Crop Profile for Pumpkins in Pennsylvania

Prepared: September 14, 1998

General Production Information

- Pennsylvania growers planted 5,800 acres of face or decorative pumpkins for the fresh market in 1997 and 6,200 acres in 1998.
- Pennsylvania has ranked 2nd in the United States in pumpkin acreage and production since 1995; accounting for 10% of the total pumpkin production in the US.
- The gross return for pumpkins in Pennsylvania is approximately $3,400/A with a statewide crop value of $20 million.
- The average production cost of pumpkins in Pennsylvania is $1,000 to $1,400 per acre depending on: pumpkin size and market destination.

Production Regions

Pennsylvania=s pumpkin crop is grown throughout the state with relatively large or concentrated acreage in the following regions: Southeast B 1,500 acres, Northeast B 500 acres, Capital B800 acres, South central B 500 acres, North central B 200 acres, Southwest B 1,000 acres, and Northwest B 1,000 acres.

Cultural Practices

The majority of the pumpkin acreage (90%) in Pennsylvania is direct seeded, while the other 10% of the crop is transplanted. Many growers (70%) are planting into soil after conventional tillage preparation while 20% of the growers are growing pumpkins under no-till conditions; especially following a hairy vetch or crimson clover cover crop that has been chemically killed before planting. A cover crop on the soil surface will reduce dirty pumpkins at harvest, provide some weed suppression, and minimize fruit rot by creating a barrier between pumpkins and soil. No postemergence herbicide is labeled for broadleaf weed control in pumpkins. Yellow nutsedge and certain Ahard to control@ broadleaf weeds may escape the preemergence residual herbicide application in no-till production. Since cultivation is usually not an option in no-till production systems and postemergence herbicides are not available to control escaped broadleaf weeds, CHOOSE fields carefully for no-till pumpkin production. Avoid fields with heavy populations of yellow nutsedge or broadleaf weeds that may not be controlled by the residual herbicide(s). A small percentage of the growers (10%) are growing pumpkins on raised beds with plastic mulch and drip irrigation. Soil types for pumpkin production range from silts to gravely loams and clays. Growers who want a predictable, constant yield have been irrigating their crops with overhead or drip irrigation throughout the growing season. Plant populations are based on specific pumpkin fruit sizes and the recommended plant spacings are: small B 18 to 20 sq. ft. per plant, medium - 28 sq. ft. per plant, and large B 40 sq. ft. per plant. Planting dates for pumpkins in Pennsylvania depends on location in the state, maturity of the variety, and whether they are direct seeded or transplanted but range from June 10 through July 6 each year.

Insect Pests

Pumpkins tend to be more tolerant of insect damage than other vine crops, but cultivars vary a great deal, and some are susceptible to insect damage. Insect also are essential for pollination and two insect groups (cucumber beetles and aphids) are very significant vectors of plant pathogens. Information about insects in pumpkins is partially developed from work in other vine crops.

At planting, **seed corn maggots** have been an increasingly problem in Pennsylvania. Adult flies lays eggs at the base of transplants and the developing maggot riddles the roots. There are multiple generations, but the first tend to be the most damaging. Pumpkins tend to be planted later than other vine crops, and late-planted vine crops may escape damage by the 1st generation. Post-plant rescue treatments with diazinon drenches are not very effective. Growers with a history of seed corn maggot treatments treat the seed in the hopper box or use a transplant drench with diazinon or chlorpyrifos.

Cucumber beetles are a group that are the most significant insect pest of most cucurbits. The group includes the striped cucumber beetle (which overwinters and is the most important in Pennsylvania) or the spotted cucumber beetle (which does not overwinter well in Pennsylvania). The striped cucumber beetle immigrates into fields immediately upon plant emergence or transplanting. Very rapid and high immigration pressure is not uncommon. Stands can be reduced from adult feeding, and developing larvae from eggs laid by these adults graze on roots. Management of bacterial wilt vectored by these beetles is often the more serious concern. Serology data suggest that >5% of the striped cucumber beetle immigrants carry the causal agent of bacterial wilt, and the percentage can rise to >50% during the season. Later generations of the striped cucumber beetle, immigrating spotted cucumber beetles, and two corn rootworms (the western corn rootworm and the northern corn rootworm), become the cucumber beetle complex late in the season. These feed in flowers and damage rinds. Both adults and larvae can damage rinds, and the feeding sites may serve as routes of entry for fungal pathogens.

Growers remember relying upon carbofuran at planting as a systemic to stop cucumber beetles and bacterial wilt, but this option has been phased out. Foliar sprays, based on the presence of the beetles, is the current practice. Materials include carbamates [carbaryl, or carbaryl formulated with a kairomonal bait (Adios)], pyrethroids (esfenvalerate) and organochlorines (methoxychlor or endosulfan). Resistance is a concern for one species (the western corn rootworm) of this complex. Imidacloprid offers a potential for cucumber beetle control with a systemic, which would result in fewer applications and increased farm-worker safety. *Research has been conducted and published from Pennsylvania showing the promise of imidacloprid as part of an IPM approach, but as of September 1998, an IR-4 petition for a Section 3 label has been delayed with EPA for over 2 years.*

Several species of **aphids** are significant as a vector of viruses, and major losses due to viruses have been observed in pumpkins in Pennsylvania as recently as 1997. The viruses can be transmitted so rapidly that insecticide control alone is insufficient to control disease. Some growers stagger multiple plantings to ensure harvest over a wider time interval, but this can make virus management more difficult as the aphids move from planting to planting. Growers use Metasystox-R, endosulfan, or oxamyl against aphids as part of a wider disease management plan (see the section on virus diseases). Research is needed for host plant resistance in commercial cultivars. Use of colored mulches may provide partial control for part of the season. Control of melon aphid (*Aphis gossypii*) has been inconsistent. This species exhibits resistance in some parts of the country, but has not been examined for resistance in Pennsylvania.

Other insect pests include squash vine borer, squash bugs, mites and whiteflies. **Squash vine borer** has only 1 generation per year. Larger plantings are less likely to develop severe infestations, but growers have reported fields of processing pumpkins (those grown to make a pie filling) severely hit with vine borer in Pennsylvania in the past. The problem is sporadic, and early tests using pheromone traps to time sprays have been inconclusive. Esfenvalerate, methoxychlor or endosulfan are listed for vine borer control. **Squash bugs** tend to have higher populations on squash and pumpkin than other vine crops, and they can be difficult to control after canopy closure. Soon after flowering or vine run, growers are advised to use pyrethroids (esfenvalerate or permethrin) or carbaryl if squash bugs are a problem to avoid population increase under a dense canopy. **Mites** and **whiteflies** are sporadic pests, but population increase can be rapid when and where they occur. They are more likely to be a late season pest in Pennsylvania. Avermectins or dicofol is recommended for mites, and endosulfan for whiteflies. If imidacloprid gets a registration, it will be considered for whiteflies (imidacloprid is already used where Section 18s allow against whitefly in vine crops in the west). Resistance is a concern with whiteflies.

In addition to insects as pests, **honeybees**, **bumble bees** and **solitary bees** pollinate pumpkins. Declines in honeybee populations due to two species of introduced mite parasites (tracheal mite and Varroa mite) have been very dramatic in the Northeast, with exceptional declines in densities of feral honeybee colonies. Renting honeybees for pollination is beginning. The current status of pumpkin pollination is not well characterized.

Diseases

Disease Name, Cause, Biology and Loss:

1. **Damping-off** is caused by several species of *Pythium, Phytophthora, Rhizoctonia,* and *Fusarium.* Losses vary. Occurrence is sporadic but when present, losses can be high. Greatest losses occur when conditions are cool and wet. Crop loss attributed to damping-off in Pennsylvania is estimated at about 0.5%.

2. **Virus diseases** are caused by CMV, WMV, PRSV, and ZYMV. Losses vary. Occurrence is sporadic but when present, losses can be high. Greatest losses occur when virus source plants (including some perennial weeds) are nearby and prevalent, and when aphid vectors are prevalent. Crop loss attributed to viruses in Pennsylvania is estimated at about 2%.

3. **Bacterial leaf spots** are caused by *Pseudomonas syringae* pv. *lachramans,* and *Xanthomonas campestris* pv. *cucurbitae.* Losses vary. Occurrence is sporadic. Occurrence and subsequent losses depend on presence of initial inoculum, either associated with seed or with soil where disease occurred within the past few years. Once present, ultimate severity depends on timing of initial symptoms, and on subsequent environment. Spread and development is promoted by splashing and blowing water from rainfall and overhead irrigation. Crop loss attributed to bacterial leaf spots in Pennsylvania is estimated at about 0.5%.

4. **Bacterial wilt** is caused by *Erwinia tracheiphila* which is spread by cucumber beetles. This disease occurs yearly. Greatest losses occur when plants are young and cucumber beetle vectors are prevalent. Crop loss attributed to damping-off can be very high in individual fields, but average loss in PA is estimated at about 2%.

5. **Downy mildew** of pumpkin is caused by pathotype 5 of *Psudoperonospora cubensis.* Usually, initial inoculum is introduced by wind from warmer (southern) areas, with spread occurring as a step-wise process, and originating where cucurbits are not killed by winter temperatures. In southern PA, where seasons are relatively long, downy mildew occurs most years. Greatest losses occur when inoculum is introduced early and subsequent environmental conditions are warm and moist. Crop loss attributed to downy mildew in Pennsylvania is estimated at about 5%.

6. **Powdery mildew** is caused by *Sphaerotheca fuliginea* (the predominant causal fungus) and *Erysiphe cichoracearum.* Usually, initial inoculum is introduced by wind from warmer (southern) areas, with spread occurring as a step-wise process, and originating where cucurbits are not killed by winter temperatures. Powdery mildew occurs most years in most fields. In southern PA, where seasons are relatively long, powdery mildew is especially important. Greatest losses occur when inoculum is introduced early and subsequent environment is warm. Crop loss attributed to powdery mildew in Pennsylvania is estimated at about 10%.

7. **Scab** is caused by *Cladosporium cucumerinum.* Occurrence is sporadic. Losses vary. Greatest losses are associated with wet cool conditions, usually after foliage is dense. Crop loss attributed to scab in Pennsylvania is estimated at about 1%.

8. **<u>Black rot</u>** is caused by *Didymella bryoniae.* Some pumpkins from most plantings are affected every year. Losses vary depending on rotation, variety, environment, and length of the storage period. Greatest losses occur on relatively soft varieties following wet growing conditions. Crop loss attributed to black rot in Pennsylvania is estimated at about 15%.

9. **<u>Phytophthora blight</u>** can be caused by several species of *Phytophthora*, but primarily is caused by *P. capsici.* Losses vary. Greatest losses occur in wet fields, usually when temperatures are high. Crop losses attributed to Phytophthora blight in Pennsylvania can be 50% or more on individual farms during wet seasons, but average loss for PA is estimated at about 2%.

Disease Control Programs and Additional Considerations:

- **<u>Phytophthora damping-off, blight, and fruit rot</u>**: Pre-plant soil fumigants used in the past include Vapam, methyl bromide, and chloropicrin. Soil fumigants are used only when other controls are inadequate. The protectant fungicides, Ridomil Gold/Bravo and Ridomil Gold/ Copper are required at 14-day intervals, with a fixed copper applied between these applications; the fungicides are recommended only in combination with rotation and optimum drainage as part of a disease management program. It is possible that Aliette- and/or fluazinam-combination treatments could be alternated with the Ridomil Gold-combination treatments. Alternating Ridomil Gold-combination treatments with treatments including Aliette or fluazinam could help slow development of resistance to fungicides; resistance to metalaxyl appears to be present in Florida isolates but has not been detected in New York isolates. Growers use rotation and improved drainage as primary controls. Chemicals are not used unless the cultural controls are inadequate. Solarization was not very helpful in a New York test. Use of dead oat straw or ryegrass living mulches appear to provide limited control, but disease level can be higher where black plastic mulch is used. Varieties with some disease tolerance may be available in the future; some experimental lines are promising.

- **<u>Viruses that are aphid-borne</u>**: Please see the insect section for information on chemical controls for the insect vectors. Growers attempt to control overwintering source weeds, but this is difficult because many source plants grow wild in ditch banks, in hedge rows, and along roadways. A few tests indicate that some varieties may be more tolerant to some viruses than others. However, degree of control does not appear to be at a commercial level. Research is needed to identify effective resistance to the several important viruses, and to incorporate resistance to multiple viruses into commercial varieties.

- **<u>Bacterial spots</u>**: When disease appears, the only treatment currently labeled to help slow spread is to spray with a fixed copper. Tank mixing maneb with the fixed copper could be helpful and should be evaluated. There are no other alternative chemical treatments. More effective chemicals are needed. At present, there are no reports of resistant varieties. To minimize buildup of inoculum in fields, pumpkins are rotated with non-cucurbit crops. To minimize the chance of introducing the bacterial pathogens with seed, growers purchase seed from reputable seed suppliers, and do not save their own seed.

- **Bacterial wilt**: The primary method is to control the beetles which transmit bacteria to plants. Please see the insect section for specific information. For pickling cucumbers, losses may be reduced by increasing seeding rate. This approach is not feasible for other cucurbits where excessive populations can result in poor yield and/or fruit quality. Use of floating row covers may keep beetle vectors from getting to plants, but this approach is not feasible on a large scale due to increased costs associated with purchase and management of the row cover.

- **Downy mildew**: Downy mildew usually does not appear until mid-August, but scouting of fields after mid-July is important so that sprays can be started if downy mildew appears earlier. Usually, maneb and/or Bravo is applied at 7- to 10-day intervals early in the season starting when vines run. Then if downy mildew is detected nearby, more specialized fungicides are applied on alternate weeks. These specialized fungicides include: Ridomil Gold/Bravo, Ridomil Gold/ Copper, and Aliette. Fixed copper alone, and fixed copper plus sulfur treatments are possible, but are less effective than the best treatments. Copper and sulfur treatments could be phytotoxic, especially when temperatures are high; therefore, before extensive use, field tests are important to determine effects on yield and quality. Some varieties have limited levels of resistance to downy mildew. However, current varieties benefit greatly from a regular fungicide program to control downy mildew. Higher levels of resistance to downy mildew are needed.

- **Powdery mildew**: Powdery mildew usually appears after mid-July. Many growers scout fields to determine when powdery mildew is appearing. The first powdery mildew fungicide application is recommended when powdery mildew is detected on the underside of any leaf of 45-50 leaves inspected. Although the protectant fungicide, chlorothalonil, can control the powdery mildew fungus, actual control in the field is limited because it is difficult to attain complete coverage of all leaf, vine and stem surfaces; usually, chlorothalonil provides good control only on the top surfaces of leaves. To obtain commercially acceptable control, fungicides with at least translaminar systemic activity (eg. Benalte, Bayleton) are needed. However, in most areas, the powdery mildew fungus has developed resistance to Benlate and/or Bayleton. It appears that this shift from sensitive to resistant populations can occur within one season. To minimize resistance problems, researchers recommend mixing materials and alternating application of fungicides which exhibit unique modes of action. At present, alternation of the following mixtures is recommended:

    - a. chlorothalonil (Bravo or Terranil) <u>plus</u> Bayleton, alternated with

    - b. chlorothalonil (Bravo or Terranil) <u>plus</u> Benlate or Topsin-M

    - Systemic fungicides with new modes of action are needed to replace or supplement some current fungicides. Alternative fungicides evaluated for control of powdery mildew include fixed copper materials, mixtures of potassium bicarbonate + ultrafine spray oil, and sulfur. Control provided by fixed copper materials is variable, may be related to specific products, and usually is inferior to control provided by chlorothalonil. However, limited use of fixed copper may be helpful in slowing development of resistance to some materials such as Benlate, Bayleton, Quadris, and Nova. The relatively low cost of fixed copper materials is an advantage. However, since copper can be phytotoxic on leaves at high rates, especially at high temperatures, and also is a heavy metal which could accumulate to toxic levels in soil, excessive use should be avoided. Control provided by the bicarbonate + spray oil, and sulfur treatments is relatively weak, even in comparison to chlorothalonil treatments. Some new fungicides with limited systemic characteristics (eg. Quadris, Nova) appear to be highly effective for powdery mildew control. Quadris may be granted a full Section 3 label for this use in 1999. Work to ensure availability of at least one additional "systemic" powdery mildew material is important; alternation of such materials should minimize chance of resistance development in the fungus to the fungicides. All current varieties are susceptible to powdery mildew, although some varieties are more tolerant than others. Partial resistance to powdery mildew is now being incorporated into experimental crosses of pumpkins. This resistance appears to more effective than that available in any current commercial varieties. Early observations indicate that this resistance could facilitate reduced need for fungicide applications but probably will not eliminate the need for fungicides to control powdery mildew. Little has been done to identify and evaluate bio-control microorganisms for control of powdery mildew. One biocontrol fungus, *Ampelomyces quisqualis* (AQ10) appears to help control powdery mildew. Two other biocontrol fungi evaluated for this purpose were not effective.

- **Black rot**: In spite of rotation and use of varieties with some tolerance to black rot, fungicides are important in the control of black rot. Control with fungicides requires regular applications starting at fruit set. The fungicide program suggested by researchers is to apply one of the following at 7-10 day intervals starting when fruit start to form:
    - a. chlorothalonil (Bravo or Terranil) plus Benlate, or
    - b. chlorothalonil (Bravo or Terranil) plus Topsin-M
    - Field test results indicate that mancozeb provides control of gummy stem blight equivalent to that provided by chlorothalonil; however, mancozeb is not labeled on pumpkins. Growers rotate pumpkins to provide at least 2 years between cucurbit plantings. In addition, when possible, growers use varieties with some tolerance to black rot. Varieties with firm rinds are more tolerant to black rot than varieties with less firm rinds. In the future, registration of at least one new fungicide (Quadris), effective against black rot (gummy stem blight), is anticipated. This registration should help growers with control of black rot. However, treatment with Quadris (0.2 ai/A) will be considerably more expensive than treatment with chlorothalonil. Some new breeding lines have fruit that is very firm, and as a result, could be more resistant to black rot than most previous

varieties.

- **Scab**: Chlorothalonil (Bravo, Terranil) provides good control of scab. No other labeled fungicides are effective for scab control. Rotation is practiced and is helpful. There is little information on varietal reaction to scab on pumpkin. Results from one test indicate that varietal differences exist; if needed, research to evaluate degree of resistance, and breeding to incorporate the resistance into commercial varieties could be justified.

Weeds

Both grass and broadleaf weeds are problems for pumpkin growers in Pennsylvania. In addition to the annual weeds, there are several important perennial weeds (quackgrass, yellow nutsedge, Canada thistle, pokeweed, horsenettle, horseradish, milkweed and field bindweed) that can be competitive with pumpkins in the growers field and significantly increase in population within one year. Weed seed suppression is encouraged by either a post directed-spray application with a contact or selective herbicide, mowing or cultivation prior to the vines running in the field. Crop rotation does help to reduce early season weed populations as well as no-tilling pumpkin seed into hairy vetch or crimson clover that has been killed before planting the pumpkin seed. Controlling weeds, especially the tall, vigorous growing species like common lambsquarter, common ragweed and the various pigweed species is critical if uniform application of fungicides and insecticides are required by the grower. The labeled herbicides for weed control recommended in Pennsylvania are:

- Bensulide (Prefar 4EC) as a preplant incorporated or preemergence application at 5 to 6 quarts per acre. Requires incorporation to at a maximum of 2 inch depth before seeding or transplanting. Primarily a annual grass material with carpetweed control and pigweed suppression or control. Weak on many broadleaf weeds, including common lambsquarter, common cocklebur, and jimsonweed.

- Clomazone (Command 4EC or 3ME) as a preemergence application at 8 to 14 fluid ounces per acre. Controls many annual grasses and broadleaf weeds, except pigweed species, carpetweed, annual morningglory species and yellow nutsedge. Some temporary injury (partial whitening of leaf or stem) may be observed after seedling emergence. Symptoms of Command application soon dissipate (plant turns green) with no affect on pumpkin yield or maturity.

- Ethalfluralin (Curbit 3E) as a preemergence application at 1.5 to 2.o pints per acre. Controls annual grasses and certain annual broadleaf weeds, including carpetweed, and pigweed species. Control of many other broadleaf weeds (common lambsquarter, jimsonweed, morningglory species, ragweed species, mustard species and others) may not be acceptable. Dry weather after application may reduce weed control. Cultivate to control emerged weeds if rainfall or irrigation does not occur prior to weed emergence. DO NOT preplant incorporate, apply under plastic mulch, use on pumpkin transplants, or when soils are cold and wet as crop injury can result.

- Paraquat (Gramoxone Extra 2.5) as a postemergence directed shielded spray application at 1.6 pints per acre and nonionic surfactant according to the labeled directions. Used to control emerged weeds between the rows after crop establishment. DO NOT allow spray or spray drift to contact crop (injury may result) and exceed a spray pressure of 30 psi.

- Sethoxydim (Poast 1.5 EC) as a postemergence application at 1 to 1.5 pints per acre with oil concentrate to be 1% of the spray solution (1 gallon oil per 100 gallons spray solution. Only controls annual and certain perennial grasses. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. WILL NOT control yellow nutsedge, wild onion, or broadleaf weeds. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present.

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Database and web development by the NSF Center for Integrated Pest Managment located at North Carolina State University. All materials may be used freely with credit to the USDA.