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UK UNIVERSITY OF KENTUCKY College of Agriculture

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Sweetpotato Production for Kentucky

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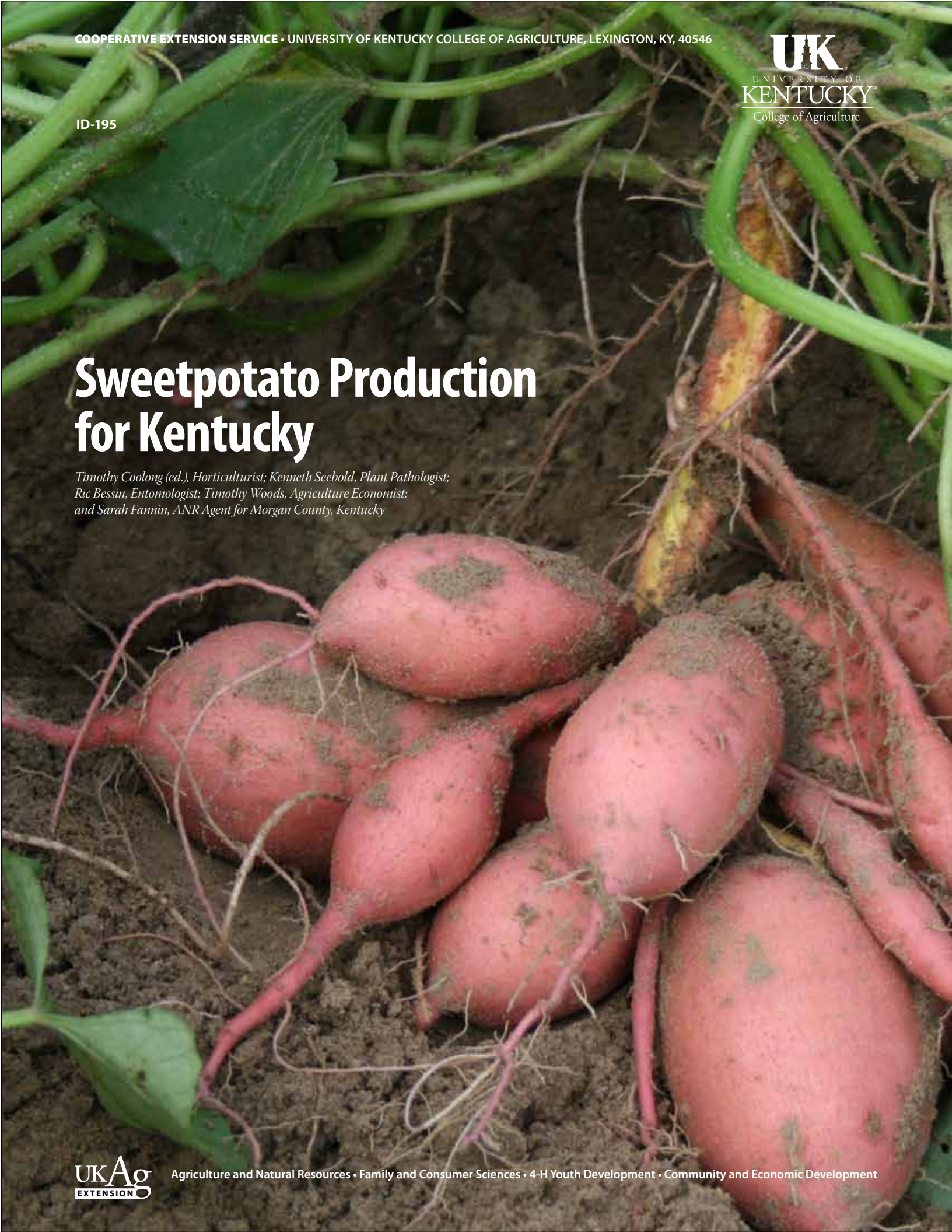

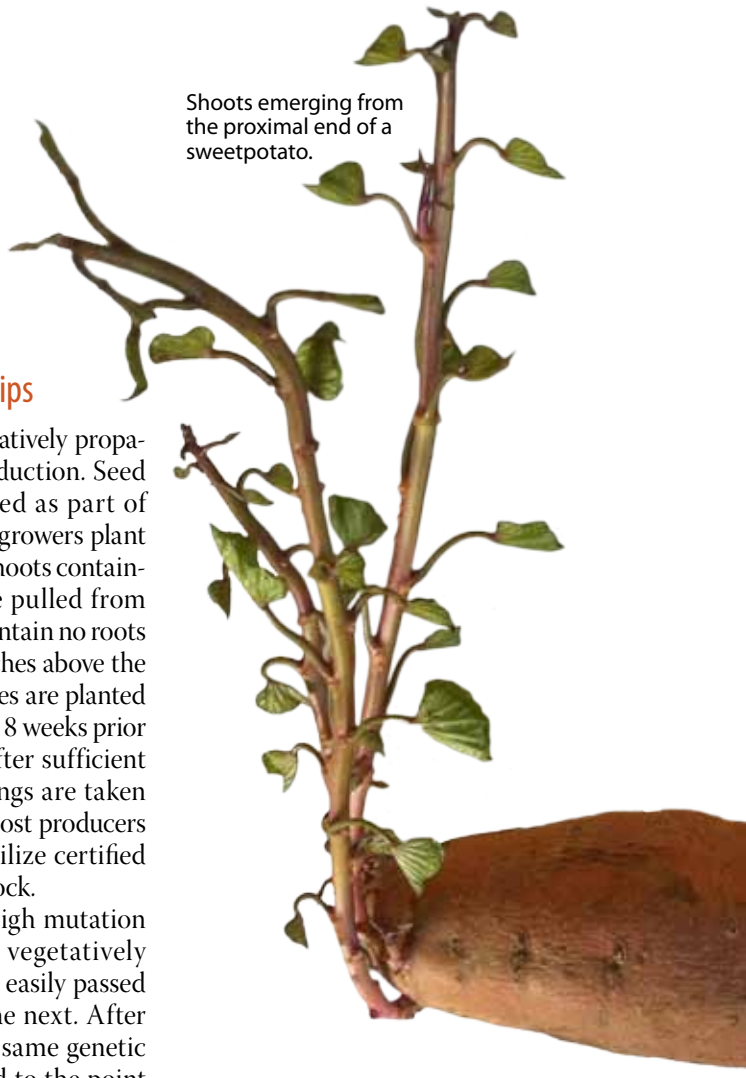

Shoots emerging from the proximal end of a sweetpotato.

Origins and Botany

Sweetpotato (*Ipomoea batatas* L.) is a member of the morningglory or Convolvulaceae family. Sweetpotatoes have their origins in tropical America, with early remains having been found in Panama, Peru and Mexico. A perennial plant in their native regions, they are typically killed by frost when grown in a temperate climate. Sweetpotatoes are true roots and not tubers as is the case with the Irish Potato (*Solanum tuberosum*). Because they are true roots they will continue to grow and enlarge as long as the plant continues to grow. Most modern cultivars consistently produce between seven to ten roots per plant. Average roots, when harvested at the appropriate time, weigh between one-half and three-quarter pound. Sweetpotato roots can exhibit a variety of colors. Traditionally the market demands an orange-fleshed root, but several other colors, including white, red, yellow and even purple, are grown. Sweetpotatoes are nutritious and a good source of carotenoids, vitamin A and vitamin C.

Sweetpotatoes produce trumpet-like flowers similar to a morningglory, although not usually in temperate areas. The plant produces flowers in response to short days. When they are grown during the summer months in the U.S., day lengths are typically too long to induce flowering. Occasionally plants will produce an odd flower here or there, but they should be of no concern to growers.

Although often used interchangeably, sweetpotatoes and yams are in fact quite different vegetables. Yams refer to root crops in the *Dioscorea* genus and are traditionally grown in tropical areas outside of the continental U.S. Yams are typically much starchier and larger than sweetpotatoes, with roots weighing between 4 and 20 pounds on average, with some weighing more than 100 pounds (Rubatzky and Yamaguchi, 1997).

Cultivation

Producing cuttings or slips

Sweetpotatoes are vegetatively propagated for commercial production. Seed production is only utilized as part of breeding programs. Most growers plant slips or cuttings. Slips are shoots containing some roots which are pulled from growing plants; cuttings contain no roots and are removed 1 to 2 inches above the soil line. Seed sweetpotatoes are planted in beds in early spring, 6 to 8 weeks prior to the planting season. After sufficient vines are produced, cuttings are taken and planted in the field. Most producers selling slips or cuttings utilize certified disease-free seed potato stock.

Sweetpotatoes have a high mutation rate. Because plants are vegetatively propagated, mutations are easily passed from one generation to the next. After several years of using the same genetic stock, mutations can build to the point where off-types are propagated and yields are reduced. In addition, vegetative propagation can easily pass disease-causing pathogens to the next generation. Therefore it is advised that after a few seasons growers replace their seed stock with new certified disease-free stock. Certified disease-free seed potatoes are the product of tissue culture of somatic embryos and are not only disease free but produce few mutations. To offset the cost of utilizing completely new seed stock every two to three years growers can replace a small portion of their plants each year.

The cost of buying cuttings or slips remains the single biggest expense for the production of sweetpotatoes. Slips or cuttings can be grown successfully in Kentucky during late April and May for planting in early to mid-June. Although slips have traditionally been the method of transplant production for sweetpotatoes,

Sweetpotato slips (left) with some small roots and cuttings with no roots (right).

SARE
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Cut seed roots infected with *Rhizopus* soft rot.

cuttings are now preferred. Cuttings of sweetpotato shoots are taken 1 to 2 inches above the soil line, so they lack roots and the fleshy base associated with slips. Cuttings reduce the risk of spreading disease; keeping open wounds away from soil and preventing the mixture of soil with cuttings reduces the likelihood of transferring soil-borne diseases such as scurf.

When planting seed sweetpotatoes, growers should not cut the roots as one would when seeding out Irish potatoes, for several reasons. With Irish potatoes a seed potato may be cut into halves, thirds, or quarters, resulting in two or more plants from one seed potato. However, cutting a sweetpotato in half will not generate twice as many slips. One can expect to get ten or more shoots per single sweetpotato. Cutting the sweetpotato in half would simply generate two roots with five shoots each. Sweetpotatoes also produce the vast majority of shoots from the proximal end of the root. If the root were cut longitudinally in half, one piece would have several shoots and the other would have few if any. In addition, cutting the seed roots of sweetpotatoes exposes them to soil-borne diseases, and the high sugars in sweetpotatoes make them a favorable environment for colonization by soil bacteria and fungi (see photo at left).

On average 10 to 12 bushels (55 pounds each) of sweetpotato roots are required to produce one acre's worth of slips, depending on row spacing and plant population per acre. Growers should utilize medium and large sweetpotatoes when producing slips. Although small roots have been shown to produce more shoots per unit weight; growers might be selecting inferior sweetpotatoes if they plant only small (<3 to 4 oz) roots. Growers must also take into consideration that sweetpotatoes harvested in September can lose 10 percent or more of their weight during winter storage. Further storage losses due to disease can also occur. If 550 to 660 pounds of roots are required to produce an acre's worth of slips, at least 2 extra bushels per acre should be stored to accommodate storage losses.

Sweetpotatoes do not have a natural dormancy period, and if conditions are correct they can sprout shortly after harvest. However, after a long period of cool storage, sprouting can be encouraged by warming sweetpotatoes to 70 to 80°F prior to planting. To discourage soil-borne diseases, seed roots can also be treated with fungicides prior to planting. Growers in Central and Eastern Kentucky can generally plant sweetpotatoes for cutting production during the last week of April; growers in Western Kentucky typically are able to go into the field up to a week earlier. Temperatures should not be below 50°F on the day of planting so that sweetpotatoes are not subjected to cold damage. However, once seed potatoes are planted and covered with soil they can typically withstand much cooler temperatures. Cuttings can be produced through a variety of methods. The homeowner may want to simply place a root in a small pot and cover with soil; the market grower can utilize a small raised bed structure. Larger growers will want to grow slips from ground beds.

Cuttings on a small scale

The following method has been used successfully to produce approximately a half acre (6,500) of slips.

Many growers choose to construct a raised bed for small-scale slip production; the example utilizes a 6-foot by 12-foot raised bed to produce slips. The raised bed structure is put in place and disease-free seed potatoes are placed end to end to fill the bed. The bed pictured required approximately 500 sweetpotatoes, weighing approximately 250 pounds, to fill, resulting in an average of seven seed potatoes per square foot.

To prevent weeds, Devrinol (napropamide) preemergent herbicide can be applied to the soil surface with a backpack sprayer after sweetpotatoes are covered. However, given the small area being considered, one or two hand weedings would be sufficient as well. The raised bed structure can then be covered with clear plastic to form a mini-cold frame.

Soil is added to the bed to cover the seed potatoes to a depth of three inches.

Mini-cold frame for slip production.

Sweetpotato sprouting four weeks after planting (left) and six weeks after planting (right).

The sweetpotato bed should be monitored to ensure that it does not dry out. Plants should begin sprouting within three weeks. After approximately four weeks the plastic covering should be removed as temperatures increase. Once plants start sprouting one or two applications of a general purpose fertilizer will spur growth. Plants will grow vigorously from this point and will be ready for harvest about six weeks after planting, typically the first or second week of June.

When cuttings are taken, prune sweetpotato shoots approximately 1 to 2 inches above the soil line. Plants will resprout for additional cuttings. Allow two weeks for resprouting to occur for a second cutting.

Cuttings on a larger scale

The following method has successfully been used to produce approximately one acre (13,000) of slips.

For growers wanting to produce cuttings for larger plantings, cold frames over raised beds may not be practical. On a larger scale, sweetpotatoes can be laid end to end in a row approximately 2 feet wide (or wider or narrower based on the available equipment) and as long as necessary. Approximately 550 pounds of sweetpotatoes were used to produce one acre of slips. After slips are placed in the ground they are covered with soil. To prevent weeds, Devrinol (napropamide) preemergent herbicide can be applied to the soil surface after sweetpotatoes are covered.

A gang of disks used to form the bed. Any implement that will push dirt over the sweetpotatoes will suffice.

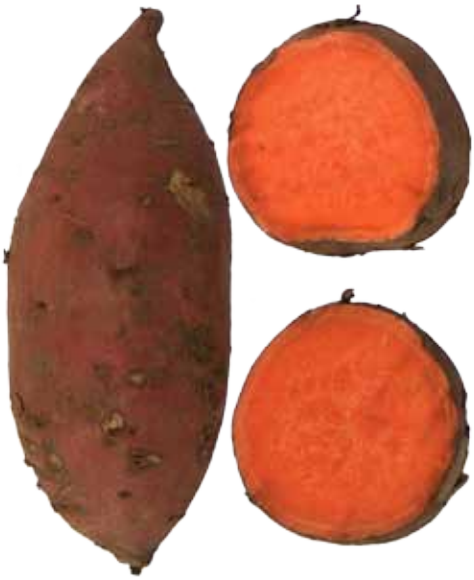
Sweetpotatoes placed end to end in a well prepped field (left) and covered with three to four inches of soil (right).

Clear plastic mulch over the sweetpotato bed (left), punching holes with a waterwheel (center), and sprouts damaged due to the heat under the clear plastic (right). When sprouts consistently appear, remove the plastic.

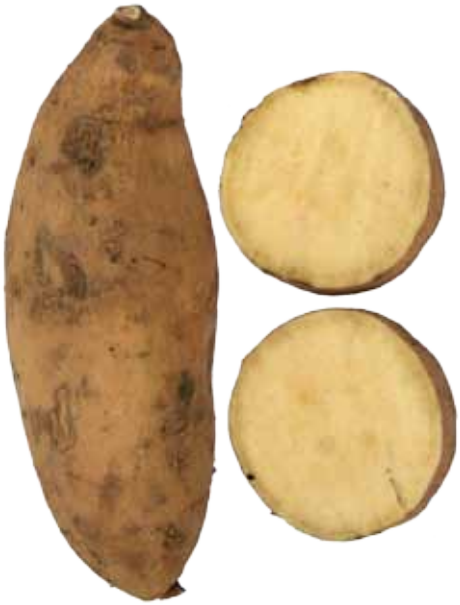
Clear plastic mulch should be placed over beds to increase soil temperatures, which encourages sprouting. In Kentucky plastic should be used in order to have cuttings for planting by early to mid-June. Drip irrigation tubing should be placed under the plastic mulch to irrigate and provide fertility if necessary. After a week or so punch some holes in the clear plastic mulch to ensure that there is enough oxygen in the soil that roots will not rot. One can use almost anything to punch holes; waterwheel setters work well as long as the spikes on the wheel do not punch deeply enough to harm the buried roots. After about three weeks, initial sprouts should appear under the plastic mulch. Be careful to frequently monitor the bed as the clear plastic will burn sprouts that emerge beneath it. When sprouts are consistently breaking through the soil cut the plastic away from the bed to allow the plants to continue growing. After two more weeks sprouts should be 8 to 10 inches long, allowing for cutting. During this time supplemental fertility and water can be applied through the drip irrigation if desired. An application of 5 to 10 pounds nitrogen per acre with a general purpose fertilizer should be sufficient.

After cuttings are taken they can be stored for short periods. Do *not* store cuttings in a refrigerator or a cooler below 50°F or they will suffer cold injury. Commercially, slips are often bundled in bunches of 1,000 and packed in cardboard boxes. Growers often wait one to two days after taking cuttings before planting in the field.

Sweetpotato sprouts at plastic removal (left), approximately one week (center) and two weeks (right) after plastic removal. Cuttings are ready for harvest two weeks after plastic removal.

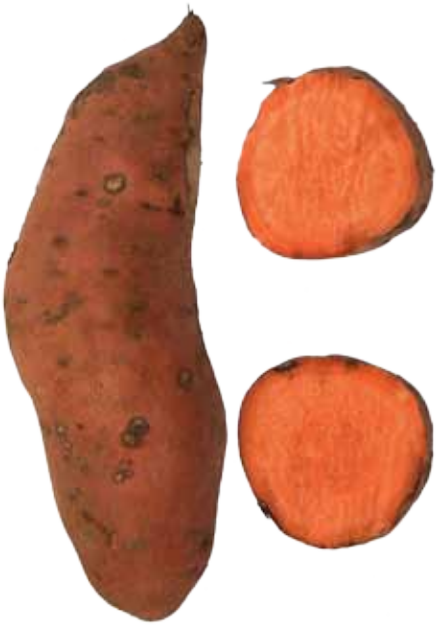


Beauregard. Highest yield potential in Kentucky. Yields have surpassed 500 boxes per acre. Matures in 90 to 95 days. Copper-red skin with orange flesh. Most common variety grown. Must harvest on time or roots will get too large.



O'Henry. Best performing white-fleshed variety. Tan-colored skin. High yield potential of 400 to 500 boxes per acre. Similar shape and growth habit as Beauregard. Matures in 95 days.

Covington. Highest quality but with lower yield potential than Beauregard. Yields in Kentucky approach 400 boxes per acre. Rose-colored skin with orange flesh. Matures in 100 days. Uniform roots with exceptionally strong vines.



Centennial. Copper skin with orange flesh. Older variety but still a good yielder. Longer and tapered. Matures in 100 to 110 days.

Variety selection

Variety selection is crucial for commercial sweetpotato production. Although growers may have traditional favorites, newer varieties should be selected for their superior yield potential. Maturation time is an important criterion when choosing varieties. Some varieties, such as Beauregard, mature in only 90 to 95 days, much sooner than many traditional varieties. Maturation time is important since sweetpotato roots will continue to grow even after they have reached marketable size. Varieties that should be harvested at 90 days will be too large for wholesale markets if left in the field for 110 to 120 days. It is not uncommon to harvest 5- to 7-pound sweetpotatoes that have been left in the field too long. Growers in the eastern portion of Kentucky should consider varieties that mature earlier since it is not uncommon for this region to experience early frosts.

Hernandez. Good yield potential, longer more tapered root than Beauregard. Orange skin with exceptionally deep orange flesh. Matures in 100 days.

Field preparation and planting

Field preparation should begin with a soil test the fall prior to growing sweetpotatoes. Sweetpotatoes do not require a lot of nitrogen fertility but do require significant potassium and phosphorous. Sweetpotatoes will grow well in a soil with pH of 6.0 to 6.8. Lime should be added during fall or winter so that it can adequately react with the soil prior to planting. Applications of phosphorous and potassium are recommended during field preparation. Generally sweetpotatoes require approximately 50 to 80 pounds of nitrogen per acre. We suggest 50 pounds preplant with a side dress of an additional 20 to 30 pounds four weeks after transplant or before vines begin to fill in rows. Despite requiring less nitrogen than most vegetable crops, sweetpotatoes do remove a significant amount of potassium from soils.

Sweetpotatoes perform best on a sandy, well-drained soil; however, they have been grown successfully on a wide range of soils across Kentucky. Heavy clays and excessively shallow, rocky, or poorly drained soils should be avoided. Sweetpotatoes can be planted on ridges or on flat ground; each method has benefits and drawbacks. Traditionally sweetpotatoes are grown on 8- to 10-inch-tall ridges. Growing sweetpotatoes on ridges improves drainage and root quality, particularly on heavier soils, and allows for substantially easier harvest. The principal drawback to growing sweetpotatoes on ridges is that they will dry out very quickly during the summer. If growers do not have access to irrigation they may want to seriously consider growing sweetpotatoes on very shallow ridges or flat ground.

Although this method will make harvest more difficult, soil moisture will be more available to plants grown on flat ground. In years of drought, Kentucky farm trials have shown that growing sweetpotatoes on tall ridges without access to irrigation can result in significant (up to 30%) losses of yield. On very heavy soils or fields with hard pans, growers will likely have to use ridges to produce sweetpotatoes, regardless of irrigation.

Growers will plow and disk soil to prepare a fine planting bed and then use lister plows or gangs of disks to prepare ridges. When planting sweetpotatoes many growers in Kentucky transplant slips on rows with 42-inch centers. This is a common spacing for tobacco and works very well for sweetpotatoes, allowing growers to use readily available tobacco-type transplanters and cultivation equipment. A 40- to 44-inch row spacing will allow for vines to completely cover row middles about five to six weeks after transplanting, which will improve weed control. Although many growers have successfully planted sweetpotatoes on a narrower 36-inch spacing, mechanical harvesting can be difficult as harvest equipment often has to run over the top of a planted row of sweetpotatoes to harvest the adjacent row. Growers should try to match row spacing to the available equipment to ensure more efficient production. Sweetpotatoes are often successfully transplanted using a finger-type tobacco transplanter or skid-type transplanter. Carousel transplanters are far less effective since sweetpotato slips typically do not weigh enough to fall through the transplanter quickly and often become hung up, resulting in frequent

A two-row disk set up to form raised beds for sweetpotatoes. A spray tank and pump has been added to apply insecticide during bed formation.

Fertilizer requirements.

Soil Test *(lb/A)*		**Fertilizer Required** *(lb/A)*
Phosphorous		**Phosphate** *(P_2O_5)*
Low	<31	180
Medium	31-60	120
High	61-80	60
Very High	>80	0
Potassium		**Potash** *(K_2O)*
Low	<201	275
Medium	201-300	100-250
High	301-450	50-100
Very High	>450	0
Nitrogen		**N**
Apply 50 to 80 lb/A of actual N.		

skips. In-row spacing is very important for sweetpotato production. When growing an aggressive variety such as Beauregard, a closer in-row spacing of 10 inches is used to discourage the production of excessively large roots. A wider in-row spacing of 12 to 14 inches is often used on less aggressive varieties.

Although many producers do not use irrigation, having water available at transplant significantly improves stand establishment. A starter solution, though not necessary, is often preferred. Adding approximately 3 pounds of 10-52-17 or similar to 50 gallons of transplant water is common practice. With adequate water and quality slips, stand survival rates of 95 percent have been achieved in Kentucky.

Irrigation

Studies conducted at the University of Kentucky in Lexington showed that drip irrigation significantly increased yields when growing Beauregard sweetpotatoes on raised beds in dry years. However in typical growing seasons drip irrigation did not increase yields significantly, although slip establishment was improved. On-farm demonstrations in Kentucky have suggested that yields suffer significantly in dry years when sweetpotatoes are grown without irrigation, particularly when grown on sandy soils. Growers must calculate the risk of yield loss in a dry season versus the cost of irrigation; however, for the greatest chance of success on a large scale, we recommend that growers have access to some form of irrigation in case of persistent drought and to improve stand establishment after transplant. Irrigation of sweetpotatoes need not be as frequent as for other vegetable crops, such as tomatoes, but is helpful during bulking stages. Growers should be aware that many older varieties may be prone to splitting and cracking when excessive irrigation is applied.

Number of slips per acre*.

Row spacing *(in)*	Within-row spacing *(in)*		
	10	12	14
36	17,420	14,520	12,450
40	15,840	13,200	11,310
42	14,940	12,450	10,670
44	14,280	11,900	10,200
48	13,180	10,890	9,330

**Assuming completely planted acre with no drive rows.*

Drip irrigation, though efficient, is fairly expensive to install and requires clean, filtered water. A well-managed drip irrigation system can be 95 percent efficient in putting water where it is available to plants; overhead systems may only be 70 percent efficient. If sweeetpotatoes are to be part of a mixed vegetable production system where drip irrigation is already being employed, it would make economic sense to use drip irrigation. When growing only sweetpotatoes, producers may consider using overhead irrigation. Growers have effectively used traveling-gun irrigation systems for sweetpotato production in Kentucky. Traveling guns are cost-effective and require less maintenance than a typical drip irrigation system.

Plasticulture

Plastic mulches are widely used for vegetable crop production in Kentucky. They generally improve yields, particularly of warm-season crops, by reducing in-row weed pressure, improving water retention and warming soils in the spring. However, with a few exceptions, plastic mulches have not proven to be a particularly suitable option for growing sweetpotatoes. Generally plastic-mulch layers and bed shapers require wider row spacing than traditional bare-ground production. This wide row spacing reduces the number of plants per acre and subsequently can reduce yields. Typically, raised beds with black plastic mulches are formed on 6-foot

Removing plastic mulch with a mulch lifter prior to digging sweetpotatoes. The sweetpotato vines make plastic mulch removal difficult.


A tobacco finger-type transplanter.


Splitting in a sweetpotato grown under excessive irrigation.

Gangs of rolling cultivators used to cultivate sweetpotato beds.

centers. This results in approximately 7,200 row-feet per acre. Bare-ground production, when using 42-inch row spacing, results in over 12,400 row-feet per acre. Results from research conducted at the University of Kentucky comparing single- and double-row plantings on black plastic mulches showed a 26 percent increase in yields when going from a single- to double-row planting, despite requiring twice as many slips per row. One of the biggest issues with growing sweetpotatoes—particularly Beauregard—on plastic mulch is that they tend to get too large, given the growing conditions and additional growing space the plastic mulch system affords. Plastic mulches also increase the difficulty of harvest. Plants must be mowed completely and mulch removed prior to using mechanized harvesters. The additional step of removing the mulch can add significant labor costs for larger plantings.

Despite drawbacks, plastic mulches at times have proven effective for sweetpotato production. Plastic mulches have been successfully used for organic sweetpotato production, providing excellent in-row weed control. In addition, many small-scale growers who dig sweetpotatoes by hand prefer the ease of digging in the non-compacted soils under plastic mulches.

Weed management

Sweetpotatoes are an aggressive crop that can quickly form a canopy, shading out weeds. Most successful weed management programs combine timely mechanical cultivation and/or herbicide applications. The number of herbicides for sweetpotato production in Kentucky is limited, and most have fairly lengthy pre-harvest intervals. Some growers have successfully produced quality sweetpotatoes relying solely on mechanical cultivation.

Typically three cultivations are required for weed control in sweetpotatoes. For best results, mechanical cultivation should be combined with stale seed-bedding techniques prior to planting. Because sweetpotatoes are often transplanted in early June in Kentucky, there is sufficient time to stale seed-bed fields prior to planting. Cultivations should begin within 10

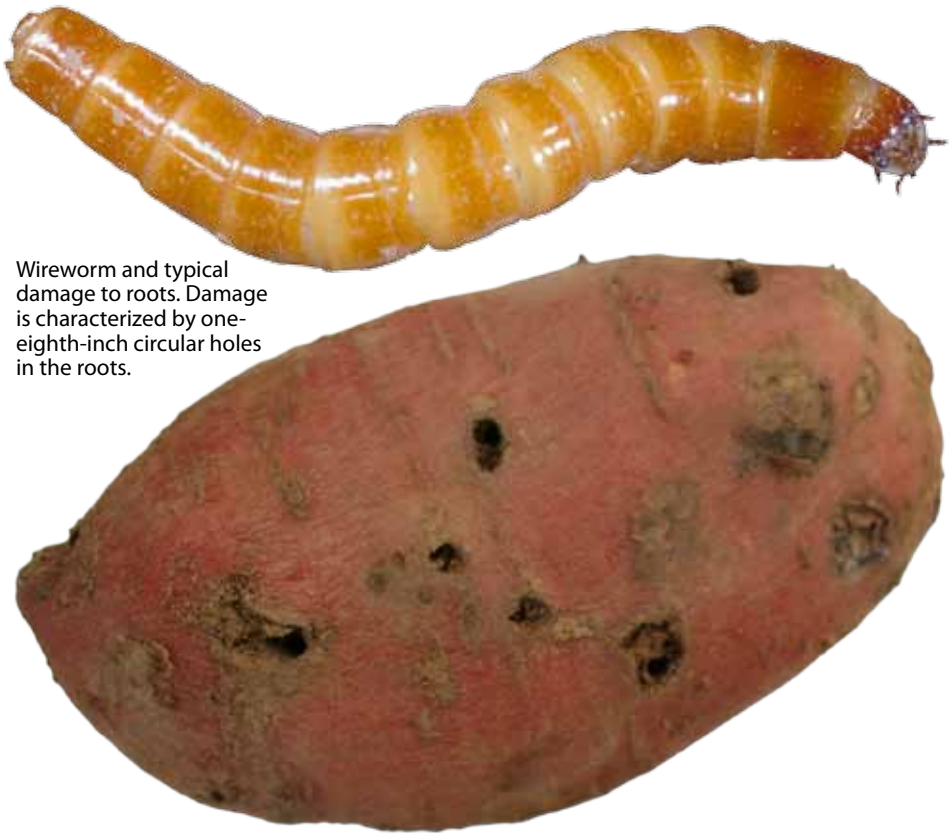
Chemical weed control in sweetpotato.

Product *(amount/A)*	**Active ingredient** *(lb/A)*	**Comments**
Preplant or preemergent		
Roundup WeatherMax 16-22 fl oz	glyphosate-salt 0.69-0.94	For non-selective post-emergence control of annual and perennial grasses and broadleaf weeds. Use only AMS 1-2% v/v. Adding a non-ionic surfactant can reduce weed control effectiveness.
Valor 2-3 oz	flumioxazin 0.062-0.094	Apply 2-5 days prior to transplanting for preemergent control of sedges, annual grasses and broadleaf weeds. Do not use on greenhouse-grown transplants or on transplants harvested more than two days prior to transplant. Do not apply post-transplant or serious crop injury may occur. Refer to label when using on varieties other than Beauregard.
Command 3ME 1.3-4 pt	clomazone 0.48-1.5	For pre-plant incorporated pre-emergence control of annual grasses and broadleaf weeds. When using post-transplant apply at a maximum rate of 1.5 pt/A prior to weed emergence. PHI of 95 days or 125 days if more than 3.3 pt/A applied. Weak control of pigweed.
Dacthal W-75 6-14 lb	DCPA 4.5-10.5	For pre-emergence control of annual grasses and small-seeded broadleaves. May be sprayed over transplants. Layby applications can be made up to 6 weeks after transplanting for late season control. Do not use in transplant beds or injury may occur.
Devrinol 50 DF 2-4 lb	napropamide 1-2 lb	Apply to soil surface immediately after transplanting. If rainfall does not occur within 24 hours shallowly incorporate or apply sufficient irrigation to wet the soil 2-4 inches. Transplant production beds. Apply to soil surface after sweetpotato roots are covered but prior to plant emergence.
Postemergence		
Aim 1.9 EW 0.5-1.5 fl oz	carfentrazone ethyl 0.008-0.023	Apply post-directed using shielded sprayers for control of emerged weeds. Will burn crop if contact occurs. Will not control grasses. Good coverage is essential for weed control. Spray when weeds are less than 4 inches tall.
Roundup WeatherMax 16-22 fl oz	glyphosate-salt 0.69-0.94	For non-selective post-emergence control of annual and perennial grasses and broadleaf weeds. Can be applied to row middles using a shielded sprayer or as a wick-application in row middles. Do not allow to come in contact with crop or severe injury may result.
Grasses only		
Select 2EC 6-16 fl oz	clethodim 0.09- 0.24	For selective post-emergence of actively growing annual grasses and suppression of perennial grasses. Add crop oil 1% v/v. Using crop oils at very high temperatures may increase risk of crop injury. PHI = 30 days.
Fusilade-DX 2E 6-16 fl oz	fluazifop-p 0.1-0.25	For selective post-emergence control of annual grasses and suppression of perennial grasses. Include 1% v/v crop oil or 0.25% v/v non-ionic surfactant/A. Do not apply on days that are unusually hot or humid. PHI = 55 days.

days after planting and continue until plants are beginning to cover the areas between beds. The final cultivation may result in cutting the tips of vines, which usually is not a problem. On fields with very high weed seed banks mechanical cultivation may not be sufficient to reduce weeds within rows.

Insect management

Soil-borne insect pests are the most important insect pests of sweetpotatoes in Kentucky. Wireworms and grubs can be challenging to control as they can attack over an extended period of time. Although economic wireworm damage to field crops is rare, when they are a problem they can be very destructive and difficult to control. However, with sweetpotatoes, economic damage by wireworms can be common in some areas and may result in more than 40 percent damaged roots. Wireworms can be found in soils following any type of rotation, but they are usually more severe when crops follow established sod, or the second year following sod. Wireworms feed upon the small roots of sweetpotatoes throughout the season. Most wireworm larvae are hard, chestnut brown, smooth, varying from 0.5 to 1.5 inches in length when grown. Some species are soft and white or yellowish in color. Most wireworms have lifecycles that last two or more years, so recent history of wireworms in a field often indicates increased risk. Wireworms usually are managed with soil insecticides applied pre-planting and incorporated at planting and/or during cultivation.



Wireworm and typical damage to roots. Damage is characterized by one-eighth-inch circular holes in the roots.

Insect control.

Insect/Insecticide		Product Amt/A	PHI *(days)*	Comments and Seasonal Limits
Soil Application				
Wireworms	Belay 2.13 SC	6-12 fl oz	14	Limit 12 fl oz of total use/A. At planting or at cultivation.
	Brigade 2 EC	3.2-9.6 fl oz	21	At cultivation.
	Brigade 2 EC	9.6-19.2 fl oz	21	Preplant only.
	Lorsban 15 G	13.5 lb	125	Limit 1 application. Pre-plant incorporated.
	Lorsban 4 E	4 pt	125	Limit 1 application. Pre-plant incorporated.
Foliar Application				
Flea Beetles, Tortoise Beetles	Baythroid XL	1.6-2.8 fl oz	0	Limit 2.8 fl oz per 5-day interval. Limit 16.8 fl oz/A. For flea beetles.
	Brigade 2 EC	2.1-6.4 fl oz	21	Limit 32 fl oz of total use/A.
	Endosulfan 3 EC	0.67 qt	1	Limit 3 applications.
	Mustang Max	1.76-4 fl oz	1	Limit 24 fl oz/A. Allow 4 days between applications.
	Sevin XLR	1-2 lb	7	Limit 8 applications. Allow 7 days between sprays.
Leafhoppers	Actara 25 WDG	1.5 oz	14	Limit 3 oz/A. Allow 7 days between applications.
	Baythroid XL	0.8-1.6 fl oz	0	Limit 2.8 fl oz per 5-day interval. Limit 16.8 fl oz/A.
	Malathion 8	1-1.75 pt	3	
	Mustang Max	1.76-4 fl oz	1	Limit 24 fl oz/A. Allow 4 days between applications.
	Provado 1.6 F	3.5 fl oz	7	Limit 10.5 fl oz/A. Allow 7 days between applications.
Sweetpotato Weevil	Sevin XLR			Prior to planting, dip cuttings in suspension of Sevin XLR at a rate of 2.6 fl oz/gal water.
	Baythroid XL	1.6 to 2.8 fl oz	0	Limit 2.8 fl oz per 5-day interval. Limit 16.8 fl oz/A.

As with wireworms, white grubs are soil insects that attack the developing roots. White grubs are the larval stage of May and June beetles. Wireworms produce small holes in the roots; white grub damage results in large feeding sites of half an inch to more than an inch in diameter. White grub numbers in the soil are influenced by past rotations, proximity to wooded areas and levels of organic matter in the soil. Fields previously in sod or with high organic matter are more likely to have high grub numbers. Control of grubs in sweetpotatoes is through the use of soil-applied insecticides before or during planting.

A few insects feed in the foliage of sweetpotatoes, but economic infestations, while they do occur, are not common. Tortoise beetles chew round holes in the leaves and may be found on the undersides of the leaves. Spotted cucumber beetles may also feed on vines and leaves. These insects are controlled with foliar insecticides on an as-needed basis.

Disease Management

Purchase either certified transplants or produce your own plants. Start with certified, disease-free roots planted in a commercial growing mix or in new sand for best results. If these disease-management practices are not possible, consider the following measures: Sanitize beds or greenhouses; if bedding material is reused or if soil is used, work up the material to a depth of 8 to 10 inches and steam-sterilize (180°F for 30 minutes) or fumigate. Fumigants for this use include chloropicrin and metam-sodium applied as a drench or injected.

Before bedding, dip "seed" roots for two minutes into a solution of Mertect 340F or Botran 75W and plant immediately.

Scurf appears as grey-black patches on the skin of sweetpotatoes.

Disease control.

Product	Amt/A	Seasonal limits/A	Comments
Damping-off *(Pythium)*			
Ridomil Gold SL	1 to 2 pt	1 app	Apply to soil as a broadcast spray or in a 7-inch band; incorporate into the upper 2 in of soil mechanically (pre-plant) or with irrigation (pre- and at-planting) if rainfall is not expected within 24 hours of treatment.
Ultra Flourish	2 to 4 pt		
MetaStar 2EC AG	4 to 8 pt		
Leaf diseases			
Quadris*	6 to 15.5 fl oz	4 apps	Apply before disease onset, continue on a 7- to 14-day schedule. User higher rates when pressure is severe
Evito 480 SC8	3.8 fl oz	6 apps	Apply before disease onset, continue on a 7- to 10-day schedule.
Headline*	6 to 9 fl oz	2 apps	Apply before disease onset, continue on a 7- to 14-day schedule as needed. User higher rates when pressure is severe.
Reason*	5.5 to 8.2 fl oz	16.4 fl oz	Apply before disease onset, continue on a 5- to 10-day schedule.
Scala	7 fl oz	35 fl oz	Apply before disease onset, continue on a 7- to 14-day schedule.
Scurf, black rot, Sclerotinia blight, post-harvest rot			
Botran 75 W	2 lb/15 gal water	1 app	Seed dip. For control of scurf, dip seed in solution for 10-15 seconds; plant immediately. Discard unused solution daily.
	3 to 3.75 lb/1,000 sq ft		Plant bed application. For control of Sclerotinia blight, spray or sprinkle solution over bedded seed before covering.
	0.5 to 1 lb/100 gal water		Post-harvest dip. Dip harvested tubers in solution, or spray; do not rinse after treatment. Use low rate for dip. For suppression of rhizopus rot.
Maxim 4 FS	0.08 to 0.16 oz/cwt	1 app	Dip seed pieces in a water-based slurry; spread and allow to dry.
Mertect 340 F	3.3 qt/100 gal water	1 app	Dip seed pieces in solution 1-2 minutes; plant immediately. Discard solution when it becomes dirty or volume becomes too low to treat.
Scholar SC	16 to 32 fl oz/100 gal	1 app	Use as a post-harvest dip and low volume application. Dip for approximately 30 seconds and allow root to drain. Add 8 fl oz of Scholar SC to 100 gal treating suspension after 500 bushels are treated. After each 1,000 bushels treated, drain and flush the tank and refill with a fresh dip suspension.

* *Do not make back-to-back applications or rotate with fungicides with the same mode of action (FRAC Group 11). Fungicides with the same group number have the same mode of action. Do not tank-mix products with the same group number, and rotate among fungicides with different group numbers to discourage resistance development.*

Pesticide safety.

	Signal[1]	Re-entry *(hrs)*	Harvest *(days)*[2]
Insecticides			
Actara 25 WDG	C	12	14
Admire Pro	C	12	125
Assail 30 SG	C	12	7
Avaunt 30 DG	C	12	14
Belay 2.13 SC	C	12	14
Endosulfan 3 EC	DP	24	1
Fulfill 50 DF	C	12	14
Intrepid 2 F	C	4	7
Lorsban 4 E	W	24	125
Lorsban 15 G	C	12	125
Lorsban 75 WP	W	48	125
Malathion 8	W	12	3
Movento 2	C	24	7
Oberon 2 SC	C	12	7
Platinum 2 F	C	12	AP
Provado 1.6 F	C	12	7
Rimon 0.83 EC	W	12	14
Sevin XLR	W	12	7
RESTRICTED USE			
Baythroid XL	W	12	0
Brigade 2 EC	W	12	21
Brigadier 2	W	12	21
Decis 1.5 EC	DP	12	3
Leverage 2.7	W	12	7
Mustang Max	W	12	1
Renounce 20 WP	C	12	0
Vydate L	DP	48	AP
Fungicides			
Quadris[3]	C	4	14
Botran 75 W	C	12	0
Evito 480 SC	C	12	7
Headline	W	12	3
Maxim 4 FS	C	0	0
Mertect 340 F	C	12	0
Meta Star 2EC AG	W	48	0
Reason 500 SC	C	12	14
Ridomil Gold EC/SL	C	48	0
Scala SC	C	12	17
Scholar SC	C	0	0
Ultra Flourish	W	48	0

[1] W: Warning, C: Caution, D: Danger; P: Poison
[2] AP: At planting.
[3] Several formulations are marketed.

A severely damaged root due to careless harvest and handling.

See tables for rates, and use directions. Soil or media temperatures in the beds should be maintained at around 80°F to encourage rapid plant growth and reduce rotting. Using sprouts cut above the soil line aids in reducing certain transplant-borne diseases.

Black rot, Sclerotinia blight, and scurf. Removing slips above the soil line and re-rooting will adequately control scurf but not black rot. Use crop rotations of three to four years away from sweetpotatoes. Carefully handle roots during harvest to avoid bruising. Follow all harvesting and post-harvest handling guidelines, including proper curing, to reduce the incidence of the post-harvest phases of these diseases.

Fusarium wilt. Use resistant varieties and only nitrate forms of nitrogen on problem fields. High soil pH will improve control of Fusarium wilt but will also favor soil pox. Rotation for three years away from sweetpotatoes is also helpful. Use certified, disease-free seed roots and transplants. Sweetpotatoes and tobacco are thought to be susceptible to the same strains of *Fusarium*, so avoid growing them in rotation. If they must be grown in rotation, use Fusarium wilt-resistant varieties for both crops and control nematodes if present.

Nematodes. Use rotation for two or more years to tall fescue. Pre-plant fumigant materials are options, although these are expensive and require specialized training and equipment for proper application. Most growers will find it more cost-effective to use crop rotation as a tool to manage nematodes. For more information on soil fumigants, refer to *Vegetable Production Guide for Commercial Growers* (ID-36) or contact your local cooperative extension office.

Pox. To prevent pathogen buildup, practice crop rotation as recommended for black rot and maintain acid soils (below pH 5.5) for fields routinely used for sweetpotatoes. Use disease-free roots and transplants. Soil fumigation may be necessary for serious cases—see Nematodes in this section for information on fumigants.

Harvesting

Proper care while harvesting can make a significant difference in marketable yields and returns for growers. An estimated 20 to 25 percent of the sweetpotato crop in the United States is lost during harvest, curing, and storage operations. Sweetpotatoes have a very delicate skin that is easily damaged during harvest operations (Edmunds et al. 2008). Avoid irrigating immediately prior to harvest. Allowing soil and plants to dry slightly prior to digging promotes a more durable skin. Sweetpotatoes can be dug by hand or with traditional potato plows, chain diggers, or sweetpotato flip-plows. Regardless of harvest method, on-farm demonstration projects in Kentucky suggest that harvest efficiencies are improved when using raised bed production. Although not necessary, mowing sweetpotato vines prior to digging improves ease of harvest.

Many growers who are only producing a few hundred pounds of sweetpotatoes for market sales prefer to dig by hand. This practice certainly is acceptable and if done carefully can result in less damage to

A sweetpotato chain digger with packing station (top left). A blade on the front of the device lifts roots on the chain where they are pulled from the ground to be separated and packed (top right). A sweetpotato flip plow (bottom left). Roots left on top of the soil from the plow (bottom right).

roots than mechanical methods. However, other harvest methods must be used for larger plantings.

Some growers have successfully used potato plows to harvest sweetpotato roots. Although single-row potato plows are inexpensive and easy to locate, harvesting roots this way often leads to significant damage to the skin, which can lead to storage losses. Other harvesting methods include using chain diggers. Chain diggers are typically PTO-driven harvesters that will either pull roots up to a packing station on the digger or let them fall back to the ground to be picked up by a harvest crew. Care must be taken to match ground speed with PTO speed so that roots are not skinned while being harvested. Vines should be cut prior to harvesting with a chain digger to prevent them catching on the chain apparatus and causing the roots to hang up and be skinned by the chain. Rubber or plastic guards over the metal chain will prevent damage.

Specially designed flip-plows are also used for sweetpotato harvest. These plows can be made to fit a variety of production styles, though are usually made to harvest two or four rows at a time. These plows are essentially large disks that move through the soil flipping the sweetpotatoes out of the ground to be picked up by a harvest crew for packing. A single flat disk is also attached to the plow to prevent the tractor/harvester from being pulled off the row. If used correctly these plows will result in little damage to the roots. However, rows must be straight to avoid cutting and damaging large numbers of roots. Whichever harvest method is utilized, be sure to match row spacing to the harvest implement prior to planting.

After roots are dug they should be picked up and moved from the field to prevent sunscald. Care should be taken with roots at this time. The skin of uncured roots is very fragile. Throwing roots into harvest bins or walking on roots will damage them, leaving them susceptible to disease during storage. Harvest bins typically will hold 20 bushels of sweetpotatoes, though typically are only filled with 18 to 19 bushels to prevent crushing. Pallet bins can either be made of wood or plastic. Plastic bins have advantages; they can be cleaned and sterilized easily after use and tend to last longer than wood bins. However, wood bins are typically cheaper and can be constructed locally. A typical bin dimension is 42 x 48 inches with a height of 35 inches (including the pallet base for forks).

If fall harvesting is delayed, roots may be susceptible to frost injury during harvest. If there is danger of a frost, sweetpotatoes are best left in the ground where the

ambient soil temperature should protect them. Harvests should resume as soon as possible after frosts since the vines will have been killed. In addition, note that sweetpotato roots experience chilling injury when exposed to temperatures below 50°F. Therefore, even when frost is not expected, sweetpotatoes can be injured by cool night temperatures if left in the field. Chilling injury may take several weeks before it is noticed on roots but can lead to serious losses in storage.

Grading.

USDA grade	Size specifications *(in)*		Comments
	Diameter	Length	
U.S. Extra No. 1	1.75-3.25	3-9	All grades must be free from physical damage, insect damage, sprouting, freeze damage, wet rots, diseases and must be firm and of fairly good shape. Tolerances for the percentage of roots that fail to meet specifications vary between grades.
U.S. No. 11	1.75-3.5	3-9	
U.S. No. 1 Petite	1.5-2.25	3-7	
U.S. Commercial	1.75-3.5	3-9	
U.S. No. 22	>1.5		

[1] Can weigh no more than 20 oz
[2] Can weigh no more than 36 oz

Source: *Adapted from* United States Standards for Grades of Sweetpotatoes, *effective April 21, 2005. The complete standards can be found at: http://www.ams.usda.gov/AMSv1.0/getfile?dDocName=STELPRDC5050330. Producers are encouraged to read the complete grading guidelines.*

Curing

When subjected to ideal curing and storage conditions, sweetpotatoes can be stored for 6 months or more with minimal losses; however, significant losses routinely occur for sweetpotatoes in Kentucky. This loss may be the result of damage incurred while roots are dug, improper curing, or a lack of adequate storage facilities. Curing is one of the simplest practices growers can perform to improve the storage life and quality of sweetpotato roots and it enhances flavor by increasing sugars while decreasing starch in sweetpotatoes. Curing greatly improves storage life by drying the outside of roots thereby strengthening the fragile skin. Selling roots shortly after harvest without first curing them is discouraged. Ideal curing conditions for sweetpotatoes are 85°F with 85 to 90 percent relative humidity for 3 to 5 days. Proper curing facilities should also allow for adequate ventilation.

Roots are picked from the field and cured prior to washing and removing soil. When soil that may be tightly adhered to roots is removed prior to curing damage may be incurred. Instead, sweetpotatoes should be cured shortly (within 12 hours) after harvest, then stored or washed and packaged for sale.

To successfully store and market large acreages of sweetpotatoes, a dedicated curing and storage facility should be planned. However, most growers will not have the resources or the need to build such a facility. An area of a barn or covered structure can be converted to a temporary curing facility. Bins or boxes can be stacked with 4 to 6 inches between stacks to allow for air circulation. The area should be heated so that the sweetpotatoes in the boxes actually reach 85°F for 3 to 5 days. Humidity can be increased by adding a humidifier, though often the release of water from curing roots will increase humidity somewhat. An inexpensive hygrometer can be purchased to monitor humidity. Do not exceed the recommended curing period as significant weight loss can result from extended exposure to high temperatures. After curing, place roots in cool storage of 55 to 60°F and 85 percent relative humidity. Remove roots from storage as necessary to wash and pack.

For smaller quantities of sweetpotatoes a variation of field curing that is often used in the tropics has been successfully attempted by some growers in Kentucky. A high tunnel or similar type structure can be used where temperatures in the fall are elevated but not in excess of 85 to 90°F. Then boards or straw can be placed on the ground and sweetpotato roots stacked in a pile and covered with straw (6 to 10 inches) and burlap (not plastic). The straw will trap heat and moisture from the roots yet still allow some ventilation. After 4 to 5 days the straw can be removed and roots put in storage. On-farm trials of this type of curing have shown that roots should be placed on or close to the ground to better trap heat. Placing roots on a wagon subjects them to temperature fluctuations that do not allow for proper curing. Growers should avoid wet areas and be aware of rodents that may be attracted to roots.

Storage

Sweetpotatoes should be stored at 85 to 90 percent relative humidity and 55°F. Care must be taken to avoid chilling injury by keeping temperatures above 50°F. Often sweetpotatoes subjected to chilling injury will not show symptoms until 2 to 3 weeks after the initial injury. During winter months it is important to have heating capabilities for storage facilities so that temperatures do not drop below 50°F, damaging the crop. After curing, sweetpotatoes should go into storage and be graded and washed prior to packing.

Grading

Grading typically follows USDA guidelines unless otherwise specified by the purchaser. Although there are five specific grades, most wholesale buyers in Kentucky have typically chosen to purchase U.S. No. 1. Specially designed dunk tanks are used for large pallet-size bins. Typically a high-volume water spray is used to initially clean roots and then roots are sorted according to size and graded. Roots can then be sprayed or dunked to apply fungicides. Internal damage can result to sweetpotatoes dropped more than a few inches. Packing lines should have padding on metal surfaces to prevent damage.

Packing

Sweetpotatoes are typically packed in 40-pound boxes. A traditional bushel of sweetpotatoes weighs either 55 or 50 pounds, depending if they are green (fresh) or dry (cured). When selling sweetpotatoes on a wholesale market, be sure to clarify what unit of measurement is expected. Other packaging options include polyethylene bags or shrink-wrapped individual packages. Market growers often sell sweetpotatoes loose, either individually or by the pound.

Although prices tend to rise after the typical harvest season, growers must determine the cost of running a storage facility and potential losses to disease and abiotic disorders during storage.

Storage Diseases

Harvest and handling conditions greatly influence susceptibility to post-harvest decays. A common disease of storage is Rhizopus soft rot caused by the fungus *Rhizopus stolonifer.* This disease appears as a "hairy" fungal rot and typically invades sweetpotatoes through wounds caused at harvest or during the curing process. Follow proper curing protocols to ensure adequate wound healing. Store only blemish-free roots; discard damaged or rotted roots. Botran 75 WP at 1 pound per 100 gallons is labeled as a post-harvest dip or spray (after cleaning roots but before packing) to control these rots (see tables for specific information). Calcium hypochlorite 65 percent at 10 oz per 100 gallons is also labeled as a post-harvest spray for general sanitation.

Marketing

Sweetpotatoes have steadily grown in popularity in the U.S. Consumption has grown steadily to its recent peak of 5.2 pounds per capita annually. The market for sweetpotatoes remains strong for product produced and sold locally for retail prices. When selling smaller quantities, generally prices per pound increase significantly. Farm market prices have run around $0.75 to $1.00 per pound. Surveys of Kentucky and Ohio consumers have shown greater willingness to pay for local sweetpotatoes, especially when nutrition information is provided. Older consumers consume more sweetpotatoes than younger consumers, although younger consumers showed stronger interest in value-added products such as sweetpotato fries and chips. Some consumers show particular interest in white and purple varieties, especially in farmers markets. Consumer interest in organic sweetpotatoes is also fairly strong, although production costs need to be weighed carefully against any price premiums.

A handful of growers are successfully producing for the wholesale market. The prices are lower than for direct markets, typically around $0.20 to $0.25 per pound, but involve much larger volumes. North Carolina produces almost half the acreage of sweetpotatoes in the U.S. Weather and production outcomes there have a significant bearing on wholesale market opportunities for Kentucky. Exports have grown slightly in recent years, but the vast amount of production in the U.S. is consumed in the domestic market.

A number of producers also sell sweetpotatoes at produce auctions located throughout the state. Prices can be variable when selling at the auctions, although they have generally run about 10 percent above general wholesale prices. Growers who obtain the best prices at auctions have established relationships during the course of one or more growing seasons and routinely bring products to the auction. Those who do not carefully grade their sweetpotatoes or only bring a large load of product one or two times during the season may not see good prices. Demand for different types of sweetpotatoes

Bacterial root rot (left) can cause losses during storage.
Rhizopus soft rot (right) on a sweetpotato root.

varies across Kentucky. White-fleshed sweetpotatoes are generally most popular in Eastern Kentucky and seldom grown in the Western portion of the Commonwealth.

A number of active regional and national trade associations continue to support generic promotion and the development of value-added products, including the North Carolina Sweet Potato Commission and the Louisiana Sweet Potato Commission. These associations make much of their product and marketing material openly available.

Budgets

Enterprise budgets for sweetpotatoes have been prepared for Kentucky, assuming typical yields, markets, drip irrigation and input rates. Revenues and costs are summarized in the budget below.

Growers are encouraged to use this framework to estimate their own returns, breakeven costs, and sensitivity of returns to changing prices or other variables. Returns to land, capital and management under fairly pessimistic market/input cost conditions would be around $740 per acre; a conservative measure of around $2,895, and an optimistic scenario of $3,775.

Other financial decisions that could impact profitability would relate to the scale of operation. Larger growers can capture scale economies associated with growing their own slips, buying input costs in bulk and setting up curing facilities on site in an effort to manage costs and market opportunities.

Kentucky estimated per–acre costs and returns for 2011 for fresh market, irrigated sweetpotatoes.

	Quantity	Unit	$/Unit	Total
GROSS RETURNS				
U.S. No. 1	275	box	$ 20.00	$ 5,500.00
U.S. No. 2	150	box	$ 12.00	$ 1,800.00
TOTAL	425	box		**$ 7,300.00**
VARIABLE COSTS				
Preharvest				
Lime	0.5	ton	$ 20.00	$ 10.00
Fertilizer: Starter			$ -	$ -
Spread		lb	$ -	$ 200.00
Plants	13	thousand	$ 50.00	$ 650.00
Transplant labor	10	hr	$ 9.00	$ 90.00
Herbicides	1	A	$ 75.00	$ 75.00
Pesticides	1	A	$ 125.00	$ 125.00
Drip lines	1	A	$ 382.00	$ 382.00
Machinery	1	A	$ 71.48	$ 71.48
Total pre-harvest costs				$ 1,603.48
Harvesting/marketing				
Machinery	1	A		$ 28.27
Boxes	425	box	$ 1.00	$ 425.00
Hired labor: Harvest	40	hr	$ 9.00	$ 360.00
Sorting/grading/packing	425	box	$ 1.00	$ 425.00
Marketing costs (10% of gross)	10.0%	gross		$ 730.00
Total harvesting/marketing costs				$ 1,968.27
Interest on variable costs				$ 116.44
TOTAL VARIABLE COSTS				**$ 3,688.20**
RETURN ABOVE VARIABLE COSTS				**$ 3,611.80**
FIXED COSTS				
Machinery and equipment				$ 100.19
Depreciation on irrigation system				$ 200.00
Taxes on land				$ 5.00
Insurance				$ 36.50
TOTAL FIXED COSTS				**$ 341.69**
TOTAL EXPENSES				**$ 4,029.89**
Return to operator labor, land, capital, and management				$ 3,270.11
Operator and unpaid family labor	25	hr	$ 15.00	$ 375.00
RETURN TO LAND, CAPITAL AND MANAGEMENT				**$ 2,895.11**

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