Crop Profile for Pumpkins in Tennessee

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General Production Information

Tennessee’s national ranking in pumpkin production fluctuates annually often competing for third place with other states and falling as low as seventh place. States producing similar acreage as Tennessee include Illinois, New York, and California. Tennessee's contribution to the national pumpkin production is approximately thirteen percent of total national production. Pumpkins generate approximately $5 million dollars in Tennessee's economy. Approximately 4,000 acres were planted in Tennessee during 2001 and approximately 3,500 acres were harvested. A typical yield per acre averages from 800 to 1,200 marketable pumpkins per acre and varies, depending on type planted. Pumpkins are the most popular vegetable in the cucurbit group (mostly Cucurbita argyrosperma), which includes gourds and summer and winter squashes. The majority of pumpkins grown in Tennessee are grown for ornamental purposes.

Cultural Practices

Site Selection: Pumpkins produce the best yields and quality on well drained, fertile soils.

Seeding Rates: Commonly 1 to 3 pounds per acre but varies with seed size, seeds per hill and row spacings.

Planting: Planted at 12' x 12' apart or 10' x 10' apart for large vigorous vine types. Smaller vine types are successfully grown at an 8' x 8' spacing. Spray rows are added for tractor passage for pesticide application and harvest. Pumpkins are planted when soil temperature is 65 degrees at 4 to 6 inch depth around June 15 until July 10.

Fertility: There are two common pumpkin production systems used in Tennessee. These include conventional tillage techniques and plastic culture, while less than 5% of total production utilizes minimum tillage techniques. Fertilizer applications depend on the production system selected by the grower. In minimum tillage systems, legume cover crops are grown to help reduce the amount of nitrogen needed. Nitrogen is then applied as a sidedressed application at 15-30 lbs per acre when runners are a minimum of 12 inches in length. Soils low in phosphorous may have as much as 90 lbs per acre added and soils low in potash may have as much as 60 lbs per acre added. In conventional planted

system more 30-40 lbs per acre of nitrogen is needed just prior to or at planting. The desired pH range for pumpkin production is 6.1 to 6.5. By having the proper pH, growers receive the greatest return for their fertilizer dollar. Good fertilization encourages deep rooting Vines to grow quickly and reduce weed problems later.

Rotation: 95% of the commercial fields are rotated each year, primarily for disease control. Rotation will greatly reduce the potential for disease infestation. Non-cucurbit crops are grown for three to four years. Wheat is often planted in pumpkin fields as winter cover. Strawberries are commonly grown the prior year.

Plastic: Pumpkin production on plastic is increasing in use in Tennessee, since this production method results in better early weed control and improved moisture conditions. Also, use of plastic is being done by growers who have the potential for double crop systems. Strawberry growers who produce crops on plastic are beginning to double crop with pumpkins behind strawberries.

Pollination: Pumpkins require insect pollination because they do not have both male and female parts in the same flower. Bees are the primary method by which pollen transfers from one flower to the other. Beekeepers are often contacted to place two to four beehives per acre to increase pollination and fruit set. Invasive parasitic mites have reduced colonies of native honey bee pollinators in Tennessee over the past eight years.

Production practices: Fields are commonly entered for scouting purposes on an average of 6 times per year. Fields are inspected within two weeks of planting for occasionally spot removal of weeds by hoeing or occasional chemical spot application.

Harvest: Starts when rind and stem harden and skin is deep, bright orange. Usually starts in mid September for roadside, grocery, and chain store markets. 80% are harvested in a first-week of October for seasonal fall sales. 90% are sold or in transit by October 10. Fields are usually harvested once in the season. Besides the use of plastic mulches and pre-emergent type herbicides, approximately 25% of the pumpkin acreage has growers who remove weeds by hand and/or hoeing. This normally occurs 2-4 weeks after planting in problem areas. On occasions, areas with greater populations of weeds may be spot sprayed with selective herbicides for reduced grass populations.

Uses: Pumpkin production in Tennessee consists of ornamental/seasonal novelty use. Growers commonly feed cull pumpkins to livestock. Production occurs statewide.

Varieties: The most common varieties grown in Tennessee are Appalachian, Gold Strike, Magic Lantern, Howden Biggie, and Prizewinner.

Worker Activities

Land Preparation: Soils are generally “cultivated” prior to planting. One person normally operates a

non-enclosed tractor with an appropriate cultivator which conducts this operation. Fertilizer is often broadcast and incorporated during the final soil preparation. Approximately 70% of Tennessee pumpkin production is done on bare ground. Pumpkin production on plastic is increasing in use in Tennessee, since this production method results in better early weed control and improved moisture conditions. Also, use of plastic is being done by growers who have the potential for double crop systems. Strawberry growers who produce crops on plastic are beginning to double crop with pumpkins behind strawberries. Under no-till conditions, no soil preparation is involved; however, immediately before or after planting a burndown and / or a preemergence herbicide is applied. Again, one person operating a tractor and the appropriate machinery conducts this operation. Tractors for this purpose are generally not equipped with cabs. When utilizing plasticulture techniques, one or two additional people are required to assist with the laying of the plastic mulch and drip tape. These people are responsible for securing the end of the irrigation tape and covering the ends of the plastic. This process requires the use of shovels.

Planting Method: Seed are planted by hand or mechanically with a planter (seeder). Approximately 75% of the acreage is planted mechanically utilizing a planter. This process requires one operator normally in a non-enclosed tractor. The remainder is planted by hand or using a transplanter where hand contact with the seed is involved. Mechanized lanters are available for use in both bare ground and plasticulture production systems. However, those designed for use in the plasticulture system are very expensive ($7,500) and very meticulous to operate. A small percentage of growers plant two seed and thin the “hill” to one plant after emergence. However, a majority of growers (85% or more) do little or no thinning. Some replanting by hand does take place.

Irrigation: Most pumpkins are irrigated utilizing overhead (reel and gun) or trickle irrigation. For the overhead, reel and gun system, aluminum pipe is placed along the end of the field connecting the water source to the reel. The reel is set on one end of the field and the gun is pulled to the opposite end of the field. The gun is connected to the reel by flexible pipe and / or a cable that pulls the gun toward the reel. The reel and gun are moved to the location of the next pass until the entire field is irrigated. In platiculture, irrigation tape is applied during soil preparation or by hand just after plant emergence. The irrigation tape is attached to a manifold at the end or in the middle of the field. This operation is usually conducted just after planting and remains in place until clean up at the end of the season.

Cultivation: Depending on the herbicides used and the weed pressure present, cultivation may or may not occur. Probably 50% of the growers mechanically cultivate utilizing a tractor. About 75% of the growers will conduct some sort of hand weeding or hoeing. Often only 1 to 2 hand-weeding jobs will be conducted per season.

Scouting: Approximately 50% of the acreage is scouted on a weekly basis. An average number of times of entry for scouting of all scouted acreage would be 6 times per season. The remaining acreage is scouted as is convenient. Scouting generally consists of walking through the field, as well as perimeter observations from a vehicle.

Management: Most of the crop protectants are ground-applied. A majority of these applications (80% or more) will be applied using a tractor not equipped with an enclosed cab.

Harvest: Pumpkins are hand harvested. Either the day of harvest or a day prior to loading, fruit are often cut and windrowed. Wagons, open or containing bins, are then pulled through the field and fruit are hand loaded onto the wagon or into the bins. Loose pumpkins are often off loaded into trucks or market stands for local sales. The bins are off loaded onto tractor-trailers for shipment to market. The number of harvests ranges from an once-over harvest to 2 or 3 harvests.

Worker Safety: Most larger farms which produce large acreage of pumpkins, hire migrant workers or individuals located near their community. Tennessee producers are required by federal and state laws to follow safety standards known as the Worker Protection Standards (WPS). The Worker Protection Standards are regulations which cover pesticide usage in agricultural, forest, nursery and greenhouse production. Any Tennessee producer employing individuals to work in agricultural production must inform and/or train workers concerning the Worker Protection Standards. Worker Protection Standards are standards which are to be followed by employers to help eliminate possible pesticide contamination of pesticide applicators, handlers or workers. Information pertaining to pesticide application must be posted in a central location. Information concerning products used, location of application and re-entry interval is posted at the central location. Also, other items pertaining to safety are provided to workers, applicators and/or handlers. Table 1. includes re-entry intervals of products commonly used in Tennessee pumpkin production. If workers, handlers and/or applicators must enter the field earlier than indicated by the pesticide label, individuals maybe required to wear certain personal protective equipment. In most cases this includes boots, gloves, hat, long sleeve shirts, and long legged trousers. The Signal Word indicated by Caution, Warning or Danger are indicators of the level of human hazard which may vary between formulations containing the same active ingredient. The Signal Word lets the applicator, handler or worker know the relative toxicity of a product. Early re-entry is generally not necessary in Tennessee pumpkin production. Treated areas are also posted to inform workers that treatments have been made and re-entry is restricted. If employers and employees follow WPS regulations, harvest interval and re-entry intervals agricultural workers are less likely to be at risk to pesticide exposure in Tennessee agricultural production.

Table 1. Re-entry interval of products used in pumpkin production

Pesticide Type	Active Ingredient	Re-entry Interval	Signal Word
Fungicides	Chlorothalonil	48 hrs	Caution-Danger*
	Maneb	24 hrs	Caution
	Mefenoxam	48 hrs	Caution
	Azoxystrobin	4 hrs	Caution
	Trifloxystrobin	12 hrs	Caution

	Benlate	24 hrs	Caution
	Myclobutanil	24 hrs	Warning
	Copper	12 hrs	Caution
Herbicides	Bensulide	12 hrs	Caution
	Naptalam	48 hrs	Warning
	Paraquat	12 hrs	Danger
	Clomazone	12 hrs	Warning
	Sethoxydim	12 hrs	Warning
	Glyphosate	12 hrs	Warning
	Paraquat dichloride	24 hrs	Danger
	Clethodim	24 hrs	Caution
Insecticides	Dimetoate	48 hrs	Warning
	Endosulfan	24 hrs	Danger
	Imidacloprid	12 hrs	Caution
	Carbaryl	12 hrs	Caution
	Esfenvaterate	12 hrs	Warning
	Methomyl	48 hrs	Danger
	Abamectin	12 hrs	Warning
	Malathion	12 hrs	Caution
	Bacillus thuringiensis	4 hrs	Caution
	Tebufenozide	4 hrs	Caution
	Spinosad	4 hrs	Caution
	Cryomazine	12 hrs	Caution
	Permethrin	12 hrs	Warning
	Bifenthrin	24 hrs	Warning

* Signal word may vary depending on formulation of product used.

Table 2: Varieties and Production

Most Common Types	**Market Size**	**% of Total Acreage**

Giant (Big Max, Prize Winner)	50-150 lbs	10%
"Jack" Types (Big Autumn, Howden's Field, Jackpot, Magic Lantern, Merlin, Trick or Treat, Wizard)	15-25 lbs	84%
Ornamental / Speciality (Lumina, Rouge VIF)	10-25 lbs	1%
Sugar or Pie types (Sugar, Pie, Buckskin)	5-10 lbs	1%
Miniatures & decorative types (Jack?Be?Little, multi?colored, novelty gourd types)	<1 lb	1%
Others	Various sizes	2%

Insect Pests

General Insect Control Strategies:

Field rotations help reduce overwintering insect populations. But some pests migrate from other crops to fields of pumpkins each year. Approximately 80% of the pumpkin fields are scouted before treatment by growers, or based on advice received from Extension agents. The majority of the insecticides are ground applied. Vines limit ground operations after 6-8 weeks, so spray rows are often considered when planning production fields.

Key insect pests include squash bugs, spotted and stripped cucumber beetles, and other pests including squash vine borer and pickleworm. All of these pests are discussed below. 100% of the commercial acreage is treated for one or more of these pests. Other insects which are commonly observed in Tennessee Pumpkin production include; aphids, cutworms, corn earworms, spider mites, beet armyworm caterpillars (cabbage looper, cabbage webworm, imported cabbage worm, diamondback moth caterpillar, cross-striped cabbage worm, garden webworm, armyworms, and beet armyworm) and leaf miners.

Squash Bug
(Anasa tristis)

Biology: Squash bugs are a key pest of nearly 100% of the fields each year and cause more losses than all other insect pests. Adult squash bugs are large (about 5/8 of an inch long) and suck sap from vines, leaves, stems, and the base of the plant Squash bug causes wilting of vines, reduced yields, poor quality, and possibly death.

Cultural/Non-chemical Controls: Eggs can be parasitized by tiny wasps which can be purchased but are not practical in commercial fields. Hand removal of squash bugs is an excellent control method in home gardens but is impractical in commercial production. Scouting of the area may aid in determining when to apply controls.

Chemical Control: The adult squash bug has a hard, impervious shell and are very difficult to control as adults. To obtain adequate control growers must treat the nymphs. Adults squash bugs are difficult to control. Scouting is essential for control and one should look for egg masses on undersides of leaves. Pumpkins are treated when most of the eggs have hatched and nymphs are still small. Since squash bugs live on the underside of leaves, to obtain effective control, sprays must penetrate into the canopy. Squash bugs are controlled by insecticides and these are often used in rotation for resistance management. Products labeled for use of control include: carbaryl (Sevin) which has a 0-day PHI, applied at the rate of 1 lb active ingredient per acre at a cost of $9.00 per acre per application. Endosulfan (Thiodan/Phaser) has a 2-day PHI,is applied at the rate of 0.5 – 1 lb active ingredient per acre at a cost of $8.45 – 16.90 per application per acre. Esfenvalerate(Asana) has a 3-day PHI is applied at the rate of 0.03 –0.05 lbs active ingredient per acre at a cost of $4.37 – 7.16 per acre per application, and bifenthrin (Capture) has a 3-day PHI and is applied at the rate of 0.04 – 0.10 lbs active ingredient per acre at a cost ranging from $8.13 – 20.01 per application per acre. Products are commonly rotated to reduce pest resistance.

Alternative Control: permethrin (Ambush 2EC) 0-day PHI, 0.2 lbs ai per acre no more than 1.6 lbs a.i. per acre per season at a cost of $11.60 per application.

Spotted Cucumber Beetle

(Dibrotic undecipunctata howardi)

Biology: Spotted cucumber beetles are the adults of southern corn rootworm (SCRW). Outbreaks often occur, however vary from season to season and from field to field, the SCRW populations increase in West Tennessee in corn and grain sorghum growing areas. Adults feed on young pumpkin plants and larvae feed on crop roots-both of which cause stunted plants and reduced yields.

Cultural/Non-chemical Controls: Soil burial of previous crop debris destroys overwintering habitat of adult beetles. Populations vary when areas have been previously planted with corn and grain sorghum. Treat as needed with insecticide when populations are noted in scouting use insecticides such as: esfenvalerate has a 3-day PHI is used at the rate range of 0.03 – 0.05 lbs active ingredient per acre at a cost ranging from $4.37 – 7.16 per acre per application, carbaryl has a 0–day PHI is applied at the rate of 1 lb active ingredient per acre per application at a cost of $7.80-9.00 per acre depending on formulation used. Carbaryl may cause phytotoxicity during hot, humid weather, imidacloprid (Provado) has a 0-day PHI at a rate of 0.047 lbs active ingredient per acre per application at a cost of 13.33 per acre, malathion has a 3-day PHI is used at the rate of 1.75 lbs active ingredient per acre per application at a cost of $2.21 per acre per application and bifenthrin which has a 3-day PHI applied at rates ranging from 0.04-0.10 lbs active ingredient per acre per application at a cost ranging from $8.13 – 20.01 per acre per application.

Alternatives: imidacloprid (Admire 2F) may be used as a soil application, it has a 21-day PHI and a usage rate of 0.25-0.375 lbs a.i. per acre at a cost of $72.37 – 108.56 per acre. No more than 0.375 lbs ai per acre as a soil application. This product is generally not used as a soil application due to cost.

Striped Cucumber Beetle

(Acalymma vittata)

Biology: The adult striped cucumber beetle is yellow with black strips, feeds on young plants, and may dig in to emerging shoots. Larvae feed on pumpkin roots upon hatching. Stunted plants result. An occasional pest. Most damaging during hot, humid weather conditions after seedlings emerge. Also vectors bacterial wilt (which is discussed in the Disease section.

Cultural/Non-chemical Controls: Destruction of past crop debris helps prevent adult overwintering. Spray as you would for spotted cucumber beetle.

Alternatives: same as spotted cucumber beetle.

Squash Vine Borer

(Melittia satyriniformis)

Biology: The squash vine borer is the white larva of a clear-winged moth. Borers overwinter as larvae or pupae in cocoons in the soil. Adults emerge in late spring and lay eggs on stems and leaf petioles. Tunneled vines often wilt and die. The presence of holes in plant stems, accompanied by ooze, signal the presence of squash vine borers.

Cultural/Non-chemical Controls: Destruction of stalks and vines after harvest reduces infestations the following year. Cubectin, a pheromone-like attractant for squash vine borer, is more prevalent in miniature pumpkins and results in greater damage on Jack-Be-Littles and other ornamental pumpkins. Squash vine borer pheromone traps can assist in determining when pesticides should be used. If pheromone traps are not used, spraying should begin when runners develop in early June until August. Products used for control of squash vine borer should penetrate the canopy for thorough coverage. These products should be applied to the areas of the stems and vines near the base of the plant. Products include: carbaryl which has a 0-day PHI use at the rate range of 0.5 – 1.0 lb active ingredient and cost ranging from $4.50 – 9.00 per acre per acre per application, endosulfan has a 2-day PHI and is applied at the rate range of 0.5 – 1 lb active ingredient per acre per application. Cost of endosulfan ranges from $5.78 – 16.90 per application per acre. Permethrin has a 0-day PHI is used at a rate range of 0.1 – 0.2 lbs active ingredient per acre at a cost ranging from $5.80 – 11.60 per acre per application. Esfenvalerate has a 3-day PHI is used at the rate range of 0.03 –0.05 lbs active ingredient per acre per application at a cost of $4.32 – 7.16 per acre per application. Bifenthrin has a 3-day PHI used at a rate range of 0.04 – 0.10 lbs. active ingredient per acre per application at a cost of $8.13 – 20.01 per acre per application.

Alternatives: neem extract.

Occasional pests or minor pests

Other pests which are occasionally observed to cause problems in pumpkin production include: spider mites, aphids, beet armyworms, leafminers, cutworms, whiteflies and corn earworms. Spider mites, whiteflies and aphids reproduce rapidly and populations can grow to unmanageable sizes if control measures are not taken. Also, rotation of products with different modes of action is critical to reduce risk of resistance occurring within insect populations.

Major Insecticides:

- **Endosulfan** (Phaser, Thiodan): has a 2-day PHI and is applied at a rate range of 0.5 to 1 lbs ai/ acre. Applied 1 to 2 times a year. Used on 100% of the acreage. Primarily used for control of squash bug and spotted cucumber beetles. Not to exceed 3 lbs. ai per acre per year. EC formulations cost range $5.78 – 11.39 per application and WP formulations cost range from $8.45 – 16.90 per application depending on rate used.

Synthetic pyrethroids:

- **Esfenvalerate** (Asana 0.66EC): has a 3-day PHI. Applied at a rate range of 0.03 - 0.05 pounds ai/ acre, 1 to 2 times a year. Used on 20% of the acreage. Cost of $4.33 – 7.16 per application. Generally rotated with endosulfan, generally used for squash bug.
- **Permethrin** (Ambush 2EC, Pounce 3.2EC): Is a Restricted Use Pesticide and has a 0-day PHI. Applied at a rate range of 0.1- 0.2 lbs ai/acre. No more than 1.6 lbs ai per acre per season should be applied. Applied on less than 5% of the acreage. Used for control of squash vine borer, caterpillars. Depending on application rate cost ranges from $4.47 – 8.94 for Pounce and $5.80 – 11.60 for Ambush per application.

Other Insecticides Commonly Used in Pumpkins:

- **Carbaryl** (Sevin, Adios)[a carbamate]: Applied at a rate range of 0.5 – 1 lb ai/acre. Cost varies depending on formulation and rate used from $4.50 – 9.00 per acre. Applied on less than 10% of the acreage in the past. Alternative chemical for squash bug, cucumber beetles and squash vine borer. Marginal effectiveness for squash bug, usually requires the higher rate. Lower rates (0.5 lbs ai) result in good control of squash vine borer.

- **Bifenthrin** (Capture 2EC): has a 3-day PHI. Applied at a rate range of 0.04 – 0.1 lb ai/acre. Cost of $8.13 – 20.01 per application. Used for aphid, spider mites, whitefly and Lygus spp., squash bug, squash vine borer, and cucumber beetle control. Higher rates are used on whiteflies, spider mites and Lygus spp. No more than 0.3 lbs ai per acre per season. No more than two applications after bloom.

- **Imidacloprid** (Admire, Provado): Admire is applied at a rate range of 0.25 – 0.375 lb ai/acre and has a 21-day PHI. Cost of an application ranges from $72.38 – 108.56 per acre. Provado is applied at a rate of 0.047 lbs ai per acre and has a 0-day PHI and cost of $13.33 per acre per application. These products are used for cucumber beetle and aphid control.

- **Bacillus thuringiensis** (Biobit, Javelin and Lepinox – subspecies *kurstaki*): is a biological control agent. Rate ranges from 0.12 – 1.5 lbs formulation per acre. Fields are normally scouted prior to application. Cost variable depending on product used from $5.50 – 9.00 per acre. Applied on less than 2% of the acreage.

- **Dicofol** (Kelthane 50WSP): has a 2–day PHI is applied at the rate of 0.625 lbs ai per acre. No more than 2 applications of this product can be made per season. Cost of $16.75 per application per acre. Applied on 2% or less of the crop for spider mite control. Generally only needed during hot dry weather, when rainfall is less frequent.

- **Abamectin**(AGRI-MEK 0.15EC): has a 7-day PHI. Used at a rate range of 0.009– 0.019 lbs per acre. Cost of $40.80 – 81.60 per acre. Used for spider mite control. Not to be applied within 25 feet of lakes or other bodies of water. To reduce possible pest resistance use in conjunction with other products with different modes of action. Do not exceed 0.056 lbs ai per acre per season. No more than two sequential applications should be may which aids in avoiding pest resistance.

- **Oxamyl** (Vydate 2L): This product is a Restricted Use Pesticide and has a 1–day PHI. If applied to the soil at a rate of 2lbs – 4lbs ai per acre, may control root knot nematodes, lesion, ring, sting and stunt nematodes at a cost of $69.50 - 139.00 per acre. Normally this product is applied 2-4 weeks after planting to foliage at a rate of 0.5 – 1 lb ai per acre at a cost of $17.38 – 34.75 per acre per application to control leafminers (*Liriomyza* spp.), aphids and thrips. Not to exceed 6 lbs ai per acre per season. Applied on 1% of acreage as a foliar application, one time per year. Use has declined from past years because more effective products have been labeled for use in pumpkin production.

- **Malathion** (Several 25WP formulation)[an OP insecticide]: has a 3-day PHI. Used at a rate of 1.75 lbs a.i. per acre. Cost of $15.47 per application. Used for aphid control. Must not be applied to wet foliage. Applied on 5% of acreage, one time per year. Use has declined from past years.

- **Spinosad**(SpinTor 2SC, Success): has a 3-day PHI. Used at a rate range of 0.062 – 0.156 lbs ai per acre. Used for control of cabbage looper, armyworms,including beet armyworms and leafminers. Leafminer control is normally achieved when higher rates are used.

- **Cyromazine** (Trigard 75WP): has a 7-day PHI. Used at a rate of 0.125 lbs ai per acre. Used for control of leafminers. No more than 5 applications per crop can be made. Cost of $29.21 per application per acre.

- **Tebufenozide** (Confirm 2F): has a 7-day PHI. Used at a rate range of 0.09 – 0.12 lbs ai per acre. Used for control of cabbage looper, cabbage webworm,cross-striped cabbageworm, garden webworm, imported cabbageworm, and armyworms (including beet armyworm). In late season high label rates are used for optimum control. Cost of $7.78 – 10.38 per application per acre.

- **Methomyl** (Lannate 2.4LV or 90SP): has a 7-day PHI. Used at a rate range of 0.45 – 0.9 lbs ai per acre. Used for control of caterpillars (cabbage looper, cabbage webworm, imported cabbageworm, diamondback moth caterpillar). This product should not be applied to seedlings less than 3 inches in diameter. Cost of $10.31 – 20.62 per acre per application for the LV formulation and $11.18 – 22.35 for the SP formulation.

- **Metasystox-R** (Metasystox-R 2): A Restricted Use Pesticide, has a 14-day PHI and is used to control aphids at a rate range of 0.375 – 0.5 lbs ai per acre. Not to be applied more than 1 time per season. Cost not available.

- **Neem Extract** (Trilogy 5.46 lbs): Controls aphids, whiteflies, spider mites also suppression of some fungi. Apply no more than 27.3 lbs ai per acre per application. Cost not available.

Table 3: Percent acreage and average no of applications of insecticides made in 2001

Product*	**% acreage applied**	**Ave no. applications made on treated acreage**
Malathion	5	1
Methomyl	7	1
Cyromazine	2	1
Tebufenozide	1	1
Metasystox-R	1	1
Spinosad	1	1
Endosulfan	30	1
Oxyamyl	1	1
Abamectin	2	1
Dicofol	2	1
Bt	1	1
Imidacloprid	1	1
Bifenthrin	15	2
Carbaryl	35	2

Esfenvalerate	35	2

*Insect control maybe hampered due to poor penetration of the dense canopy. Applications made early in the morning may affect pollinators. In the afternoon, vines wilt, coverage is poor, and efficiency is substantially reduced. Applications made in late afternoon to evening are best to reduce affecting morning pollinators.

Diseases

Major diseases (in order of importance) include powdery mildew, downy mildew, and microdochium blight. Other diseases include cucurbit yellow vine disease, Fusarium fruit rot, Fusarium root and crown rot, angular leaf spot, bacterial leaf spot, Phytophthora blight, anthracnose, root-knot nematodes and viruses.

General Disease Control Strategies:
Non-chemical methods are used to the fullest extent (rotations and use of resistant varieties). Crop debris is disked into the soil after harvest to avoid harboring diseases. Experienced farmers rotate pumpkin fields with other crops, usually for three to four years to reduce disease inoculum before planting pumpkins again. Very little host plant resistance exists in pumpkin varieties. Growers make fungicide applications with ground equipment. Aerial application would benefit growers since vines restrict equipment use, however field size is generally small in size in Tennessee and aerial applications are not feasible. Essentially 100% of the commercial crop is treated with fungicides, mostly based on weekly field scouting and spray advising is often received from extension agents. Fungicides applied for one major foliar disease also control other diseases. The spray program for disease control recommended in Tennessee is provided in Table 4.

Common seed treatments include captan, which is generally applied by seed producers. Insecticides are used to control insect-transmitted diseases.

Specific Diseases, their Biology and Control

Powdery Mildew
(primarily *Sphaerotheca fuliginea*, some *Erysiphe cichoracearum*)

Biology: Powdery mildew is clearly the major disease problem in pumpkin production and causes the most damage when it appears late in the season. Plants infected with powdery mildew develop white, powdery spots on upper and lower leaf surfaces and the whole plant may become covered with white dusty spores as the disease progresses. The fruit is not attacked directly, but it may become malformed or develop sunscald if the pumpkins lack leaf coverage. High daytime temperatures, cool nights, and

high relative humidity favor powdery mildew. Yield losses of 30% or more may occur in untreated fields.

Cultural/Non-chemical Controls: Some resistant or tolerant varieties are becoming available. Magic Lantern F1 and Merlin F1 are two of the newest resistant varieties.

Chemical Controls: (See Table 2 for details) Chlorothalonil spray programs will suppress powdery mildew, but will need assistance from more effective powdery mildew materials such as Quadris, Flint, Nova, Procure and sulfur during late summer and fall. Growers are advised to scout for powdery mildew and begin using fungicides when it first appears. Fungicides are applied at 14 day intervals, until harvest, usually in 1 to 4 applications per season. Fungicides are alternated within a field to aid in resistance management plans. For further information on strategies for incorporating powdery mildew control into a spray program, refer to Table 4.

Downy Mildew

(Pseudoperonospora cubensis)

Biology: Cucurbit downy mildew does not occur in Tennessee every year because the fungus does not over-winter in Tennessee. Downy mildew arrives in fields from southern areas in spore showers, and can cause sudden damage if leaves are wet. On pumpkins, downy mildew is characterized by tiny yellow spots, which eventually coalesce to cause general necrosis of leaves.

Controls: Spray programs should include chlorothalonil or maneb, applied each week. A powdery mildew material such as Nova or sulfur should be added. If Quadris or Flint are used, the highest labeled rate should be used to obtain good downy mildew control.

Microdochium blight

(Microdochium tabacinum)

Biology: Microdochium blight is a fairly new disease that can be severe in Tennessee pumpkin production. This disease causes white to tan dry lesions, leaving a brittle fruit surface. Leaves can prematurely wither and defoliation may occur rapidly reducing fruit weight. Lesions on the fruit stems reduce marketability.

Cultural/Non-chemical Controls: Rotation to crops other than pumpkins, zucchini, or yellow summer squash. Avoid sprinkler irrigation.

Chemical Controls: Chlorothalonil, maneb or Flint.

Bacterial Leaf Spot

(Xanthomonas campestris)

Biology: This organism causes losses primarily through fruit infections, which often lead to soft rot of the fruit. Fruit lesions are small, circular spots with a white to tan center and a dark brown, purple, or green halo. On leaves, lesions are small, angular tan spots. The bacterium can be seedborne.

Cultural/Non-chemical Controls: Use disease-free seed and avoid sprinkler irrigation.

Chemical Controls: Repeated applications of copper sprays as a foliar protectant helps prevent buildup on the foliage and thus, infection of the fruit.

Cucurbit Yellow Vine Disease

(Serratia marcescens)

Biology: CYVD is caused by a bacterium that is transmitted by squash bugs, and multiplies only in the phloem of the plant. It also affects squash, watermelon, and cantaloupe. CYVD is characterized by yellowing or wilting of leaves and stunting of plants, followed by a slow decline of the plant and dying of leaves.

Cultural/Non-chemical Controls: Pumpkin varieties are being identified that are tolerant of CYVD.

Chemical Controls: Scout for squash bugs and use effective insecticides, if seen.

Fusarium Crown and Root Rot

(Fusarium solani)

Biology: The rot affects the upper tap root and the crown of the vine. Symptoms include sloughing off of the root cortex tissue, destroying all of the tissue except the fibrous vascular strands. The tissue may have an orange color. The plant wilts and dies. The fungus is soilborne and can be seedborne. In the soil, the fungus can survive for only 2 to 3 years.

Cultural/Non-chemical Controls: Follow a 2-year rotation plan out of cucurbits. Planting fungicide-treated seed can reduce the incidence of disease if seed are infested.

Angular Leaf Spot

(Pseudomonas lachrymans)

Biology: Angular leaf spot disease is caused by *Pseudomonas lachrymans* bacterium. Infection on leaves, stems, and fruit causes angular, necrotic spots. Angular leaf spot discolors the internal flesh of pumpkin and overwinters on seeds and diseased crop debris. Bacteria are spread by splashing rain, mechanical movements among wet vines, and is favored by warm, moist weather.

Cultural/Non-chemical Controls: Growers plant good quality seed and destroy crop debris in the fall after harvest and use a three to four year crop rotation to decrease survival of the angular leaf spot

pathogen. Disease prevention is possible with repeated protective sprays.

Chemical Controls: The only chemical controls include products containing copper.

Phytophthora blight

(Phytophthora capsici)

Biology: Phytophthora blight symptoms include seedling damping off, foliar blight, root and crown rot, stem lesions and fruit rot. The fungus is soil borne and spreads across fields in run-off water. Infection is through roots, fruit, or leaves. Spores can be spread from plant parts by wind.

Cultural/Non-chemical Controls: Crop rotation, selection of well-drained sites for fields, tiling and other methods of improving soil drainage.

Chemical Controls: No fungicides are sufficiently effective.

Fruit rots

*(Fusarium, Colletotrichum, Mycosphaerella, Rhizoctonia, Sclerotium, Phytophthora*and various bacteria)

Biology: Pumpkins may rot while still on the vine or after harvest. In Tennessee, these rots are typically caused by fungi, but on occasion by soft rot bacteria. Most of these organisms gain entry into the fruit in the field, generally when the fruit is wet. Most fruit rot organisms build up in the field by infecting leaves and stems and then infecting fruit. Some fruit rot organisms may be introduced into the field by seed.

Cultural/Non-chemical and Chemical Controls: Crop rotation is a major factor in controlling several of these diseases. Two year rotations in non-cucurbit crops should be maintained to reduce many fruit rots. Seed treatments can also reduce fruit rots. Proper post harvest handling/care can prevent infections and may extend storage life of fruit. Allow fruit to mature prior to harvest. A regular spray program as shown in Table 4, will slow the buildup of fruit-rotting fungi in the field. Applications of insecticides may help reduce fruit rots by reducing entry ways caused by insects. Post harvest washing of fruit with 10 percent bleach solution and allowing fruit to dry reduces infections that develop in storage.

Viruses

(watermelon mosaic, zucchini yellow mosaic,papaya ringspot, and cucumber mosaic viruses)

Biology: The major cucurbit viruses are transmitted by aphids, and their severity level tends to correspond to aphid populations. Virus symptoms are seldom seen prior to late summer, as aphid populations increase and bring the viruses into the fields from the weeds. The viruses are inserted into the plant as the aphid probes, preventing effective control of the disease with insecticides. Plant symptoms include leaf distortion, leaf mosaic patterns, green fruit, and misshapen fruit.

Cultural/Non-chemical Controls: Reflective mulches and good weed control are often cited as control methods, but are of marginal value.

Chemical Controls: None. Insecticides are not very effective in reducing spread.

Anthracnose

(Colletotrichum orbiculare)

Biology: Anthracnose is a soil-borne fungus that appears on foliage as small yellow or reddish-brown water-soaked spots, eventually grow large and turn brown. On fruit anthracnose appears as circular, black, sunken lesions that vary in size with age. Lesions on fruit do not penetrate but do provide an entrance for soft rot bacteria. Anthracnose overwinters in crop debris, may survive in or on seeds, and can be spread by workers, equipment, or splashing rain. The disease is favored by warm, wet weather.

Cultural/Non-chemical Controls: To avoid harboring this disease, stalks and vines are destroyed after harvest. Since anthracnose can live in or on seeds, growers plant disease-free seed or seed treated with a fungicide. Crop rotations significantly reduce anthracnose outbreaks. To reduce the spread growers try to avoid working when plant foliage is wet.

Bacterial Soft Rot

(Erwinia carotovora)

Biology: This fruit rot may occur in the field or after harvest. The tissue becomes extremely soft and mushy and often collapses, losing its original form. The bacteria enter the fruit through injuries or infections caused by other fruit-rot pathogens.

Cultural/Non-chemical Controls: Careful handling of the fruit during and after harvest, spraying harvested fruit with a chlorine solution, and proper curing of harvested fruit to allow injuries to heal are recommended.

Chemical Controls: The grower should follow a recommended spray program for disease and insect control during the growing season.

Wet Rot

(Choanephora cucurbitarum)

Biology: Wet rot affects flowers and young fruit. Flowers turn soft and drop off the plant. If the fruit has begun to develop, the fungus invades the fruit tissue, causing it to decay in a wet rot. The fungus fruiting structures give it the appearance of numerous pins stuck in a pincushion. The fungus is very common and lives as a saprophyte.

Cultural/Non-chemical Controls: This fungus is not a problem where production is located in open, airy fields not surrounded by trees. Avoid excessive nitrogen fertilization and plant populations.

Chemical Controls: None.

Bacterial Wilt
(Erwinia tracheiphila)

Biology: The causal bacterium is transmitted by the cucumber beetle, and multiplies in the xylem of the plant. The plant wilts due to plugging of the water-conducting xylem. The bacterium overwinters either in the gut of the beetle or in weed hosts. Pumpkins are rather tolerant of this disease.

Cultural/Non-chemical Controls: None.

Chemical Controls: Use insecticides suitable for control of cucumber beetles.

Gummy Stem Blight or Black Rot
(Didymella bryoniae)

Biology: Gummy stem blight is an incidental leaf spot disease on pumpkins. On the fruit, this fungus causes a black lesion similar to anthracnose, and is known as black rot. The fungus can enter a field on seed, and over-winters on plant debris. It is spread by wind and rain. Gummy stem blight is favored by warm, wet weather and usually occurs in conjunction with other foliar diseases.

Cultural/Non-chemical Controls: Some pumpkin varieties that have exhibited some tolerance against gummy stem blight such as Howden types, Small Sugar, Spookie, and Thompson Halloween. Avoid fields with a history of gummy stem blight. Rotation with non•cucurbit crops reduces build up of the pathogen.

Chemical Controls: A spray program that includes chlorothalonil, maneb or Quadris aids in black rot control.

Nematodes

Root Knot Nematodes
(Meloidogyne spp)

Biology: Nematodes are small, worm-like animals found in the soil and are visible under magnification. Nematodes feed on plant roots. The root-knot nematode is the most damaging type, and burrows into

roots to feed and cause small, knot-like galls and swellings on the roots. Nematodes cause plants to grow slowly or foliage to wilt easily.

Cultural/Non-chemical Controls: Nematode populations can be suppressed by crop rotations by crop rotation with non-susceptible host plants, such as grain sorghum and other grass family crops. Normally, infested areas are rotated with grass for two or more years to reduce nematode populations in Tennessee.

Chemical Controls: Nematicides are expensive and are rarely used in pumpkin production since rotation is one of the easiest methods of reducing problems of this pest. Soil fumigants labeled for pumpkins include methyl bromide, chloropicrin, and Telone. The non-fumigant nematicide Vydate is also labeled for use on pumpkins.

Fungicide Use in Pumkin Production

Early Season: Use a primary fungicide (chlorothalonil or maneb) every 7 to 14 days (more frequently in wet weather, less frequently in dry weather). Begin the program at vine tip-over to early bloom (3 to 4 weeks after seeding). Inspect the field for disease symptoms beginning at emergence, so that the spray program can be started sooner than planned, if needed. Chlorothalonil or maneb can be alternated with Quadris or Flint, if desired, but little will be accomplished with such a substitution. Neither chlorothalonil nor maneb is subject to the development of resistance, so continued use is not a problem. Of the major diseases of pumpkins, only microdochium blight control will be improved by using Flint.

Mid – Late Season: Scout for powdery mildew when this disease becomes a threat, around mid-summer. When the first powdery mildew colonies (circular, white patches) are seen, add sulfur or Nova to the tank with the primary fungicide (preferably chlorothalonil, when powdery mildew is present). This tank mix can be alternated with Quadris or Flint, if desired. If a chlorothalonil/sulfur tank mix is used, thorough coverage is more critical than for Nova, Quadris, or Flint. Air blast sprayers are needed when canopies become thick. Apply sprays every 7 to 14 days, depending on rainfall. Add a fixed copper to the tank mix if angular leaf spot or bacterial leaf spot appear.

Primary Fungicides (for routine, full-season spray programs):

- **Chlorothalonil** (Bravo, Equus, others): has a 0-day PHI and is applied at a rate range of 1.125 – 2.25 pounds ai/acre, several times a year at 7 to 14 day intervals. Used on 90% of the acreage. Used in rotation with other fungicides (azoxystrobin or trifloxystrobin). Primarily used to control powdery mildew, downy mildew, and microdochium blight. Also controls anthracnose and gummy stem blight. At a cost of $8.58 – 17.16 per application. Complete foliar coverage is essential and 40 - 60 gpa of water is common. Chlorothalonil spray programs will suppress powdery mildew, but will need assistance from more effective powdery mildew materials such as Azoxystrobin, trifloxystrobin, myclobutanil and sulfur during late summer and fall. In selecting fungicides, growers often consider not only powdery mildew, but downy mildew and microdochium blight controls. This product may increase natural sunburn of fruit if sprayed to mature fruit. This product should not be applied during drought

conditions.

- **Maneb** (Manex, others): 80WP has a 5-day PHI, is used at the rate of 1.2 –1.6 lbs active ingredient per acre per application. Maneb is effective against downy mildew and microdochium blight, but not powdery mildew. During a powdery mildew season, chlorothalonil is recommended as a primary fungicide because of its activity against all three major diseases. If maneb is used during this time of year, sulfur or myclobutanil should be added to them.

- **Azoxystrobin** (Quadris)[strobilurin family]: has a 1-day PHI. Applied at a rate range of 0.178 – 0.25 lbs ai per acre. Expensive, applied 1 time a year on 60% of the crop. No more than 4 applications of strobilurin fungicides (Quadris or Flint) per crop. Controls powdery mildew, anthracnose, alternaria leaf spot and gummy stem blight. Higher rates are needed for good control of downy mildew. Must be alternated with chlorothalonil or maneb for resistance management. Highly effective systemic control at labeled rates. Consecutive applications of strobilurin products are not recommended. Cost of $24.23 – 33.93 per application.

- **Trifloxystrobin** (Flint)[strobilurin family]: Highly effective systemic protection. Has a 0-day PHI with a rate range of 0.047 – 0.0625 lbs active ingredient per acre. No more than 4 applications (4 oz ai per acre per crop) of strobilurin fungicides (Quadris or Flint) per crop. This product provides good control of microdochium blight. Use should be alternated with chlorothalonil or maneb. Flint is not labeled for control of anthracnose or gummy stem blight. Also used for powdery mildew and downy mildew control, however higher rates are used for downy mildew control. Consecutive applications of strobilurin products are not recommended due to possible resistance. Cost of $33- 44 per application.

Alternative Fungicides (supplementary to the primary fungicides):

- **Myclobutanil** (Nova 40W): 0-day PHI with a rate range of 0.0625 – 0.125 pounds ai/acre. Used in combination with chlorothalonil or maneb, applied 1 to 2 times a year on 30% of the acreage. Excellent powdery mildew control. Mixing this product with copper compounds may reduce its efficacy. Cost of $10.00 – 20.00 per application per acre.

- **Fosetyl-al** (Aliette 80WDG): has a 0-day PHI, rate range of 1.6 - 4 lbs ai per acre. This product may be used in most counties of Tennessee, however is restricted to protect endangered fresh water mollusks and their habitat in Blount and Lincoln counties. These counties are restricted to a maximum of 3 lbs active ingredient per acre per application. No more than 7 applications are allowed per season. Cost of treatment per application ranges from $25.90 – 64.75 per acre. This product can be used for downy mildew and Phytophthora fruit and root rot control, but efficacy is not good. Phytotoxicity may occur using this product if tank mixed with solubilized copper.

- **Benomyl** (Benlate 50WP): has a 1-day PHI and has a use rate of 0.125- 0.25 lb active ingredient per acre. This product is labeled for control of anthracnose, powdery mildew and target spot, but is no longer recommended because of widespread occurrence of resistant powdery mildew. Use of this

product has declined and future use will not continue due to manufacturer's decision to discontinue this product. Cost of treatment is $4.50 – 9.00 per application per acre.

- **Copper** (Kocide, Nu-Cop): These are the only products for control of bacterial diseases (angular leaf spot and bacterial leaf spot). These products have a 0-day PHI and are inexpensive. Only used when weather conditions (wet) warrant its use. Applied on a 7 – 10-day spray schedule. Not to be mixed with Nova. Cost of $0.90 - 2.53 per lb of formulation per application. Provide supplemental control of various fungal pathogens. Copper products are often mixed with maneb.

- **Thiophanate-methyl** (Topsin M): No significant use of this product. It is not recommended because of widespread occurrence of powdery mildews that are resistant to it. Cost not available.

- **Fludioxonil** (Maxim 4FS): Used as a seed treatment for soilborne and seed-borne fungi which cause seed decay. Applied to the seed at 0.0025 – 0.05 lbs ai per 100 lbs of seed. Treated seed are not to be used as feed, food or oil. Cost not available

Table 5. Usage of disease-control products on pumpkins in Tennessee.

Product	**Avg. no. applications on treated acreage**	**% acreage treated**
fludioxonil*	1	Not available
chlorothalonil	8	80
Sulfur	5	50
Copper	5	50
azoxystrobin	2	40
myclobutanil	3	30
trifloxystrobin	2	10
mancozeb	5	25
Maneb	5	5
mefanoxam	1	1
Benomyl	NA	0
fosetyl-al	NA	0
thiophanate-methyl	NA	0

*Seed treatment

Table 6: Yield-loss estimates for diseases of pumpkins in Tennessee.

Disease	% yield loss
powdery mildew	6.0
downy mildew	3.0
microdochium blight	2.0
viruses	2.0
bacterial soft rot	0.5
Fusarium fruit rot	0.5
cucurbit yellow vine disease	0.3
angular leaf spot	0.3
bacterial wilt	0.1
Fusarium crown and root rot	0.1
phytophthora blight	0.1
bacterial leaf spot	0.1
Anthracnose	0.1
black rot (gummy stem blight)	0.1
wet rot	0.1

*Five-year average.

Weeds

General Weed Control Strategies:

Weeds are the most common pest encountered by pumpkin growers. Weeds reduce yields and cut quality by reducing size from 20-pound fruit to 15-pound sizes. Weeds compete for sunlight, water, and nutrients and also host pathogens, viruses, and insects. The most troublesome weeds in Texas pumpkins include annual weeds (pigweed, cocklebur, lance leaf sage, several annual grasses, devil's claw) and perennial weeds (johnsongrass, nutsedge, black nightshade, silverleaf nightshade).

In making a decision to apply a herbicide, farmers consider field history, previous weed problems, and economic thresholds. In selecting a specific herbicide, growers consider "past performance" in controlling weed targets and "herbicide cost." As for actual application, farmers do most of the spraying

and 90% of the herbicide is applied with ground sprayers.

Cultural/Non-chemical Controls:

Pumpkin vines grow four to six inches a day once plants are established. Early weed control at seedling stage is very important to avoid reducing yields later. Vines spread rapidly. Weed emergence is reduced later as the crop shades soil.

Tillage: 50% of pumpkin acreage is cultivated for weeds, 1.5 times a year. Because of their growth habit, pumpkins can only be cultivated for the few weeks (up to July 15) before the plants start to extend runners or vines. Late cultivation may prune roots and vines and reduce yields by slowing plant development.

No-Till: 50% of the pumpkin acreage is planted in no-tillage system. Weeds are controlled by use of chemical burn down agents normally 2 – 4 weeks prior to planting with products such as paraquat or glyphosate.

Hand Hoeing: 10% to 30% of the pumpkin fields are hand-hoed to remove weeds. Removing spotty infestations or escaped weeds prevents the spread of weed seed and improves yields and harvesting.

Cultural/Resistance Management: Crops are rotated to reduce weed build-ups. The common rotation is cotton, grain sorghum, strawberry, and/or wheat with pumpkin. Farmers use high quality, weed-free planting seed, clean tillage and harvesting equipment before moving to the next field, and keep turn-rows, fence rows, and other non-crop areas clean by tillage and/or chemical methods.

Chemical Control:

Minimal Tillage: Some fields are planting in small grains to control soil erosion from winter rainfall. Herbicides are used to kill the stubble and then the crop is planted into a stale seed bed. Soil applied herbicides and tillage are still essential to control weeds.

Preplant: Some growers apply trifluralin in the winter, which gives them options on planting different crops, including cotton and pumpkins. PPI herbicides applied close to planting time in the spring sometimes may cause temporary crop injury.

Preemergence (PE): After the crop is planted, PE herbicides are used in conjunction with tillage to control weeds.

Before Vines Run: Some growers apply a pre-plant incorporated (PPI) or PE herbicide to soil during or after the last tillage, since further cultivation is not possible.

Postemergence: If weeds appear after tillage, over-the-top herbicide treatments are essential to avoid

yield loss, reduction in pumpkin size, and so field hands can easily harvest the crop.

Stale Seedbed/Conservation Tillage: Herbicide applied to emerged weeds and/or wheat stubble before planting in undisturbed soil. Used on 100% of crop. Products used by this method include glyphosate and paraquat.

Glyphosate (several): Applied on 3% of the acreage, one time, at 1-1.5 pounds ai per acre. Glyphosate controls annuals and gives excellent root kill on perennials, however can be more costly than paraquat. Cost of $7.72 – 23.18 depending on rate and formulation used. Often used in spray rows.

Paraquat (Gramoxone): Applied on 5% of acreage, one time, at 0.5 to 0.9 pounds ai per acre. Gives quick knock down before planting. This product is used as a burndown pre-plant material. Cost of $8.64 per acre per application.

Preplant: Herbicide is incorporated in soil before planting.

Bensulide (Prefar 4E): can be applied as a preplant and incorporated or preemergence if followed by irrigation. Best activity is achieved when application is followed soon after by irrigation or rainfall. Cost of $57.50 – 69.00 per acre.

Preemergence: Herbicide is applied @ planting time).

Clomazone (Command 4E): Applied at 1 pound ai per acre on 45% of crop. Cost of $10.50 per acre. Very safe on crop, somewhat weak on broadleaf weeds. Frequently banded over the row. Use is expected to increase. Applications are incorporated into the soil 1 inch in depth or less, seeds are planted below treated soil. Product should not be allowed to drift. Not to be used within 1,500 feet of towns, subdivisions, ornamentals or nurseries.

Ethalfluralin (Curbit): Applied on 40% or more of crop at 1.12 – 1.7 pounds ai/acre. Most effective if rain or sprinkler irrigated. Some pumpkin varieties are sensitive to ethalfluralin. Prize winner is highly sensitive. This product requires light cultivation after application and not to be cultivated into soil. Cost of $28.5 – 32.06 per acre.

Bensulide (Prefar 4E)[an OP compound]: Applied on less than 2% of crop, at 5 to 6 pounds ai per acre. Limited use as preplant or at planting in Tennessee. Cost of $57.50-69.00 per acre.

Postemergence: Applied where weeds are present in the crop.

Sethoxydim (Poast or Poast Plus): 0.2 – 0.3 lbs active ingredient per acre. Cost of $8.50 – 12.75 per application per acre on a broadcast basis. This product is often applied as a spot treatment, which may reduce cost drastically. Applied on 10% or less of crop. Particularly effective on grasses.

Clethodim (Select 2E): 0.9-0.125 lbs active ingredient per acre. Limited use of this product during 2001, however and increase is expected in following years. This product is used to control annual and perennial grass weeds. Cost of $10.00 - $12.00 per application per acre on a broadcast basis.

Other Products: Numerous other herbicides have been evaluated but lack crop safety for use in pumpkin.

Paraquat dichloride (Boa 2.5): is a Restricted Use Pesticide. Rate of 0.50 lbs ai per acre. No more than three applications per season. For suppression of emerged weeds. Should not be applied to areas grazed by animals. Cost $8.70 per acre per application.

Table 8. Herbicide use in Tennessee During 2001

Product*	**% acreage treated**	**Ave. No. of applications made on treated Acreage**
Paraquat	50	1
Glyphosate	50	1
Sethoxydim	30	1
Bensulide	10	1
Ethalfluralin	65	1
Clomazone	75	1
Paraquat dichloride	50	1
Clethodim	15	1

* Paraquat, paraquat dichloride and glyphosate are prior to planting to burn down weeds.

Occasionally they may be used between rows usually two-three weeks after planting.

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References

1. Anonomyus, 2001. 2001 Insect and Plant Disease Control Manual. University of Tennessee. EPP INFO. 67.
2. Rutledge, Alvin D. 2000. Pumpkin Production Guide. University of Tennessee. PSS INFO #65.