Sweetpotato Production Guides for Hawaii

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Sweetpotato, Ipomoea batatas, a member of the morning glory family, originated in South Mexico and Central America, and is now the seventh most important food crop, world-wide. Sweetpotatoes, along with taro, were the major staples for the early Hawaiians since 500 BC. Commercial cultivation in the islands began in 1849. In 1919 sweetpotatoes were considered 10th in value among agricultural crops in Hawaii when grown as an emergency crop during the war years. By 1948, the farm-gate value for sweetpotatoes was $100,000. The sweetpotato is grown for its enlarged roots which can be boiled, baked or fried, or processed into chips. The stems and tips may also be boiled or fried for use in soups or salads. Both roots and foliage can also be grown as feed. The 1991 farm-gate value for sweetpotatoes in Hawaii was about $600,000, and is presently planted and harvested year-round throughout the state, with production acreage primarily in Molokai. Sweetpotato has a wide adaptability to Hawaii's environments and has a high content of vitamins beta carotene and ascorbic acid. In addition, the young leaves, common in some oriental and Filipino dishes, have a 25-33% protein content on a dry weight basis.

Climate

Short days promote fleshy root development and flowering, while long days promote top growth. The optimum soil temperature range for fleshy root development is 70-80F (21-28C). Optimum growing temperatures for top growth are >77F (>25C), but it can be grown at altitudes of up to 2,000 ft. The sweetpotato is considered to be drought tolerant, but the first 40 days after planting are the most sensitive to deficits in irrigation. Sweetpotato yields in sandy loam soils with 25% moisture content will generally be similar or greater than yields in soils with 40, 60, and 80% moisture content. Most cultivars are susceptible to waterlogging and to water tables <1.5 ft (<0.5 m). The sweetpotato tolerates ranges of 20-50

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inches (500-1300 mm) in rainfall per growth cycle with optimum levels at 35-50 inches (900-1330 mm).

Cultivars

Two types of sweetpotatoes are grown in Hawaii. The dry-fleshed with white to pale yellow or purple skin type is locally referred to as "sweetpotato." The second type, locally referred to as "yam", is moist-fleshed with orange flesh and used for baking. Hawaii's population prefer the drier and firmer varieties of sweetpotatoes. Sweetpotato is in fact one word, and should not be confused with the Irish or Peruvian potato (Solanum tuberosum), nor with the true "yam" (Dioscorea sp.). Dozens of clones are native to Hawaii. Improved selections of many of these clones are still grown commercially or in home-gardens throughout the state. Cultivar selection should be based on market demand, yields, and resistance to pests and diseases. Sweetpotato cultivars grown commercially in Kauai include lines 'UH 78-12' and 'UH 71-7'. Current cultivars recommended for local commercial production include:

Moist (baking) types:

1. Hoolehua Gold- reddish skin with orange flesh.
2. Kona B- High yielding cultivar. Light red to orangish skin with light orange flesh.
3. Iliua- orange flesh.

Dry (boiling, frying) types:

1. Waimanalo Red- Early maturing variety and high yielding. Red skin with white flesh. This cultivar was introduced from Okinawa.
2. Hoolehua Red- red skin with white flesh.
3. Rapoza- whitish skin with purple flesh.
3. Onokeo- Purple skin, white flesh, excellent quality.
4. Miyashiro-

Semi-dry type:

1. 71-5- light red skin with yellow-orange flesh.

Cultivars from the Continental U.S.: Standard commercial cultivars developed in the Continental U.S. (moist type, with orange flesh) may

perform well when grown in Hawaii but take too long to mature (about 7 months) compared to local cultivars (about 5 months). Until recently 'Jewel', developed by the North Carolina Experiment station in 1970, was the standard cultivar representing 75-85% of sweetpotato production in the Continental U.S., especially in areas with sandy-loams. 'Jewel' is resistant to rootknot nematodes, fusarium wilt, and tolerates sweet potato fleabeetles, and internal cork. The Louisiana Experiment Station introduced 'Beauregard' in 1988 and is rapidly overtaking 'Jewel' in several production areas as the industry standard. 'Beauregard' is high yielding and matures a month earlier than 'Jewel' but is not nematode resistant, and in addition, does not store as well as 'Jewel'. `Satsuma' is a popular Asian variety, in demand by Asian and Polynesian consumers in the continental U.S.

Source of materials for local cultivars:
Local growers; College of Tropical Agriculture and Human Resources; County Extension Agents.

FERTILIZER RECOMMENDATIONS

Soil Type
Preferred soils are sandy loams, leveled or slightly sloped, moderately fertile and well drained. Poorly drained, heavy soils with clay will result in irregularly sized and shaped fleshy roots. Soils high in organic matter may result in rough, cracked, jumbo-sized roots. Avoid soils contaminated with diseases, nematodes or sweetpotato weevils. Three-year rotations are recommended to reduce damage from scurf and fusarium wilt. Optimum soil pH range is 5.5-6.8. Sweetpotatoes are sensitive to alkaline and saline soils. Cultivar selection may vary depending on soil type where the crop will be grown.

Nutrient Uptake
Sweetpotato plants yielding 15-20,000 lbs/Acre accumulate on foliage and roots an estimated 50-80 lbs N, 20-30 lbs P, 80-100 lbs K, 4 lbs magnesium, 5 lbs calcium, and 0.8 lb iron. Sweetpotato has a high

requirement for potassium. Potassium uptake is dependent on the soil availability of magnesium for attainment of high marketable yields.

Fertilizer rates and placement

Fertilizer applications should be made to complement the nutrient content already available in the soil. To assess the soil fertility status for sweetpotato production rely on soil tests prior to planting. Soil samples should be taken and appropriate fertilizers added as recommended by University of Hawaii soil scientists for that particular soil type. Applications which are made above levels required by plants may result in excessive foliage growth at the expense of root growth, nutrient leaching into aquifers, and in undesirable accumulation of salts in the soil root zone. Sweet potato is a crop that requires not only nitrogen and phosphorus but especially adequate potassium for optimum root growth. High nitrogen will cause excessive vine growth at the expense of root yields and may result in root cracking. Planting on recently manured soils should be avoided because it renders the tubers to become more susceptible to scurf infection. Estimated fertilizer recommendations for sweetpotatoes are 50-100 lbs/A nitrogen; 100-600 lbs/A of phosphorus (P_2O_5); and 100-150 lbs/Ac of potassium (K_2O). The following fertilizer applications are recommended for Hawaii based on soil test results:

1) Soil pH is below 5.0 and/or soil calcium content is below 1,000 lbs/Ac:

At 4-8 weeks before planting apply 2,000 lbs/Ac of agricultural lime on soils with adequate moisture. Incorporate to a depth of 6 inches with a disk or rototiller.

2) Moderate phosphorus and potassium soil levels:

650 lbs/Ac of 10-10-10 plus 130 lbs/Acre of 0-0-61 (murate of potash) fertilizer. Half is applied at planting and half is sidedressed 5 weeks later before rehilling.

3) Low phosphorus soil level (consult with your local county agent to determine the phosphorus fixing rates typical in your area, the higher the soil phosphorus fixing rate, the higher the phosphorus fertilizer requirement):

1,000 lbs/Ac of 0-47-0 pre-plant broadcasted in 12 inch bands in the plant rows and incorporated into the soil at a depth of 8-12 inches.
4) Sweetpotatoes have relatively low demand for nitrogen (40-50 lbs/Ac). Nitrogen applications of 100 lbs/Ac or more may be required in locations where soil nitrogen levels are low and high yields are expected.

Nutrient Tissue Analysis

Periodic nutrient analyses of foliage tissue may be used to provide an estimate of a crop's nutritional status and serve as a record of crop performance. The tissue analysis should be calibrated with soil fertility levels, according to soil samples taken before planting. For tissue analysis collect a recently matured and healthy whole leaf. A representative tissue sample from a field will consist of 25 to 100 collected leaves free from insect or disease attack. Critical tissue nutrient levels have not been clearly established for sweetpotato. Nitrogen tissue contents up to 1.62% will increase the root to top growth ratio. Adequate soluble nutrient levels from sap analysis of sweetpotato petioles are 3,500 ppm NO_3; 2,000 ppm PO_4; and 5% K. Recommended optimum ranges from sweetpotato leaves and petioles are:

Nutrient	Range	Deficiency Level
N	3.2-4.2%	1.5-2.5%
P	0.2-0.6%	0.12%
K	2.9-4.3%	0.75%
Ca	0.75-0.95%	0.2%
Mg	0.40-0.80%	0.16%
S	0.22-0.30%	0.08%
Fe	100-250 ppm	30 ppm
Mn	40-100 ppm	2 ppm

CULTURE AND MANAGEMENT PRACTICES

Soil preparation. To improve drainage, cuttings should be planted on 8-14 inch ridges. Ridge height will depend on soil texture. The soil should

be turned 2-3 months before planting. Early plowing will help rot debris and reduce soil diseases and nematodes.

Planting distance. Plant 4 feet between rows and 10-12 inches between plants in the row.

Planting material. In Hawaii vine terminal cuttings or sprouts from tubers are used for sweetpotato propagation. A spacing of 10 by 48 inches will require 13,068 cuttings per acre while a spacing of 12 by 48 inches will require 10,890 cuttings per acre. Cuttings should be about 12 inches long and should have about 8 nodes per foot. Roots will develop from the buried nodes. All cuttings should be inspected carefully and those contaminated with insects, nematodes or diseases should be discarded.

Planting method. Cuttings of up to 2 days old are placed in the open furrows by hand, and then covered with the use of a single disk behind a tractor. To improve uniformity of harvested roots, cuttings are placed horizontally if sweetpotatoes will be irrigated. In rainfed or limited irrigated conditions lay the cutting on a 45 degree angle. The angled planting will result in larger roots close to the soil surface because the soil area will be more likely moist. Cuttings should be buried at least 4 nodes deep.

Time of planting. The best planting periods in Hawaii are March to May. Lowest yields are expected when sweetpotato is planted from October to December which is attributed to the shorter day-length and to the higher rainfall during that time of the year (Fig. 1).

Hilling. Sweetpotatoes are hilled about 5 weeks after planting with a disk-hiller. A second fertilizer application is conducted just prior to hilling in fields which receive split fertilizer applications. The hilling procedure consists of pulling soil from both sides, increasing ridge height and width by 1-3 inches. Hilling aids in weed control, root enlargement, and in reduced damage caused by the sweetpotato weevil.

Vine turning. The main purpose of vine-turning is to prevent roots from developing in the nodes of the expanding vines which come in contact with the soil. Small-irregular roots may develop if nodes from vines come in contact with the soil surface, draining carbohydrates from the normal roots destined for market. Two to three vine turnings may be necessary several days after irrigation when vine growth is vigorous, especially on moist fertile soils.

Mulches. The use of black plastic mulches in combination with drip irrigation increase both earliness, and total marketable yields compared to bare-ground plants. Efficiency of water and fertilizer use may also be improved with the use of plastic mulches for sweetpotato production.

Irrigation. Sweetpotato yields in Hawaii can be increased by 30% with timely irrigation. Generally, sweetpotatoes require less water than most other vegetables. Irrigate moderately to improve stand establishment soon after planting. Maintain a constant water supply especially beginning with the tuber formation stage at 7-9 weeks after planting. Irrigation is recommended when 40-50% of the field-capacity moisture has been depleted. Stop irrigation about a month before harvest.

Rotations. Sweetpotatoes should be raised in the same field only once every three- or four-years to reduce the incidence of insect and disease outbreaks. Sweetpotato residues may prevent nodulation in nitrogen fixing crops, so this should be taken into account when designing a rotation schedule. Crops traditionally rotated with sweetpotatoes in Hawaii include lettuce, spinach, beets, radish, kai choy, sweet corn, cowpeas, peanuts, beans, sorghum, alfalfa, and pigeon peas. Crops following sweetpotatoes in a rotation scheme should be selected carefully considering sweetpotatoes' allelopathic characteristics.

PESTS

Integrated Pest Management (IPM) consists of timely pesticide applications only after all other economically viable alternative pest controls have been exhausted. Pest control techniques are recommended when not

doing so would result in monetary losses. Control practices are not recommended when the control activity would cost more than no control actions at all. The IPM strategy is based on 1) Pest identification; 2) Understanding of pest life cycles; 3) Periodic pest scouting; 4) Development of a pest control strategy based on a systems approach which includes timely cultural, biological, and chemical controls.

Scouting for sweetpotato pests consists of walking through the field at least on a weekly basis, and looking for pests in the vines or for symptoms of poor plant growth. On a periodic basis also dig roots and inspect them for signs of pest attack. Learn to identify the major pests of sweetpotatoes and to recognize their major damage effects on the plant.

Insects

Foliage and sap feeders attack sweetpotatoes but seldom reduce yields. These include aphids, the sweetpotato whitefly, grasshoppers, red spider mites, and the sweetpotato leaf beetle. Insect pests which most often reduce marketable sweetpotato yields in Hawaii include the sweetpotato weevil, the gulf wireworm, the sweetpotato flea beetle, and the sweetpotato vineborer. Nematodes may also be a serious pest in non-resistant or non-tolerant cultivars. Emphasis of the IPM program will be prophylactic to prevent pest attacks before they appear. Once a pest has been detected, losses are often inevitable.

Sweetpotato weevil

The sweetpotato weevil, Cylas formicarius Elegantus, is the major insect pest in sweetpotatoes both in Hawaii and worldwide. The West Indian sweetpotato weevil, Euscepes postfasciatus (Fairmaire) is also a destructive pest found locally in Hawaii. The adult Cyclas beetle is about 1/2 inch long and resembles a large ant with a slender snout. The head and wing covers are blue-black and the middle body section and legs are light orange. The adults may feed on foliage and roots, however most damage is caused by the larvae feeding on the fleshy roots. Hundreds of larvae may feed on one fleshy root under high pest pressure. Affected roots are unmarketable because of the feeding damage, presence of

larvae, and also because of the bitter flavor that develops on the roots as a response to beetle feeding. Yield losses from weevil attack on sweetpotatoes are normally from 15-30%, but may be as high as 60-97% if pest populations go unchecked. Above-ground feeding by both larvae and adults does not normally affect marketable yields significantly. To control the weevil rotate or fallow production fields, disc old sweetpotato fields to eliminate reservoir weevil populations in remaining plants, eliminate volunteer sweetpotato plants including weeds of the morninglory family, plant away from weevil-infested fields, hill the plants, and conduct timely insecticide applications. It is important to start with clean, uninfested cuttings, clean fields, and to spray the base of the vines on infested fields every 3-4 weeks. A commercial pheromone is available which attracts the adult males. This pheromones may be useful in the future in a weevil control program for early detection of field infestations. In addition the pheromone may be useful for mating disruption, as a part in the overall weevil control program. Fungi and parasitic nematodes have been identified which kill the sweetpotato weevil; however further research is required to introduce these biological controls into commercially viable weevil control programs. In addition, selection of cultivars tolerant or resistant to the weevil is an important short- and long-term objective for control of the sweetpotato weevil. Thus far, resistance has not been detected in areas such as Hawaii which experience extremely high weevil population pressures.

Gulf Wireworms

Conoderes amplicollis (Gyllenhal) is a yellow worm about 1 inch long which feeds on the sweetpotato fleshy roots. The larvae of the gulf wireworm makes small irregular and ragged holes in the skin and burrows less than 1/4 inch into the fleshy roots. The feeding makes the roots unmarketable and opens the way for the entry and spread of disease microorganisms. Feeding damage is normally greater under dry conditions. Wireworms may remain in the field for several years since the larvae may take over a year to mature into an adult beetle. Wireworms are controlled with timely insecticide applications.

Sweetpotato fleabeetle

Chaetocnema confinis Crotch fleabeetles are 1/16 inch long black beetles which jumps when disturbed. Fleabeetle larvae feed on the roots leaving shallow tunnels below the periderm. The small tunnels enlarge as the roots grow and root cracks develop. The fleabeetles appear to move frequently from one feeding area to another. Volunteer weeds in the field margins may accentuate fleabeetle infestations in sweetpotato.

Sweetpotato vine or stem borer

The vine borer, Omphisa anastomasalis (Guenee) is the second most important insect pest in sweetpotatoes, after the sweetpotato weevil. The larvae of vine borers feed inside the vines and crowns, with heavy feeding resulting in reduced root growth of up to 50%. The adults moths of the vine borer which are most active at night, are white with a characteristic brownish yellow pattern in the wings. Eggs are laid singly below or above the leaf. Larvae begin to bore down the vines as soon as they hatch. The larval stages normally last 30-35 days. The larvae usually pupates in the vine for a period of about two weeks. Most yield losses in sweetpotato due to the vine borer are caused by damage to the vines and to the crown. Damage to the vines likely reduces movement of water, nutrients, and photosynthates up and down the vascular system. Insecticide sprays are normally ineffective because the borers are found inside the stems. Possible controls for the vine borer in sweetpotatoes include hilling (already practiced by farmers in Hawaii), removal of alternate weedy Ipomoea hosts, planting tolerant cultivars, and timely insecticide applications to reduce elimination of natural enemy populations. Known parasitoids of the vine borer in Hawaii include Chelonus blackburni Cameron, Enytus chilonis Cushman, and Pristomerus hawaiiensis Perkins.

Nematodes

Nematodes are tiny microscopic worms which live on plant roots and survive in the soil. Resistance to rootknot (Meloidogyne spp.) and to a lesser extent, to reniform (Rotylenchulus reniformis) nematodes has been developed in sweetpotato cultivars grown in the continental U.S. Susceptible cultivars infested with nematodes may wilt or appear stunted. Infested fleshy roots may crack and show growth deformities. Roots of root-knot nematode infested plants also develop galls. Nematode

susceptible cultivars should be grown in nematode-free soils. Rotate nematode infested soils with non-hosts such as sweet corn and other grasses. Soils may be tested for nematodes at the UH Diagnostic Center Laboratory. Nematicides should be applied if sensitive cultivars will be grown. Plow the field 2-3 months before planting to allow existing plant debris to rot prior to nematicide fumigant applications. To improve efficiency of nematicide application read the label directions carefully, and calibrate the applicator. In nematode prone areas, the use of resistant cultivars should be only one of the several management techniques used for nematode control, in addition to rotation and fumigation.

Diseases

Diseases normally do not lower sweetpotatoes yields in Hawaii because most plantings are started with disease-free tip cuttings. Leaf scab, is a problem in some areas. To prevent the spread of diseases handle the roots carefully during harvest to reduce bruising, and maintain a clean sanitation program in the field, nursery bed, machine shop, and in the packing house. Other cultural practices such as proper rotations, field selection, spacings, fertilizer applications, and irrigation help to reduce disease infestation and spread in the field. In the continental U.S. commercial cultivars have been developed with resistance to Fusarium wilt and internal cork. Stem rot, black rot, soft rot, soil pox, scurf, and surface rot are all fungi that attack sweetpotato. Black rot, soft rot, and surface rot also attack fleshy roots during storage or during transit to its market destination.

Anthracnose

Anthracnose, caused by the fungus Elsinoe batatas, became a serious problem on sweetpotato plantings in Kauai in the late 1970s. Symptoms of the fungus show prominently on the younger parts of the vine with distorted leaves and petioles with rusty-brown lesions. The vines take on a stunted and "scabby" appearance. Production will be affected if the fungus infects the crop during the growing stage. Recommended controls include: 1) Crop rotation. The fungus can survive in the refuse plant material after

harvest; 2) Using clean planting material. Clean slips can be produced from roots treated with a 10-20% chlorox solution for 20 minutes; 3) Using resistant or tolerant cultivars. The 'Waimanalo' cultivar appears to be tolerant to this disease.

Bacterial Stem and Root Rot

Erwinia chrysanthemi Burkholder, McFadden, and Dimock may appear in vines and roots in the field, in nursery bed roots and during storage. Foliage symptoms include black, necrotic, water soaked lesions. Eventually one or two branches of the plant will collapse resulting in wilting of terminal leaves. Lesions in the root develop more commonly in storage, with a characteristic black margin surrounding the lesions. The cultivar 'Beauregard' is very susceptible to Root Rot. This fungus penetrates sweetpotatoes principally through wounds created by handling or insect feeding. Controls include minimized wounding of the roots, selection of propagating material from disease-free fields, and the use of cultivars with tolerance to the disease.

Black Rot

Symptoms caused by the the fungus Ceratocystis fimbriata (previously known as Endoconidiophora fimbriata) include leaf yellowing of young plants, the underground sections of the stem show black areas, and circular depressed grayish-blue lesions develop on the fleshy roots. Affected vines will be stunted, and the slightly shrunken, circular black spots lesions in the root will develop a bitter taste. Above and below-ground lesions are localized and do not spread to the entire plant. Fungal spores reproduce rapidly and are easily spread by mites or the sweetpotato weevil during storage or transit to market resulting in severe postharvest losses. Black rot can penetrate the plant through wounds or injury caused by insects, nematodes, rodents or by farming equipment. This fungus persists in the soil for 1-2 years in affected roots left over after harvest, or in the spore form. Recommended controls include the use of disease-free propagating material, fungicide treatment of seed

roots, 3 or 4 year rotations, adequate curing of roots, and sanitation of any equipment or tools that may come in contact with the roots.

Internal Cork Virus

Internal Cork is caused by the sweetpotato feathery mottle virus. Cross-sections of affected roots show dark brown "cork-like" areas in the flesh. The virus also causes root necrosis. Infected roots usually appear normal on the outside. Foliage symptoms may range from reddish-purple spots to mild mottling and vein banding. Varieties vary in their response to internal cork virus. Sweetpotato cultivars developed in the continental U.S. have shown high tolerance to Internal Cork. For control, use cuttings from disease-free fields.

Scab

Characteristic symptoms caused by Elsinoe batatas, are small, scabby areas, and small oval lesions, especially along the midrib and veins of leaves. The lesions eventually become corky resulting in shrinkage and leaf deformation. On the petioles the damage spots may be a little larger, and sunken than on the leaves. The scab spots on both leaves and petioles may join together to a size of an inch or more. Yield losses from leaf scab can reach up to 60%. The tubers are not infected by this fungus. Scab can be spread by splashing rain and by utilizing infected cuttings for planting. Controls include disking the crop soon after harvest, one-year rotations, planting of disease-free cuttings, and avoiding overhead irrigation in fields affected by leaf scab.

Soft Rot

The fungus Rhizopus nigricans (R. stolonifer), commonly called bread mold, is an important post-harvest disease of sweetpotatoes. Affected roots develop a gray fuzzy mold, turn soft, and later turn dry and hard. The fungus enters the roots through wounds. Recommended preventative measures include careful post-harvest handling of the roots to prevent wounds, curing to heal any wounds, and disinfection of the packing shed and equipment. Spores are carried by winds and insects, especially flies. No cultivar resistant to soft rot have been identified.

Stem rot or Fusarium wilt

This fungus, Fusarium oxysporum Schlecht. f. sp. batatas (Wollenw) Snyd. & Hans., can be a serious pest in sweetpotatoes. Resistant varieties to stem rot have been developed. Fields commonly become infected through contaminated cuttings, and once in the field it penetrates healthy plants through open wounds. Yield losses may be up to 50%, and losses are more likely under warm weather and in dry soils. Plants normally die within a few days after visible symptoms appear in the plant. The vascular tissues of affected plants turn dark brown or black, especially close to the soil level. Leaves of susceptible plants may also turn yellow or brown. Resistant or tolerant cultivars grown in the continental U.S. include Jewel, Redgold, Nemagold, and Centennial. In additon to resistance, other controls include crop rotation to lower soil disease pressure, selection of seed roots from disease-free fields, and fungicide treatments.

Scurf

Symptoms caused by the asexual fungus Monilochaetes infuscans include black blotches on stem tissue near the soil level, and on the surface of fleshy roots. Infection also causes shrinkage during storage which results in unmarketable roots. Affected roots become conspicuous as they are cleaned for market. Infections in the field proceed faster in poorly drained soils. Animal manure applications and soils high in organic matter may increase the incidence of scurf. Recommended controls include root seed treatment before planting, treatment of the basal portion of the stem near the soil level, use of clean seed roots and cuttings, and a 3-4 year rotation.

Soil rot

Symptoms on fleshy roots caused by the prokaryotic microorganism (not a fungus) Streptomyces ipomoea include malformed roots, surface pits and scabby cavities, as well as black spots on the crevices. The lesions are normally smaller than an inch in size. Affected plants appear stunted and may die before the end of the growing season. Controls include the use of resistant cultivars, sulfur applications to lower soil pH to 5.2, and soil fumigation. This organism persists by feeding on organic matter residue in the soil and does not require sweetpotato residues to survive. Rotations

with other crops, however, may reduce crop losses from soil rot in sweetpotato. Because dry soil conditions favor disease growth, even watering throughout the growing season is recommended.

Weeds

Proper cultivation, field selection, rotations, and timely applications can reduce the volume of herbicides applied for weed control in sweetpotatoes. Weeds may be controlled by the "flush" control technique. After the field has been prepared for planting including preplant fertilization, sprinkle irrigate the field to promote a "flush" of growth to germinate weed seeds near the soil surface. The field is then treated with a preplant contact herbicide to kill the initial flush of growth. This may be repeated a second time. The sweetpotatoes may then be planted after either 15 or 30 days, depending on the number of "flush-growths" which were promoted to kill the germinating weed population near the soil surface. Fields should be kept weed-free during the first 4-8 weeks of growth, after which the vines will completely cover the field. Weeds will also be kept in check with the cultivation performed by disk hillers during the hilling operation. Herbicides may damage sweetpotatoes if applied incorrectly.

Some sweetpotato cultivars have been identified which showed allelopathy toward plants of other species grown in proximity. For example sweetpotato has been shown to reduce the growth of the yellow nutsedge weed and of sorghum. However, more research is needed to identify promising cultivars, and to develop management techniques to maximize the allelopathic efficiency in sweetpotatoes in competing against weeds.

HARVEST AND POST-HARVEST TREATMENTS

Maturity and Harvest

Sweetpotatoes are harvested as soon as the roots reach marketable size, which is 4 to 6 months after planting under Hawaii conditions. Unmarketable "jumbos" may develop if plants are left in the field longer than desirable. Sweetpotato weevil outbreaks may also increase crop losses if plants are left in the field beyond its normal harvest time. A rotary or flail-type mower is used to mow the vines at the base. Vines are then either removed or rolled into adjacent rows before harvesting. The roots are then spaded out by hand or plowed out with a middlebuster (double moldboard plow), or with a modified potato harvester. Roots fall to the ground at the end of the digger, where they are selected, placed in crates and transported to the packing shed. In the packing shed roots are washed, and oversized ones, or those damaged by weevils, nematodes, diseases, or machinery are culled. Fleshy root damage should be minimized when harvesting in dry soil conditions. If the harvest operation is conducted in wet soil, allow roots to dry naturally in a shaded area until the soil dries and then remove the soil by gently rubbing with the hands.

Production yields.

Average yields in Hawaii are about 12,000 lbs/Acre. This is below the average yields of over 20,000 lbs/Acre which are obtained in commercial operations on Molokai. Good yields range from 30-35,000 lbs/acre. Yields will vary depending on growing season with higher yields obtained when planted between March and May, and with lower yields when planted in the fall. Adequate yields are obtained when planting from February to July (Fig. 1). Fertilizer applications should be modified depending on the expected yields for each planting season. Good yields in the continental U.S. are about 17,500 lbs/Acre with plant populations of 12,400/Acre.

Curing, Holding and Storage

No "in-house" curing is practiced in Hawaii. Roots are shipped soon after harvest. Curing treatments in production areas where this is practiced include storage at 85F and 90-98 RH for 4-7 days with ventilation, and then stored at 60F with ventilation. Chilling damage occurs below 55F. Curing results in the formation of a cork-like layer beneath the skin or in fleshy areas which have been bruised. Benefits of curing include increased

sugar content and flavor, suberization of periderm tissue to protect the roots against bruises and disease attack, and to improve shelf-life by reducing respiration and water loss. Roots lose about 3-6% of their weight during the curing process. Cured sweetpotatoes can be stored for 4-7 months. Roots are stored at 55-60F and 85-90 RH. Sweetpotato roots will not store well if wet soil conditions were prevalent just prior to harvest, if the roots are chilled below 50F for a period of over 5 days after harvest, or if not properly cured prior to storage.

Packing

Sweetpotatoes are packed in 50 lb crates or 40 lb cartons. Weight loss during transit and marketing is minimized if roots are held in perforated film bags (32 quarter-inch holes in a 3-5 lb polyethylene bag).

Grades

U.S. grading standards include:

1) U.S. No. 1 Extra: length- no less than 3 in and no more than 9 in; width- no less than 1.75 in nor more than 3.5 in; weight- 18 oz per root.

2) U.S. No. 1: length- no less than 3 in nor greater than 3.5 in and weight of 20 oz per root.

3) U.S. No. 2 with a length greater than 1.5 in and root weight of 36 oz.

4) Culls.

Consult the Hawaii Department of Agriculture Marketing and Consumer Services Division for an update on current local grading marketing standards for sweetpotatoes: Hawaii Fancy (Grade AA); Hawaii No. 1 (Grade A), and; Hawaii No. 2 (Grade B).

Market Information

Sweetpotatoes are planted and harvested every week of the year in Hawaii. Locally about 1.3 million pounds of sweetpotatoes are grown annually, and local demand for sweetpotatoes has been steady over the past decade. About 40% of the sweetpotatoes consumed locally are imported from the continental U.S (Fig. 3). Before planting sweetpotatoes, prospective growers need to target a market, understand monthly market trends, and identify specific buyers. Production costs for sweetpotatoes in 1990 ranged from $0.35-0.45 per pound. Prices normally dip from August

to March. Returns from late spring to fall when yields are the highest are therefore the most positive (Fig. 2). Nationally, harvest volumes are greater from September to January, and lowest in June and July. North Carolina, Louisiana, and California are the largest sweetpotato producing states in the U.S. Per capita consumption of sweetpotatoes in the U.S is about 4.5 lbs annually, but consumption may be higher with some local ethnic groups in Hawaii. The potential exists for developing processed products for export to the continental U.S. or Japan, where sweetpotatoes are increasingly being recognized as a healthy substitute for high fat or high calorie desserts or fast food snacks. Presently, fresh roots can not be exported to the continental U.S. primarily because there is a quarantine on the sweetpotato weevil and on wireworms. Sweetpotato shoots are normally marketed in low volumes in local community farmer markets or in the Honolulu Chinatown produce market.

REFERENCES

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Figures

Fig. 1. Mean yield of sweetpotatoes as affected by planting date in Poamoho (1953)

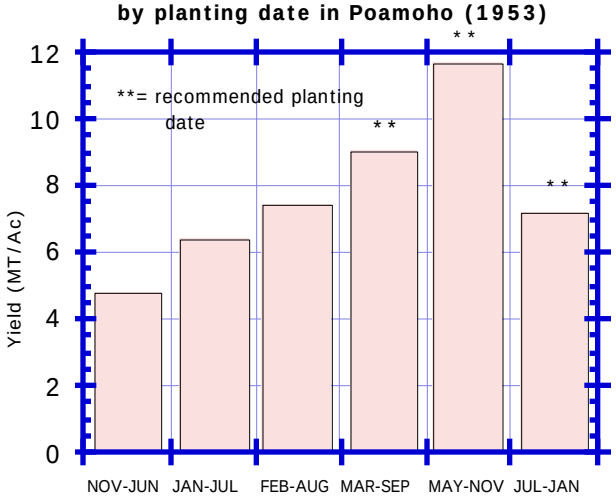


Fig. 2. Average monthly Price and Volume for Sweetpotatoes in Hawaii 1986-1991

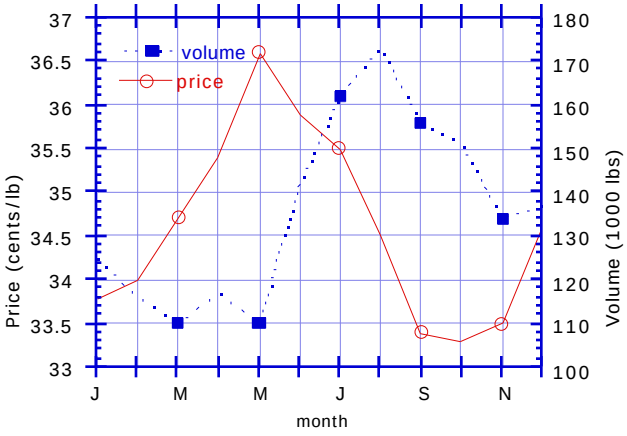
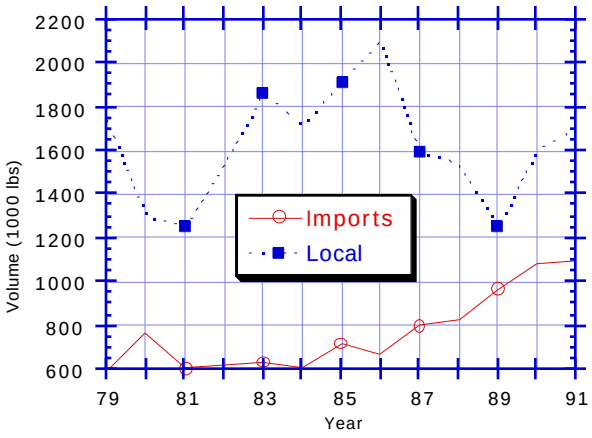


Fig. 3. Hawaii annual sweetpotato imports and local production from 1978-1991



Legend for Slides (Color Pictures)

1. In Hawaii most sweetpotatoes are planted with 12-inch cuttings taken from the previous planting. Take cuttings only from fields which have been free of insects and diseases.

2. 'Waimanalo Red' is a dry-type sweetpotato preferred locally in Hawaii for boiling and frying. Waimanalo red is early maturing and high-yielding.

3. 'Kona-B' is a moist-type high yielding sweetpotato. Proper root size and uniformity is required to meet Hawaii grading standards for sweetpotatoes.

4. Modified tractor-pulled potato harvesters can be used for harvesting sweetpotatoes. The fields are first mowed, and foliage removed, before digging sweetpotatoes with this type of equipment.

5. Pheromone traps detect movement of sweetpotato weevil males into the field, and may be helpful in control of this weevil through mating-disruption techniques.