ID-119
UK COOPERATIVE EXTENSION SERVICE
UNIVERSITY OF KENTUCKY — COLLEGE OF AGRICULTURE

Ornamental Gourd Production in Kentucky

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Gourds have been a prized possession of mankind throughout history, mostly because of their hardened, dried shells, which are ideal for use as vessels and utensils. They have been grown in every temperate and tropical region in the world.

Gourds are among the oldest cultivated plants. They are in a family of plants known as *Cucurbitaceae,* which is the same family as pumpkins, cucumbers, and melons. Because of this, they have a similar growth habit to their cousins. They have sprawling vines with large leaves and tendrils, and can readily climb. They are monoecious, which means that they have separate female and male flowers on each plant. Flowers are white or yellow. These plants are insect pollinated.

Types of Gourds

There are several different types of fruit that can be called gourds. These include the *Lagenaria, Cucurbita pepo,* and Luffa.

- The *Lagenaria* species are large with thick walls and are used as utilitarian gourds when dried. The fruits come in a wide variety of sizes and shapes. The shapes vary greatly among different varieties, but a few examples include basket, bottle, dipper, and snake.
- *Cucurbita pepo* are the colorful, ornamental gourds commonly used in fall decorations. They are closely related to pumpkins and squash, and may cross-pollinate with them if grown within close proximity. Some types of *Cucurbita pepo* can be dried for decorative purposes, although they have a much thinner shell. They are referred to as the ovifera variety. The fruit is only 1 to 6 inches in diameter and can have several different shapes, including nest egg, orange, spoon, holy crown, apples, bell, and big bell, among others. In catalogs, gourds of this type may be referred to as winter squash.
- Luffa varieties of gourds are referred to as vegetable sponges, sponge gourds, or dishrag gourds because of their soft interior that can be used like sponges. Some varieties can be eaten as a summer squash when small and immature. As drying takes place, the interior becomes a stringy, soft mass that can be removed.

Planting and Culture

Gourds are a warm-season crop and do not do well when temperatures fall below 60°F. Sunny weather is important for proper maturation of fruits. Gourds can be planted throughout the United States, but prefer an area where the midsummer temperature ranges from 70° to 85°F, with night temperatures just a few degrees cooler.

A growing season of 130 days is required for fruit maturity. Gourds should be planted in the late spring after threat of frost has passed and when the soil has begun to warm up.

Field Selection

Crop rotation is important when growing any vegetable crop. Select a field that has not had gourds, other cucurbits, peppers, tomatoes, or tobacco grown in it for at least three years because these crops could have similar diseases that could still be harbored in the soil. The grower should also be aware that some herbicides, such as Atrazine and Simazine, can carry over from previous crops, which would have a negative impact on the growth of your plant.

The chosen site should have good air movement and water drainage to reduce disease potential. Sandy loam or clay loam soils high in organic matter are the best for growing gourds.

Table 1. Ornamental gourds.

Cultivar	Days to Maturity	Comments	Source
Apple	110-120	Shaped like an apple, green with speckles of white, 6 to 8 inches in diameter	Seedway, Rupp, Harris
Autumn Wings	100	A unique gourd of many colors with wings and warts with a general spoon shape	Seedway, Rupp
Birdhouse	120-125	Large pear-shaped fruit with smooth skin and hard shell when dried	Seedway, Stokes, Harris, Rupp
Caveman's Club	120-125	12- to 18-inch-long gourds with narrow handles and a deeply veined bulb on the end	Seedway, Stokes, Rupp, Harris
Crown of Thorns	90-100	4 to 5 inches in diameter, roughly round with curved "fingers" curling toward the blossom end	Seedway, Stokes, Rupp, Harris
Dipper	120	Long neck with bulb on end	Seedway, Stokes, Rupp
Bushel	120	Large round gourds, 12 to 16 inches high with 20-inch diameter, when dried have approximately ½-inch thickness	Stokes
Kettle	120	Large, basket-shaped gourd with a domed top, used for baskets, bowls and decorative conainers.	Seedway
Large Mixture	100-130	An assortment of large types of gourds including dipper, bottle, caveman's club, swan, birdhouse	Seedway, Stokes, Rupp, Harris
Luffa	130	Inside can be peeled out after curing to reveal a sponge-like material	Rupp
Small Mixture	90-100	Assortment of small, brightly colored gourds, good for fall decorations	Stokes, Harris
Spoon	90-95	Spoon shaped with selections of solid color or bicolor	Rupp, Harris
Swan	100-125	Necked fruit gives a swan like appearance, bulb on both ends	Seedway, Stokes, Rupp, Harris
Warted Mixture	95-100	Mixture of warted gourds with various shapes and colors, including spoons, rounds, pears	Seedway, Stokes, Rupp, Harris

Seedway: 99 Industrial Road, Elizabethtown, PA 17022, 800-952-7333, www.seedway.com
Stokes: Box 548, Buffalo, NY 14240-0548, 800-263-7233, www.stokeseeds.com
Rupp Seeds: 800-700-1199
Harris Seeds: 355 Paul Road, P.O. Box 24966, Rochester, NY 14624-0966, 800-544-7938, www.harrisseeds.com

Soil Preparation

Prepare a good seed bed by plowing deeply. Avoid plowing when soil is too wet, which may result in a very cloddy condition and soil compaction. Weed control is more difficult in cloddy soil.

Fertilization

Ideal pH for gourds is 6.5 to 7.0. If pH is too low, lime should be applied because manganese toxicity can occur at low pH levels. When growing any vegetables, a soil test from your county Cooperative Extension office is recommended. This test will determine levels of phosphorus, potassium, calcium, magnesium, and nitrogen in your soil. To ensure proper growth of the gourds, 1,500 lb of calcium per acre and 180 lb of magnesium per acre should be present in your soil.

Cucurbits benefit from having 10 to 12 tons of well-rotted manure or a cover of green manure plowed under. However, overfertilizing with nitrogen can lead to an increase in vine growth that can retard fruit size.

Table 2. Fertilizer recommendations for gourds based on soil test results (lb/A).

PHOSPHORUS Soil Test Reading		**Phosphate (P_2O_5) Needed**
Low:	30 or less	180
Medium:	31-60	120
High:	61-80	60
Very High:	above 80	0
POTASSIUM Soil Test Reading		**Potash (K_2O) Needed**
Low:	200 or less	300
Medium:	201-300	200
High:	301-450	100
Very High:	above 450	50

NITROGEN

Apply 40 to 50 lb nitrogen just before planting and disk into the soil. Sidedressing or topdressing an additional 30 to 50 lb of nitrogen at first bloom is recommended. Rainfall, soil organic matter levels, and previous cropping history of the land dictate nitrogen needs. Avoid applying nitrogen over top of plants when foliage is wet because it may burn fruit as well as foliage.

Planting Time

Plant seed outdoors once the seedbeds have properly warmed up and after the threat of frost has passed. When to plant your gourd seed depends greatly on how long the plant needs to reach maturity. For instance, 90- to 95-day maturing gourds need to be planted in early to mid-June, while 100- to 115-day gourds need to be planted between late May and early June. Some gourd types can take up to 130 days to reach maturity. It is very important to plant gourd seeds at the correct time because some are used primarily for fall decoration. You do not want to plant too early and have your product rot or lose color before sale time, but you do not want it to come in so late that you miss your market window. Kettle and bushel gourds should be started indoors in early- to mid-April and set out as transplants in May once favorable temperatures are reached. They may benefit from black plastic mulch.

Plant Spacing

When using a planter, 2 to 3 lb of seed are required per acre. If planting by hand, the amount of seed required may be less. Large fruited gourds will have 125 to 150 seeds per ounce, while small gourds have 300 to 400 seeds per ounce. Seeds germinate in five to seven days at 75° to 80°F.

Cucurbita pepo seeds should be planted 1 to 2 inches deep and 6 to 12 inches apart. Rows should be placed 6 to 8 feet apart. When the plants germinate, thin them to one plant every 3 feet in the row. This is also the correct distance if you are using transplants. If you are planting in hills, sow three to four seeds per hill every 3 feet in the row. As germination occurs, thin this number to two or three seeds per hill. *Cucurbita pepo* produces vines that are 10 to 12 feet long.

Lagenaria types may have vines that grow as much as 20 to 30 feet and must be 4 to 6 feet apart within the row, with 10 to 15 feet between rows. Within two months the entire area will be filled with vines.

When growing Luffas, rows are 6 to 9 feet apart with plants spaced 4 to 5 feet apart within the row.

Gourds climb well and can be trained to grow up a trellis, fence, or tree easily. Growing the fruit this way leads to a straighter fruit and one which is less likely to rot before it matures. However, very large gourds, such as the African kettle, should not be grown on a trellis because its tendrils could not support its immense weight.

Pruning Gourd Vines

Pruning *Lagenaria* vines can lead to an increase in the number of fruit borne per vine. When the vine reaches 10 feet, remove the end of the main stem. The main stem will have mostly male flowers; the lateral shoots will be mostly female. On Luffa gourds, the first three to four lateral shoots are removed to increase yields.

Irrigation

Gourds, like many other vegetable crops, may require supplemental water during the growing season. In Kentucky, there will be at least two to four weeks when plants could be stressed from lack of adequate water. During the growing season, 1 to 2 inches of water per week is adequate. Soaker hoses or drip irrigation is ideal for irrigating gourds. Overhead irrigation may wet the leaves excessively, which can lead to disease problems. Also, do not water late in the day because this could promote diseases. Toward the end of the season, withhold water to ripen gourds and allow the fruit to harden off.

Pollination Requirements

Gourds are a monoecious plant, which means they have separate female and male flowers on the same plant. This means that insects must carry the pollen from the male flowers to the female flowers to have fruit set. Flowers remain open for only one day, which means that the bees need to be present then for proper pollination to occur. It takes from eight to 10 visits per flower to achieve pollination. One strong hive is recommended for every one to two acres of gourds planted. For growers with less than one acre of plants, wild bees should be able to accomplish the task of pollination.

The hardshell gourds, or *Lagenaria,* bloom only at night. Although the exact pollinator is not known, it is believed that the job is done by a night flying moth. Others speculate it is accomplished by a bee or even the cucumber beetle.

Growers need to be especially careful when spraying insecticides because these can also adversely affect good insects such as your pollinators. Do not spray during the time of day when bees are active. The best time to spray would be in the late afternoon or early evening.

Gathering and Maturity

Gourds must remain on the vine until they are fully mature. Mature fruit will have a deep solid color and a hard rind. *Cucurbita pepo* will be the first gourd to mature. This will occur in late summer. They can be harvested once their stems turn brown and the tendrils next to them are dry. Immature gourds will not continue to color up or harden once picked.

Lagenaria will probably not completely mature until fall. These gourds can be removed from the vine when the stem and the tendrils near the fruit are completely brown. It is best to allow them to stay on the vine until after the first hard frost, or until the vine has died.

Luffas should be left on the vine until the stem is completely dry and the gourd is turning brown on both ends. At this point, you should be able to squeeze the gourd and feel that the shell and the soft interior have separated. When shaken, seeds should rattle.

With any gourd species, it is important to handle the fruit carefully as you harvest it. Cut the stems with sharp shears or a knife. Avoid bruising or scratching the fruit to keep disease from entering or decay from beginning.

Curing and Storing Gourds

Cucurbita pepo gourds will usually last only one season, while a *Lagenaria* gourd can last many years once dried. To dry the *Lagenaria* gourds, they need to be placed in an area of good ventilation. This could mean putting them on slotted shelves or on wooden pallets. The water inside the gourds will begin to evaporate. If you do not give the fruit proper space, it will become moldy and will be more likely to rot. The colors of the fruit will begin to fade to a pale green, light brown, or ivory color. Mold may form on the outside, eating away the epidermis. It is possible to wipe the surface with a mild disinfectant at this stage to prevent mold growth and mottling of the gourd shell. With most types of gourds, the fruit will be considered dry when it loses weight and rattles when shaken.

It is not as easy to cure ornamental fall gourds, they usually just rot. To dry them, store them in a cool area and leave them alone. Eventually they will lose their color and dry into a thin walled gourd. To preserve the bright colors temporarily, the gourds can be polished with a light furniture wax or a light salad oil. Using shellac will clog the gourd's pores, and it will not be able to properly dry.

After either type of gourd has been properly dried, it is ready to be used in any fashion you so wish.

Preparing Luffa

Harvest the Luffa from the field when they have dried on the vine or after the first killing frost. They should be stored in a dry, warm, well-ventilated area. Store on racks or in mesh bags. Cut several inches off of the stem end. Turn the gourd upside down and gently tap it against your palm to dislodge the seeds. Submerge the gourd in a container of warm water for five to 20 minutes. Drain the gourd and make a shallow cut the length of the outer shell. Peel back the shell and lift out the sponge. Cut the sponges to the desired sizes and work out the remaining seeds. Put them in the washing machine on the short hot cycle with soap and a little bleach. Allow to dry.

Insect Control

Growing ornamental gourds for commercial sale is a new crop for Kentucky. Insect and disease control recommendations are those for cucurbits. The information provided here is also available in *Vegetable Production Guide for Commercial Growers* (ID-36) in a more condensed form.

Gourds are subject to the same insects that attack cucumbers, muskmelons, and squash. The principal insects affecting gourds are aphids, cucumber beetles, squash bugs, and squash vine borers. The most serious of these insect pests are the squash bugs and squash vine borers. Both of these insects can cause severe wilting and death of the plants. Because gourds require insects for pollination, fields in bloom should only be sprayed in late afternoon to minimize bee losses.

Insect control is essential on most cultivars to control bacterial wilt spread by the striped and spotted cucumber beetles.

Squash vine borers can be serious in some plantings. Squash vine borers must be controlled on a preventive basis; once they are inside the stems, there is no effective control. Squash vine borers usually begin entering the stem at ground levels around mid-June. Treat for squash vine borers beginning the third week in June and repeat three to five times at weekly intervals.

A weekly application of an insecticide starting when the vines begin to run is suggested. After harvest is complete, deep tillage or removal of crop residue will help to delay and/or reduce infestation the next spring.

Squash bugs harm gourds by removing plant sap and transmitting a bacterium that causes yellow vine decline. For this reason, early squash bug control is very important, particularly when the plants are small. Squash bug adults begin to fly into (cucurbit) gourd fields about the time vines begin to run. Fields should be monitored regularly for the insects. Egg clusters are found on the underside of leaves in the angle formed by the veins. Eggs are brown, spindle shaped and about 1/16-inch long. Fields should be treated when adults are present or when eggs are found hatching. Timing is important as larger nymphs are much more difficult to control with insecticides than small nymphs. After harvest is complete, deep tillage or removal of crop residue will help to delay and/or reduce infestation the next spring. To prevent the transmission of the bacteria that causes yellow vine decline, controls should be used as soon as squash bugs are found to be active in the field.

Cucumber beetles feed on the tender, young seedlings as they emerge from the soil, but usually these are not as serious as on cucumbers and cantaloupes. Treat for cucumber beetles as plants emerge and repeat as necessary. Occasionally, cucumber beetles will feed on the developing rind of the gourd, scarring the fruit.

If bacterial wilt-susceptible cultivars are grown, cucumber beetle control should begin as soon as plants emerge (similar to cucumber or cantaloupe); otherwise, control only when moderate populations are present. As squash bug is a vector of yellow vine decline, it should be controlled on varieties that are susceptible to yellow vine decline once plants emerge. Systemic insecticides used for cucumber beetle control as a drench immediately following transplanting have been shown to control cucumber beetles for three to five weeks and to suppress squash bugs. However, control of squash vine borer should start when gourd vines begin to run and continue on a regular basis.

If other insects or diseases become a problem, get them diagnosed promptly and properly so changes in the control programs can be made, if necessary. Also, be sure to harvest ornamental gourds promptly upon maturity and before frost.

Table 3. Chemicals labeled for insect control use on gourds.

Chemical	Rate	Comments
Acramite 50 WS	0.75 to 1.0 lb/A	Mite control as a foliar spray
Admire 2F	16 to 24 fl oz/A	Post-transplant drench for control of cucumber beetles and aphids
Capture 2EC	2.6 to 6.4 fl oz/A	Cucumber beetles, cutworms, plant bugs, squash bugs, and squash vine borers
Oberon 2 SC	7 to 8.5 fl oz/A	Mite control as a foliar spray
Platinum 2SC	5 to 8 oz/A	Aphid control as a post-transplant drench
Pounce 3.2EC	4 to 8 oz/A	Cucumber beetles, cutworms, plant bugs, squash bugs, and squash vine borers
Sevin 80 S	1.25 lb/A	Cucumber beetle control as a foliar spray
Venom 20 SG	0.44 to 0.895 lb/A	Whitefly and aphid control as a foliar spray
	1.13 to 1.34 lb/A	Whitefly and aphid control as a soil drench

Disease Management

Gourds get a number of diseases that attack all parts of the plant. Under favorable conditions, these diseases can cause considerable damage to foliage and fruit. Diseases that occur on gourds are essentially the same as those common to other cucurbits, such as cantaloupe, cucumber, pumpkin, squash, and watermelon. Use an approach that integrates cultural and chemical methods to get the best control of diseases on gourds.

Disease Management Tips

- Take advantage of the benefits offered by crop rotation. Don't plant gourds or other cucurbit crops continuously in the same place. A number of diseases, particularly those caused by soilborne pathogens, can be suppressed by rotating gourds each year to land not planted to cucurbits for two to three years (or more if possible).
- Purchase high-quality seed to avoid problems with seed-borne pathogens. Avoid saving seed, if possible, to minimize the risk of carrying pathogens over. If saving seed, harvest from sound, disease-free fruit.
- Plant into warm, well-drained soils. This will help reduce the incidence of damping-off by creating an unfavorable environment for pathogens that cause damping-off and by promoting rapid emergence of seedlings.
- Plant into areas where air movement is good and where shading is minimal. Space plants to promote good air circulation. These steps will promote rapid drying of soil and foliage, which in turn will make conditions less favorable for many diseases.
- Avoid planting gourds near tobacco or other cucurbit crops. Insects such as aphids thrive on tobacco and cucurbits and carry viral pathogens that will also infect gourds. Many fungal and bacterial diseases are common to all cucurbits and could move from one crop to another.
- Control insects. Cucumber beetles vector the pathogen that causes bacterial wilt, and aphids carry several important plant viruses.

Table 4. Disease-management chemicals labeled for gourds in Kentucky.

Product	Target Diseases	Product Rate/A per: App.	Product Rate/A per: Season	PHI (days)	FRAC Group
Acrobat 50WP[1]	Downy mildew	6.4 oz	32 oz	0	40
Aliette WDG[2]	Downy mildew	2-5 lb	See footnote 2.		33
Apron XL	*Pythium* damping-off	0.085-0.64 fl oz/cwt[3]	-	0	4
Cabrio EG[4]	*Alternaria* blight, anthracnose, downy mildew, gummy stem blight, powdery mildew	8-16 oz	64 oz	0	11
Dithane DF	Anthracnose, downy mildew	2-3 lb	19 lb	5	M2
Flint[4]	Downy mildew, powdery mildew	1.5-4 oz	8 oz	0	11
Manzate 75DF	Downy mildew	2-3 lb	18 lb	5	M2
Maxim	Seedborne diseases (except *Pythium*)	0.08-0.16 fl oz/cwt[3]	-	0	12
Nova 40W[5]	Powdery mildew	2.5-5 oz	1.5 lb	0	3
Penncozeb 75 DF	Anthracnose, downy mildew	2-3 lb	19 lb	5	M2
Phosporous acids[6]	Downy mildew	see label	n/a	0	33
Pristine[4]	*Alternaria* blight, anthracnose, downy mildew, gummy stem blight, powdery mildew	12.5-18.5 oz	74 oz	0	7/11
Procure 50WS[5]	Powdery mildew	4-8 oz	40 oz	0	3

[1] Acrobat must be tank mixed with another fungicide that is effective against downy mildew.
[2] Do not exceed seven applications per season; Do not exceed 3.75 lb of product per application in the following counties: Hart, Logan, Marshall, Warren (use of Aliette is restricted to protect freshwater mollusks and their habitat).
[3] cwt=hundredweight (100 lb of seed).
[4] Do not make more than four applications of FRAC group 11 fungicides per season; do not make back-to-back applications of these products.
[5] Do not make back-to-back applications of FRAC group 3 fungicides.
[6] Phosphorous acid generating products (PAGs) include Fosphite, Helena ProPhyt, Phostrol, and Topaz. See product labels for rates.

Table 5. Disease-management chemicals labeled for gourds in Kentucky.

Product	Target Diseases	Product Rate/A per: App.	Product Rate/A per: Season	PHI (days)	FRAC Group
Quadris[1]	*Alternaria* blight, anthracnose, belly rot, downy mildew, gummy stem blight, powdery mildew	11-15.4 fl oz	2.88 qt	1	11
Reason 500SC[1]	*Alternaria* blight, downy mildew	5.5 fl oz	22 fl oz	14	11
Ridomil Gold EC[2]	*Pythium* damping-off, cottony leak	1-2 pt	2 pt	0	4
Ridomil Gold / Copper	Downy mildew	2 lb	8 lb	5	4
Serenade ASO[3]	Downy mildew, gummy stem blight, powdery mildew	2-6 qt	no limit	0	n/a
Tanos[1]	*Alternaria* blight, anthracnose, downy mildew	8 oz	2 lb	3	11/27
Ultra Flourish[2]	*Pythium* damping-off, cottony leak	2-4 pt	4 pt	0	4

[1] Do not make more than four applications of FRAC group 11 fungicides per season; do not make back-to-back applications of these products.
[2] Apply Ridomil Gold or Ultra Flourish (same active ingredient) to soil prior to planting; do not apply to foliage. Product must be incorporated mechanically or by irrigation water (or rainfall) after application.
[3] Approved for use in organic production systems (OMRI-approved).

- Use fungicides wisely. Fungicides are an important part of any good disease management program but should not be relied upon solely. Take care to read and follow the labels of the fungicides being used. This will ensure safe and effective applications of these products and will also help prevent the buildup of fungicide-resistant pathogen populations for certain high-risk fungicides. Use a fungicide seed treatment or purchase fungicide-treated seed to avoid losses to damping-off in cold and wet soils.
- Control weeds in and around the area where gourds are planted. Along with competing for light, moisture, and nutrients, weeds harbor insects and plant pathogens that may attack gourds.

Common Diseases

Alternaria Leaf Blight

Alternaria leaf blight (ALB) occurs mainly during rainy and warm periods. Lesions appear on older leaves first, and are small and yellow-brown in color. These lesions will expand to large, brown areas that can coalesce, causing the leaf to take on a cupped appearance. Heavy defoliation due to ALB often results in sunscald on fruit. The causal agent, *Alternaria cucumerina,* can survive for up to two years in crop residue.

Management. Rotation away from susceptible crops for two years, along with deep plowing of crop residue after harvest, will reduce inoculum levels in soil. Avoid overhead irrigation, or water early in the day to minimize the length of time that foliage stays wet. Regular application of fungicides will also provide good suppression of ALB (see "Chemical Control" on page 8 for recommended materials).

Anthracnose

Anthracnose is a common disease in Kentucky, particularly in warm, wet growing seasons, and can affect all plant parts. The disease can progress rapidly on foliage and can cause serious losses during periods of warm and rainy weather. Lesions on leaves start out as small, circular spots that later expand to roughly 0.5 inch in diameter. Typically, cracks will appear in the center of lesions or the centers will drop out completely, giving a "shot-hole" appearance to the leaf. Lesions on stems are tan, shallow, and oval-to-diamond shaped. Lesions on fruit first appear as sunken, circular, water-soaked areas that expand with age (particularly after harvest). Under humid conditions, lesions may blacken and become covered with a pinkish mass of spores. The pathogen, *Colletotrichum orbiculare,* can be seed-borne and can survive on plant residue in soil or on volunteer cucurbits.

Management. Rotation away from susceptible crops for at least a year (two years is preferable), along with deep plowing of crop residue after harvest, will reduce inoculum levels in soil. Regular application of fungicides will also provide good suppression of anthracnose (see "Chemical Control" on page 8 for recommended materials).

Bacterial Wilt

Bacterial wilt, caused by *Erwinia tracheiphila,* appears initially as a sudden wilt of the vines in small sections, progressing later to large-scale collapse of vines. Feeding injury caused by cucumber beetles, the sole vector of the pathogen, is often visible on stems and leaves associated with collapsed vines. The causal agent of bacterial wilt overwinters in and is spread by cucumber beetles.

Management. Prevention is through control of the cucumber beetles (see "Insect Control" on page 4). Rescue treatments (after infection) are of no help in controlling bacterial wilt.

Belly Rot

Caused by *Rhizoctonia solani,* a soilborne fungus, this disease is characterized by sunken, water-soaked areas (or lesions) that are tan-to-brown in color on the portions of fruit in contact with soil. Lesions tend to form large, dry craters as they age.

Management. Crop rotation can be of limited value in managing belly rot; however, deep turning will encourage decomposition of crop residue (and the pathogen) in soil. Certain fungicides (see "Chemical Control" on page 8) are labeled for control of belly rot; however, results tend to be inconsistent with soil-applied materials.

Choanephora Fruit Rot (Wet Rot)

High moisture and warm temperatures favor this disease, characterized by a wet rot of blossoms and later the blossom end of fruit. White fungal growth can be observed, along with profuse sporulation that is black in color. The latter has a distinct, bristly, or whisker-like appearance. The pathogen, *Choanephora cucurbitarum,* survives on numerous hosts in the field and is spread by wind, rain, and insects.

Management. Fungicides have not been effective in managing Choanephora fruit rot. Steps taken to improve air movement within the field may help suppress the disease by decreasing periods of wetness on susceptible plant parts.

Cottony Leak

Caused by species of *Pythium,* a soilborne fungus, this disease is characterized by a soft, wet rot and the presence of profuse, fuzzy (cottony) growth of mycelium, or fungal threads, covering part or all of infected fruit.

Management. Crop rotation can be of limited value in managing cottony leak; however, practices that promote good soil drainage can minimize losses to this disease. In poorly drained soils, a pre-plant application of Ridomil Gold or Ultra Flourish will help suppress cottony leak (see "Chemical Control" on page 8).

Damping-off

This disease can occur before or after germination of seed and is caused primarily by one or more species of soilborne *Pythium.* Damping-off is favored by cool, wet soil conditions.

Management. Crop rotation can be of limited value in managing damping off; however, practices that promote good soil drainage can minimize losses to this disease. Avoid planting when soil temperatures are cool for prolonged periods of time. Seed treatment with Apron XL (0.085-0.64 fl oz/100 lb of seed) is an effective means to control damping-off caused by *Pythium* spp. Commercially available seeds are treated with this material by the manufacturer. In poorly drained soils, a pre-plant application of Ridomil Gold or Ultra Flourish will help suppress damping-off (see "Chemical Control" on page 8).

Downy Mildew

Downy mildew, caused by *Pseudoperonospora cubensis,* is a devastating and fast-moving disease of cucurbits and occurs in Kentucky mainly in late summer to early fall. High humidity or rainfall and moderate-to-warm temperatures favor disease development. Downy mildew first appears as pale- to bright-yellow spots on the upper surface of leaves in the crown area of the plant; these spots may be irregular or "blocky" in appearance. As lesions expand and the number of lesions increases, leaves become necrotic and plants will appear scorched. On the undersides of leaves, lesions will be water-soaked and slightly sunken; profuse sporulation (light to dark gray or even purple in color) will be evident when humidity is high.

Management. Downy mildew can cause near-total defoliation of a susceptible crop in less than a week under favorable conditions; waiting to treat for this disease after symptoms appear can result in severe losses. Crop rotation is of no value in managing downy mildew because the pathogen moves into Kentucky from the south each year. Selecting sites with good air movement will reduce the length of time that leaves stay wet and, therefore, decrease favorable conditions for the downy mildew pathogen. A good fungicide program, applied on a timely basis, is an effective means to manage downy mildew (see "Chemical Control" on page 8 for recommended materials). Resistance to mefenoxam (Ridomil Gold, Ridomil Gold Bravo, Ridomil Gold/Copper, and Ultra Flourish) is common in populations of the downy mildew pathogen, as is resistance to QoI (quinine-outside inhibitor) fungicides such as azoxystrobin (Quadris), pyraclostrobin (Cabrio), and fenamidone (Reason); growers should monitor the performance of these products closely. Protectants such as mancozeb (Dithane DF) work well but must be applied prior to infection for best effect.

Gummy Stem Blight (Black Rot)

This is a very destructive disease of cucurbits and is favored by warm and rainy weather. Caused by *Didymella bryoniae,* gummy stem blight can occur on all plant parts—leaves, stems, and fruit (black rot). Lesions on leaves are circular and tan-to-brown in color, and can expand quickly. Leaf veins affected by gummy stem blight will appear water-soaked and orange-brown in color. Lesions on stems and vines are water-soaked initially, orange-brown in color, and may exhibit a gummy, amber colored exudate. Older lesions tend to form tan colored cankers. Lesions on fruit begin as small, water-soaked spots that later expand and may exude a gummy ooze. Lesions on all plant parts will contain numerous black fruiting bodies (pycnidia). The gummy stem blight pathogen is seed-borne and can survive in infected crop debris.

Management. Prompt destruction of crop residue by deep-turning can be effective, as can a two-year rotation away from susceptible crops. Fungicide seed treatments are important in reducing outbreaks of gummy stem blight caused by seed-borne inoculum. As with anthracnose, regular application of fungicides will also provide good suppression of gummy stem blight (see "Chemical Control" on page 8 for recommended materials). Resistance to the benzimidazole fungicide, thiophanate-methyl (Topsin M), QoI fungicides such as azoxystrobin (Quadris) and pyraclostrobin (Cabrio) has been documented in the southeastern United States. Care should be taken when using these materials, as insensitive strains of *D. bryoniae* will not be controlled by these products.

Powdery Mildew

Powdery mildew, caused primarily by *Podosphaera xanthii,* is the most prevalent and devastating fungal disease of cucurbits in Kentucky. Favored by warm, dry conditions, powdery mildew can cause large-scale defoliation which reduces yields (size and quality) and increases the likelihood of sunscald on fruit. Symptoms appear first on older leaves or shaded portions of the plant and appear as talc-like colonies on upper and lower leaf surfaces. As the disease progresses, the entire leaf surface will be colonized by the fungus and symptoms will develop on stems and fruit. Severely infected leaves will become necrotic and die within a short period of time, resulting in defoliation. Powdery mildew is most severe after fruit-set and in densely planted fields.

Management. Resistance to powdery mildew in gourd varieties is not well described. Powdery mildew can be controlled through the preventive application of fungicides (see "Chemical Control" on page 8 for registered materials). Insensitivity to DMI fungicides such as myclobutanil (Nova), and to the QoI fungicides (Cabrio, Flint, Pristine, Quadris), has been documented in the United States, and growers should monitor crops closely for reduced efficacy when these materials are applied.

Virus Diseases

Diseases caused by viruses are common on cucurbits in Kentucky, especially during warm weather and later in the season (when insect populations tend to be higher). Cucumber mosaic virus (CMV), Papaya ringspot virus (PRSV), and Watermelon Mosaic Virus 2 (WMV-2) are among the most common viral pathogens. Symptoms include stunting, mosaic patterns on leaves, and leaf distortion. Aphids are the primary vectors for the major viruses that attack cucurbits in Kentucky.

Management. Eliminate weeds within a 150-foot border around the field, and use a barrier crop of corn around the planting. Avoid planting near other cucurbit crops or near tobacco, which may serve as a reservoir of one or more viruses. Research has demonstrated that applications of stylet oil every two to three days can slow the spread of virus within a field.

Chemical Control

Thanks to the introduction of new classes of chemistry in recent years, there are more products now for use on gourds than ever before. Fungicides and bactericides, though, should not be relied upon as the sole means of control for any disease and should be integrated into a comprehensive management program that includes other practices. For best effect, most disease-control products need to be in place prior to infection by a particular pathogen, and regular applications of these materials are important to achieve good control. How "regular application" is defined depends upon the weather and disease pressure. For example, under highly favorable conditions for disease, a grower should consider applying fungicides on a five- to seven-day schedule; when disease pressure is low or when conditions don't favor disease, this schedule could be stretched to 10 to 14 days. Spray equipment should be calibrated and configured properly to ensure good coverage.

Growers should consider that cucurbits in Kentucky are affected by a number of fungal diseases, and a spray program needs to address all potential pathogens. Fortunately, it's possible to build a fungicide program that will provide reasonable control of most, if not all, of the fungal diseases that occur on cucurbits in Kentucky. Disease-specific products can be used to supplement the fungicide program in situations when certain diseases, such as downy or powdery mildew, appear and are not suppressed adequately by the existing program.

The best choice for the "backbone" of a fungicide program should be the *least-expensive* and *efficacious* protectant fungicide that can be obtained. In the case of gourds, products containing mancozeb (Dithane, Manzate, and Penncozeb) fit this description. Begin the spray program with mancozeb, and then alternate other products with mancozeb (or tank-mix with mancozeb), being careful to observe seasonal limits for each product. Early in the season, mancozeb can be used exclusively for the first few sprays; begin applications of other products as the crop increases in size, if conditions begin to favor disease development, or if symptoms of a particular disease appear.

Resistance management is a critical issue facing agricultural producers around the world. Misuse of fungicide products can lead to the development of insensitivity (resistance) to certain active ingredients in populations of fungal plant pathogens, leading to a partial or complete loss of efficacy. The risk of resistance to a particular active ingredient depends upon the mode of action of the compound in question. Mancozeb, for example, is a "multi-site inhibitor," and affects multiple biochemical mechanisms within target fungi. This means that the risk of fungi becoming insensitive to mancozeb is very low, making products containing mancozeb good choices for tank-mix or rotational partners with specific mode of action fungicides, such as Quadris or Nova. Fungicides with specific modes of action affect single biochemical mechanisms within target fungi, and the risk of these fungi becoming insensitive to such fungicides is relatively high compared to multi-site inhibitors.

In the case of fungicides with specific modes of action, avoid sequential applications with the same product or products with the same mode of action. Repeated exposure to such products increases the risk of resistance development in fungal pathogens. Given the number of products on the market that have the same active ingredient or have the same mode of action, it can be difficult to decide which products can be used sequentially in a spray program. Manufacturers of fungicides have begun to address this issue. Fungicides that are at risk for development of resistance will list a Fungicide Resistance Action Committee (FRAC) code, along with specific resistance management guidelines, on the product label. FRAC has classified the active ingredients found in fungicide products by their mode of action and assigned them a group number, called the "FRAC group." Fungicides within the same FRAC group share the same active ingredient or have the same mode of action even if they belong to a different chemical class. Thus it is not necessary to memorize mode of action for each fungicide that is being used; instead, use the product's FRAC code to decide how each fits in a season-long spray program. Careful adherence to resistance management guidelines will go a long way in delaying or preventing the development of resistance to valuable disease management tools.

Weed Control

Control weeds by using mulches or through shallow cultivation. Cultivation is limited to hand pulling when vines are large. On younger plants, remember that gourds are relatively shallow-rooted and cultivation should be done shallowly to prevent root pruning. After harvest, destroy crop debris and establish a cover crop to reduce potential weed and disease problems in future crops.

Table 6. Weed control for gourds in Kentucky.

Preemergence		
Product/A	**a.i./A**	**Remarks**
6 to 14 pt Dacthal 6F	4.5 to 10.5 lb DCPA	For preemergence control of annual grasses and small-seeded broadleaves. Apply only to crops with four to five true leaves that are well established and when growing conditions are favorable. Do not incorporate. Not labeled for transplanted crop.
5 to 6 qt Prefar 4E	5 to 6 lb bensulide	For control of grasses and some broadleaf weeds. Apply preplant and incorporate to 1-inch depth. Can also be applied preemergence only if it can be watered immediately. Do not combine with fertilizers.
0.5 to 1 oz Sandea 75DF	0.023 to 0.046 lb halosulfuron	For weed control of broadleaf weeds and yellow nutsedge. PHI = 30 days. Maximum 2 oz/season. Can be applied to seeded or transplanted gourds grown on plastic mulch. Make sure that beds are properly crowned to reduce risk of herbicide accumulation in planting holes. Do not use if conditions favor rainfall to avoid stunting or injury to the crop. Can also be used postemergence with non-ionic surfactant 0.5% v/v to improve control.
1 to 2 pt Goal 2XL	0.25 to 0.5 lb oxyfluorfen	For preemergence and postemergence control of certain annual grasses and most broadleaves. For fallow bed preparation only. For seeded crops only. At least ¼-inch rain or irrigation should occur within three weeks of application. The fallow bed should be worked to at least 2.5 inches prior to planting to avoid crop injury. Best if used with glyphosate for control of winter annual broadleaf weeds. Minimum 90 days between application and planting at 1 pt/A rate and 120 days at 2 pt/A rate.
1.25 pt Treflan 4E	0.625 lb trifluralin	For preemergence control of annual grasses and broadleaf weeds. Best results if incorporated within 24 hours. Can be applied as a directed; spray between rows after the crop is in 3 to 4 true leaf stage and incorporate. Avoid foliage contact. PHI = 30 days. Maximum 1 application/season. Do not use if annual rain and irrigation is less than 20 inches.
Postemergence		
Product/A	**Lb a.i./A**	**Remarks**
0.5 to 2 fl oz Aim 2EC	0.008 to 0.032 lb carfentrazone	For contact postemergence control of annual broadleaf weeds and suppression of annual grasses. Can be applied as a preplant or pretransplant burndown at 2 fl oz/A. Can also be applied before crop emerges to actively growing weeds up to 4-inches tall. Can also be applied post-emergence as a directed hooded application between crop rows. Use minimum 10 gal water/A and crop oil 1% v/v. Maximum rate 6.1 fl oz/A. PHI = 0 days.
9 to 16 fl oz Select Max 1E	0.14 to 0.25 lb clethodim	For selective postemergence of actively growing annual grasses and suppression of perennial grasses. Add crop oil 1% v/v. Maximum 16 fl oz/application and 64 fl oz/season. Minimum 14 day interval between applications. PHI = 14 days.
11 to 44 fl oz Roundup WeatherMax 5.5L	0.47 to 1.88 lb glyphosate	For nonselective postemergence control of annual and perennial grasses and broadleaf weeds. Use only AMS 1% to 2% v/v. Adding a non-ionic surfactant can reduce weed control effectiveness. Can be applied preplant with three days minimum before planting. Can also be applied as a directed shielded postemergence.
1.3 to 2.7 pt Gramoxone Max 3L	0.5 to 1 lb paraquat	For nonselective contact kill of annual grasses and broadleaf weeds and top-kill of perennial weeds. Can be applied as a pre-plant or pretransplant burndown at 2 fl oz/A. Can also be applied before crop emerges to actively growing weeds up to 4-inches tall. Can also be applied postemergence as a directed hooded application between crop rows. Use higher rates for heavy weed infestations. Use non-ionic surfactant 0.25% v/v. Maximum 3 applications/season.
1 to 10% Scythe 4.2L	pelargonic acid	For nonselective contact control of annual grasses and broadleaf weeds. Use in minimum 10 gal water/A if mixed with other herbicides or a minimum 75 gal if used alone. Do not allow contact with crop foliage. Scythe at 1% to 3% enhances the activity of other postemergence herbicides such as Aim or Roundup.

Yield Expectations and Returns

A grower might expect around 900 to 4,000 hard shell *Lagenaria* gourds (swan, birdhouse, kettle, snake) per acre depending on the type. For the small miniature or ornamental gourds that weigh 3 to 4 ounces each, a grower might expect 20,000 to 30,000 per acre.

Gross returns may vary from $1,000 to $5,000 per acre, depending on cultural techniques, variety, and marketing method. Total out-of-pocket costs for seed, fertilizer, herbicides, insecticides, fungicides, land preparation, and irrigation will usually be about $700 to $800 per acre. Harvesting, handling, and storage may require around 80 hours of labor. For gourds requiring washing and packing in half-bushel boxes there will be an additional expense of about $2 per box.

Season and market conditions greatly affect returns. When production is high, anticipated markets become scarce or may disappear, leaving product unsold.

For thick-shelled gourds, profit can increase considerably by crafting them (painting, wood-burning, carving, etc.).

Table 7. Ornamental gourds—estimated per-acre costs and returns, direct market.

	Quantity	Unit	$/Unit	Total	Your Farm
GROSS RETURNS					
African Kettle Gourd	900	Large gourds	5.00	4500.00	
VARIABLE COSTS					
Production					
Transplants	605	plants	0.10	60.50	
Lime	0.5	ton	12.12	6.06	
Fertilizer	1	acre	85.00	85.00	
Herbicides	1	acre	34.25	34.25	
Insecticides	1	acre	51.87	51.87	
Fungicides	1	acre	56.25	56.25	
Machine variable costs	1	acre	57.42	57.42	
Pollination	1	hire	40.00	40.00	
Irrigation	90	hrs	0.40	36.00	
Black plastic/drip lines	1	acre	300.00	300.00	
Total Production Cost				727.35	
Harvesting and Marketing					
Plastic disposal	18	hrs	8.00	144.00	
Plastic disposal fee	1	acre	10.00	10.00	
Hired Labor:					
Harvest	80	hrs	8.00	640.00	
Marketing cost (10% of gross)	*10% of gross*			450.00	
Total Harvest & Marketing Cost				1244.00	
Interest on Variable Costs				60.72	
TOTAL VARIABLE COST				2032.07	
RETURN ABOVE VARIABLE COSTS				2467.93	
FIXED COSTS					
Depreciation of machinery & equipment				109.97	
Depreciation on irrigation system				159.94	
Taxes on land				5.00	
Insurance				22.50	
TOTAL FIXED COSTS				297.41	
TOTAL EXPENSES				2329.48	
RETURN TO OPERATOR LABOR, LAND, CAPITAL AND MGMT.				2170.52	
Operator/unpaid family labor	20	hrs	8.00	160.00	
RETURN TO LAND, CAPITAL & MANAGEMENT				2010.52	

Per acre return above variable costs at various prices and yields for *Cucurbita pepo.*

½ bu boxes/acres							
$/Box	**150**	**200**	**250**	**300**	**350**	**400**	**450**
5.50	-703	-633	-562	-491	-420	-305	-278
6.50	-570	-453	-338	-222	-106	10	126
7.00	-502	-364	-225	-87	51	190	328
7.50	-435	-274	-113	48	209	369	530
8.00	-367	-184	-1	182	366	549	732
9.00	-233	-5	224	452	680	908	1136
10.00	-98	175	448	721	994	1267	1540

Harvesting and marketing cost adjusted for yield. Return shown is an estimate of funds available for operator and unpaid labor, debt payments, and overhead. Returns will depend on the amount of hired labor used.

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Issued 3-2007