture, good growing conditions, and proper herbicide application

E = Excellent (>90% control)
G-E = Good to Excellent
G = Good (80-90% control)
F-G = Fair to Good
F = Fair (60-80% control)
P-F = Poor to Fair
P = Poor (20-60% control)
N = None (<20% control)
an "-" indicates that insufficient data or experience available.

Single active ingredient products	Barnyardgrass	Bermudagrass	Broadleaf signalgrass	Crabgrass	Fall panicum	Foxtails	Goosegrass	Johnsongrass (seedling)	Johnsongrass (rhizome)	Quackgrass	Sandbur	Shattercane	Texas panicum	Yellow nutsedge
Alanap	P	N	-	P-F	P	F	P-F	-	N	N	-	-	-	N
Command	F-G	P	G-E	F-G	E	E	E	P	N	P	G-E	P	G	N
Curbit	F	N	-	G	G	-	G	-	N	N	-	-	-	N
Prefar	G	-	-	G	G	G	F-G	G	-	-	-	-	-	N
Sandea	N	N	N	N	N	N	N	N	N	N	N	N	N	G
Pre-package mixtures														
Strategy	F-G	-	-	G	E	E	E	P	N	P	-	-	-	N

TABLE 2: RELATIVE EFFECTIVENESS OF SOIL-APPLIED PICKLE HERBICIDES FOR INDIVIDUAL BROADLEAF WEED SPECIES

Single active ingredient products	Eastern black nightshade	Burcucumber	Carpetweed	Cocklebur	Jimsonweed	Lambsquarters	Morningglory (annual spp.)	Pigweed	Giant ragweed	Common ragweed	Smartweed	Spurred anoda	Prickly sida or teaweed	Tropic croton	Velvetleaf	Purslane
Alanap	P	-	F	P	F	F	F	F-G	-	F	P	-	-	-	F	-
Command	P	P	N	P	F-G	G	N	P-F	P-F	P	F-G	E	F-G	G	E	G
Curbit	P	-	G	N	N	P-F	P	F	-	N	P	-	-	-	P	-
Prefar	N	-	N	N	N	F-G	N	F	-	N	N	-	-	-	N	-
Sandea	N	N	P	F-G	G	G	P-F	E	N	E	F-G	-	-	-	F-G	F
Pre-package mixtures																
Strategy	P	-	G	P	F	F-G	P	F	-	P	F-G	E			E	G

TABLE 3: RELATIVE EFFECTIVENESS OF POSTEMERGENCE PICKLE HERBICIDES FOR INDIVIDUAL GRASS AND GRASS-LIKE WEED SPECIES

Legend - based on adequate moisture, good growing conditions, and proper herbicide application

E = Excellent (>90% control)
G-E = Good to Excellent
G = Good (80-90% control)
F-G = Fair to Good
F = Fair (60-80% control)
P-F = Poor to Fair
P = Poor (20-60% control)
N = None (<20% control)
an "-" indicates that insufficient data or experience available.

Single active ingredient products	Barnyardgrass	Bermudagrass	Broadleaf signalgrass	Crabgrass	Fall panicum	Foxtails	Goosegrass	Johnsongrass (seedling)	Johnsongrass (rhizome)	Quackgrass	Sandbur	Shattercane	Texas panicum	Yellow nutsedge
Poast	E	F-G	G	G-E	E	E	G-E	E	G	G	G	G	G	N
Sandea	N	N	N	N	N	N	N	N	N	N	N	N	N	E
Select	E	G-E	G-E	E	E	E	G	E	G-E	G-E	G	E	G	N

Alanap does not provide postemergence control of grasses or yellow nutsedge.

TABLE 4: RELATIVE EFFECTIVENESS OF POSTEMERGENCE PICKLE HERBICIDES FOR INDIVIDUAL BROADLEAF WEED SPECIES

Single active ingredient products	Eastern black nightshade	Burcucumber	Carpetweed	Cocklebur	Jimsonweed	Lambsquarters	Morningglory (annual spp.)	Pigweed	Giant ragweed	Common ragweed	Sicklepod	Smartweed	Spurred anoda	Prickly sida or teaweed	Tropic croton	Velvetleaf	Purslane
Alanap	P	-	N	N	-	P	P-F	F	-	P	-	-	-	-	-	P	F
Sandea	F-G	P-F	P	E	G	F	F-G	E	F	F	P	F-G	F	F	-	F-G	F-C

Poast and Select do not provide control of broadleaf weeds.

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