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Fig. 1—Vigorous, disease-free, well-rooted plants are the growers' best insurance for successful sweet potato crops. Infected root stock and infected plant beds and soil are the sources of nearly all sweet potato diseases.

SWEET POTATOES

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Among the vegetables that should be grown on a larger commercial scale in Missouri, the sweet potato is one of the most promising. While the main area of commercial production is in the southeastern part of the state, other sections are well adapted and with good cultural practices will produce good yields of high-quality roots.

Best Types of Soil

The sweet potato may be grown successfully on several Missouri soil types. It does best, however, on an easily workable, moderately fertile soil, such as a well-drained sandy loam. Nitrogen-rich and heavy textured soils encourage excessive vine growth and poorly shaped roots. Poorly drained soils, regardless of texture, favor the development of disease, together with excessive root cracking during alternate wet and dry periods. Therefore, it is wise to avoid planting sweet potatoes on soil types that are underlaid with tight, impervious claypan subsoils.

Where avoidable, sweet potatoes should not be planted on soils infested with wireworms or following grass sod or other crops which favor wireworms. While chemical soil treatment (see "Insects") in most cases is generally satisfactory, it is better to avoid this problem than to attempt to correct it.

Use Only Vigorous, Disease-Free Slips

The best insurance against loss from the diseases that so frequently damage sweet potato plantings is the use of disease-free slips. Since practically all sweet potato diseases—black rot, stem rot, scurf and internal cork—start from either infected root stock or diseased plant beds, the use of disease-free stock and proper sanitation in the plant beds will greatly reduce losses from these diseases. If, in addition to these precautions, the planting is made on clean soil, little or no difficulty with these diseases will be encountered.

Growers of sweet potato slips should bed only roots that are definitely known to be free of any disease, and preferably root stock that was selected in the field at time of harvest for high yielding ability and trueness to varietal characteristics. Any plant grower—even though he may not wish to have his plants certified—will find it profitable to meet all the requirements for certification.

With the rapid build-up of internal cork (virus) in most sweet potato producing states and the indifference of many commercial plant growers to the seriousness of this disease, most commercial growers will find it advantageous to field select their own seed and grow their own plants. See "Hill-Select Seed Stock at Harvest Time" for further suggestions.

Those who desire plant certification should make application to the State Commissioner of Agriculture in Jefferson City, Mo., at a date well in advance of bedding time.

-- A Promising Missouri Crop

Sweet potato growers who purchase plants for transplanting should insist upon certified plants, even at higher prices, since certified plants are much more likely to be disease-free.

Description of Varieties

As a result of continued breeding and improvement, several new sweet potato varieties are now available commercially, representing both the "Firm" (dry) and "soft" (moist) types. Since most markets show a preference for one type or the other, the commercial grower will do well to note such preferences as well as the productive ability of each variety considered for planting.

Soft-fleshed Varieties

Porto Rico: The Porto Rico is still the most widely grown of the soft-fleshed varieties, especially in the southeastern states. The Louisiana strain (Unit I) is a more consistent type and generally yields better than most strains that are available commercially. This variety is adapted only to the southern part of Missouri where the growing season is sufficiently long to produce profitable yields. Even here it is not a top-yielding variety. Moreover, its internal flesh color (carotene) and vitamin content are considered inferior to those of several newer varieties.

Bunch or Vineless Porto Rico: Several varieties and strains of the short-vined mutation of Porto Rico are now being propagated. The productiveness and root characteristics are comparable to those of the vining parent and the shorter vine interferes less with cultivation and harvest. As a precaution against the spread of internal cork virus, growers in Missouri are requested *not to grow* any of the "vineless" varieties.

Early Port: Early Port, previously designated as L240, developed by the Louisiana station, is one of the earliest "maturing" varieties. It has a lighter skin color than Porto Rico, but a uniform orange colored flesh which indicates a high carotene (pro-vitamin A) content. Since it does not require as long a growing season as Porto Rico to size the roots properly, it can be harvested earlier (or planted later) and still produce good yields of marketable roots. The roots have a slight tendency to ridge on heavy soil types if permitted to grow too large. Some difficulty has also been reported in holding this variety in storage. In Missouri, Early Port is decreasing in popularity.

All-Gold: All-Gold, an Oklahoma introduction, is one of the most promising of the new varieties for general planting in Missouri. The roots, generally smooth and spindle-shaped, have a russet golden skin and a bright salmon colored flesh. They are of very high nutritional quality, keep well in storage, and possess very desirable canning qualities. All-Gold produces well in all parts of Missouri, but the yields generally average a little lower than those of several other varieties. It possesses some resistance to stem rot infections and may have some resistance to internal cork. Undesirable root shapes are sometimes encountered on heavy soils. It is very susceptible to nematodes.

Tango: Tango, originally designated B4570 and Missouri X, was released by the Missouri Agricultural Experiment Station in 1955 for home garden and limited commercial planting. Tango originated as a seedling selected at the U.S.D.A. Plant Industry Station, Beltsville, Md., in 1942 from a cross (Nancy Hall X Porto Rico 1-10) made at the Louisiana Agricultural Experiment Station in 1941.

Because of its high yielding ability, earliness, excellent table and keeping qualities, it was released as a replacement for Nancy Hall, long a favorite in Missouri. It is considered by many to be superior in appearance and table quality to either Nancy Hall or Porto Rico. Tango is moderately resistant to black rot, but very susceptible to wilt. It is recommended in areas where wilt is not a prominent problem. Stock of this variety to be used for seed should be hill-selected to eliminate wilt-infested plants. Other diseases have not been troublesome on this variety in approximately 10 years of testing.

Kandee: Kandee, released by the Kansas Agricultural Experiment Station, originated as a seedling from a cross made at the Louisiana Agricultural Experiment Station involving Yellow Yam, Nancy Hall and Porto Rico. It is a very promising variety in Kansas and southern Iowa, but has not become popular in Missouri except around Kansas City. The roots are medium short, oblong and very regular in shape. The skin color is reddish-bronze and the flesh color is deep orange. It yields a high percentage of No. 1 roots and the roots keep very well in storage. The greatest limitation of Kandee for this area

is its susceptibility to several diseases including stem rot, soil pox and scurf.

Sunnyside: Sunnyside, released jointly by the U.S.D.A. and Maryland Agricultural Experiment Stations, originated as a seedling selected from a progeny resulting from a cross (Yellow Yam 149 X Nancy Hall 42-1) X (Pelican Processor X Triumph) made at the Louisiana Station in 1944. Although Sunnyside has been tested at several locations in Missouri, it has not been grown on a commercial scale as the skin color is considered to be too light for market purposes. The roots are short and tapered in shape, relatively smooth and of medium size. The flesh is salmon to orange in color and very attractive when vacuum packed or canned in syrup. It is considered to be an excellent keeper in storage. Sunnyside is susceptible to fusarium wilt but has some resistance to black rot.

Gold Rush: This variety, previously designated L241, is a Louisiana introduction having very high quality and carrying considerable resistance to stem rot. It tends to root abundantly under Missouri conditions, but requires a very long growing season to size the root sufficiently for high yields. In Missouri, Gold Rush has shown most promise around St. Louis where the soils are heavily wilt-infested and more susceptible varieties cannot be grown profitably. Planting of Gold Rush is currently being discouraged because of its susceptibility to internal cork.

Firm-fleshed Varieties

In Missouri the firm-fleshed varieties are being replaced rapidly by the soft-fleshed or so-called "Yam" types.

Compared to varieties of the soft-fleshed type, most firm-fleshed varieties have roots which are smoother, more uniform and symmetrical in shape and in general are carried much closer to the main stem of the plant. Some progress has been made recently among varieties of this type in improving the internal flesh color (carotene or pro-vitamin A content), keeping and storage qualities.

Orlis (Jersey Orange): Orlis, a mutation of Little Stem Jersey (or Yellow Jersey) introduced by the Kansas Agricultural Experiment Station, appears to be well adapted for production in Missouri. It possesses a much deeper orange flesh color and higher carotene content than Yellow Jersey and generally yields slightly higher than Orange Little Stem. It is grown in certain areas of the East under the variety name "Jersey Orange".

Maryland Golden: A deep orange-fleshed variety introduced by the Maryland Agricultural Experiment Station. Maryland Golden is usually a heavy yielding variety in Missouri. Although deeper orange colored than its parent, Big Stem Jersey, it tends to become pithy in storage, shrinks excessively and is a relatively poor plant producer.

Little Stem Jersey (Yellow Jersey): This variety is very similar to Orlis except for internal flesh color. Usually it does not yield as well as Orlis and other varieties of the dry-fleshed type.

Big Stem Jersey: Big Stem Jersey, while having longer vines and producing larger roots than Little Stem Jersey, is otherwise very similar. The yields of this variety, too, have been consistently below Orlis, Rols and Maryland Golden.

Rols: Rols is a red-skin mutation from Orange Little Stem introduced by the Kansas Agricultural Experiment Station. Other than in skin color, the root is very similar to Orange Little Stem. Rols is a good yielder in Missouri, is a heavy plant producer and appears to hold up well in storage.

Nemagold: Nemagold, from the Oklahoma Station, is one of the most promising of the newer dry-fleshed Jersey-type varieties, particularly in nematode and soil rot infested areas. Yields of Nemagold compare favorably with other Jersey-type varieties, but are generally lower than most moist-fleshed varieties. The roots average medium in size. They are generally smooth, but frequently veined and vary considerably in shape with soil texture, being short and chunky on light soils and stringy (long) on heavy soils. The color of roots is a russet-gold somewhat similar to Allgold. The flesh is orange and very attractive when baked.

Nemagold is somewhat tolerant of wilt and soil rot. It has been reported less susceptible to black rot than other Jersey varieties.

Results of Variety Tests

The following summary of test results for the Missouri station for the period 1951-1955 lists only varieties of the "soft-fleshed" type that are available commercially.

TABLE 1 -- COMPARATIVE YIELD OF U.S. NO. 1 AND U.S. NO. 2 ROOTS OF MOIST-FLESHED VARIETIES.
Yields expressed in 55# Bu./Acre.

Variety	1951	1952	1953	1954	1955	Average 1951-1955
Tango	345	467	365	380	401	391
Unit I Porto Rico	251	359	276	338	377	320
Early Port	206	404	393	340	379	344
Gold Rush	232	293	246	369	252	278
All Gold	198	346	391	334	357	325
Kandee	---	---	286	287	302	291

Mo. Agr. Exp. Station, 1951-1955.

Growing Sweet Potato Slips

Fig. 2—Sweet potato slips are usually forced in hotbeds since bottom heat is desirable to stimulate early growth. Bed sanitation is essential in forcing disease-free slips.

Clean Up Plant Beds Before Bedding Roots

Sweet potato slips are generally forced in hotbeds since some bottom heat is desirable to stimulate early growth (Fig. 2). Bulletin 617, Vegetable Plants for Home and Commercial Growers, contains information on construction of manure, flue-heated, hot water and electric hotbeds. It can be obtained from County Agricultural Extension Offices or by writing the Mailing Room, 21 Mumford Hall, University of Missouri, Columbia.

Old plant refuse and bedding sand should be thoroughly cleaned out and the structures and surrounding soil thoroughly sterilized each year before bedding roots. The bed can be drenched with sprinkling can containing a formaldehyde solution. Use 1 pint of 40 percent formaldehyde for each 15 gallons of water. Wet down the bed, framework and surrounding soil thoroughly with the solution. Then allow the bed to air out a few days before putting in clean (and preferably sterile) sand and bedding roots. Where steam is available, the bedding sand can be sterilized by heating to 180° F and holding for at least 1 hour.

Bed an Adequate Amount of Stock

The amount of seed stock required for bedding will vary with the variety, the number of pullings that can be made and upon plant bed management. For best yields of most varieties, transplanting to the field must be completed a few days after the frost-free date. For that reason, a majority of the slips should come from the first pulling. Under normal conditions this will require bedding approximately 10 to 12 bushels of roots for each acre to be planted. Generally some second pulling slips may be used, but their use should not delay planting more than a few days. A delay of more than two weeks after the frost-free date may reduce the yield substantially (see Table 3).

"Nicking" to Eliminate Off-type and Diseased Roots

As the seed is taken out of storage and prepared for bedding, discard any badly shriveled roots and any showing disease symptoms. The small ends of the roots can be "nicked" or cut off to determine the presence of disease and the degree of interior color. Roots showing internal discoloration should not be bedded. While this procedure assists in the elimination of cork and wilt infected roots, it should not be considered a way to maintain "disease-free" stock.

Treat Roots with a Fungicide Before Bedding

Before bedding, the roots should be treated with a good fungicide to destroy any disease organisms on their surface and to help protect them from decay in the plant bed. Several commercial fungicides, such as Spergon, Semesan Bel and Phygon XL, have been found satisfactory and are very convenient to use. Because of differences in their chemical nature and the concentration of active ingredients, these materials should be used according to the directions on the container label. These solutions are not weakened materially by repeated use and can be used for several bushels of seed stock, as long as the solution remains clean and there is sufficient solution to cover all of the roots in the container.

For most materials, it is necessary to dip the roots only long enough to thoroughly wet them. There appears to be no particular advantage in soaking them; in fact, injury may result from some fungicides if the roots are permitted to remain too long. When pulling the slips for transplanting, the root ends can also be dipped in one

of these solutions before setting.

Caution: Since all of these chemicals are highly poisonous to animal life, they should be kept out of the reach of children and livestock and carefully disposed of after use by burying.

Bedding the Roots

Immediately before bedding, a layer of clean sand 3 or 4 inches deep is placed on the bottom of the bed. For electrically-heated beds it may be desirable to insulate the bottom with a 2 or 3 inch layer of sawdust before putting in the heating cables and the bedding sand. The method of placing the cable will vary with the size of the hotbed, the rating (amperage) of the cables, and the amount of heat required to maintain satisfactory temperatures.

The roots are then placed 1 to 1½ inches apart in the sand. After the roots are bedded, they are covered with sand to a depth of about 1 inch and watered. The sand and water should be at a temperature of approximately 80° F since chilling will bring about a delay in sprouting and may cause the roots to decay. *Under no circumstances should the roots be allowed to chill.* The temperature of the plant bed may be as high as 85° F when the roots are bedded. It should then be allowed to drop gradually but should not go below 70° F.

A temperature between 70° and 80° F is most satisfactory for the greater part of the plant forcing period. Since the temperature should not be allowed to go above 85° F, the sash of the hotbed must be elevated during sunny days to keep the temperature down.

The bedding material should be examined throughout its depth every few days to determine the need for water. The bedding material should not become too dry for good growth or become wet enough to encourage disease. When the first sprouts push through the sand, an additional layer of 2 or 3 inches of sand can be placed on the bed to encourage the production of a stronger root system. Partially decayed sawdust may also be used for this last cover. Plants should be exposed to outside temperatures both day and night for about a week before pulling time, to harden them off.

If insects, particularly aphids, become troublesome spray or dust with Lindane. To make the spray, add Lindane (25% wettable powder) to water at the rate of 1 pound per 100 gallons or 1 level teaspoon per gallon. Malathion is also effective when used at a rate of 4 teaspoons of 25% wettable powder, or 1½ teaspoons 50% Malathion emulsifiable concentrate, per gallon of water.

Under this system of plant production, about six weeks are required to obtain a good supply of plants of most varieties. Therefore, where plants are to be transplanted to the field around May 15, the roots should be bedded around April 1. Sweet potato slips are ready for pulling upon reaching a length of 6 to 8 inches. Generally, plants smaller than 6 inches in length result in poor stands and yields and plants longer than 8 to 10 inches are difficult to transplant. In case the plants are in danger of becoming too rangy, they can be held back to some extent by withholding water and heat from the plant bed.

It is best to water the plant bed lightly, to loosen the slips, the day before the plants are to be pulled. They should be pulled and handled carefully to avoid injury to the slips and to bedded roots. Before setting them in the field, the plants should be sorted to eliminate all small weak plants. Immediately after pulling, the roots of the slips should be placed in wet sawdust or peat moss and covered with wet burlap to keep them from drying. Dipping the roots in a fungicide solution, such as was used in treating the seed stock before bedding, is of some value in preventing the spread of any disease which may occur in the plant bed. It must be realized, however, that this treatment supplements rather than replaces the other sanitation practices, which are using disease-free seed stock, fungicide treatment before bedding, and growing in a clean soil.

Fertilization

General Considerations

The fact that the sweet potato will perform better than most vegetables on low fertility soils has no doubt contributed to a rather common belief that it is a poor land crop and will not do well on high fertility soils. Considerable experimental evidence has been gathered to prove that this belief is unfounded. A well balanced fertility program is just as essential for good yields of high quality sweet potatoes as for other vegetable crops.

The sweet potato is particularly sensitive to the nitrogen-potassium balance of soil. The tendency toward excessive vine growth and stringy (long, slender) roots which growers term "going to vine" is generally associated with nitrogen-rich soils or a high nitrogen-low potash unbalance. Although this unbalanced condition should

be avoided where possible, the effect can be partially overcome by increasing the potash supply. This is shown in the results of a randomized block experiment conducted on the University's vegetable experimental field at Campbell, Mo., in the summer of 1950 (Table 2).

TABLE 2 -- MARKETABLE YIELD OF UNIT I PORTO RICO SWEET POTATOES GROWN AT VARIABLE LEVELS OF NITROGEN, POTASSIUM AND MAGNESIUM.

Yields Bu./A. (55 lb.) U. S. No. 1 and No. 2

Soil Potassium Level Lb./A.	Soil Nitrogen Level Lb. N/A	Yields 2.3% Mg. Saturation	Yields 4.6% Mg. Saturation
200	50	474	548
	150	355	357
420	50	474	526
	150	459	389

It is apparent from these results that the large decrease in yield shown at the high nitrogen level (150 lb.) compared with the low nitrogen level (50 lb.), was significantly less at the higher (7%) potash level.*

The beneficial effect of heavy potash fertilization of the sweet potato is not surprising when you consider the amount of potassium removed in the roots and the fact that it is commonly grown on lighter soils which, as a rule, are low in potash reserves. A yield of 300 bushels per acre has been found to remove approximately 75 pounds of nitrogen, 20 pounds of phosphorous (P_2O_5) and 115 pounds of potassium (K_2O), considering both vines and roots.

Fertilize According to Soil Tests

Because of the great variation in degree and balance of fertility with soil type and previous management, fertilizer applications are best made according to soil test. Where possible, avoid nitrogen-rich soils which encourage vigorous vine growth. County Extension Agents can give you instructions on how to take soil samples and will test the soil for you.

The value of maintaining proper fertility balance by basing your fertilizer applications on soil tests is well illustrated by an experiment conducted at the University's vegetable experimental field, Campbell, Mo., in 1953 (Table 3).

Variable levels of calcium, magnesium and potassium were established on replicated and randomized plots on Lintonia fine sandy loam. Before fertilization the soil tested 2% organic matter, 177 pounds per acre exchangeable potash, 75 pounds per acre exchangeable magnesium and 1800 pounds per acre exchangeable calcium. Tests were made before treatment and three months after fertilization, using six samples from each treatment.

The Tango variety was transplanted on May 21 and harvested Sept. 29. The planting was irrigated at 10 to 14-day intervals to maintain a favorable moisture level in the upper 2 feet of soil. Phosphorus (P_2O_5) was increased to 418 pounds per acre on all plots.

Where the soil is tested by the Missouri method, fertilize to bring the fertility to the following level, which is

TABLE 3 -- EFFECT OF FERTILIZER APPLICATIONS ON SOIL TEST RESULTS AND YIELD OF SWEET POTATOES

Fertilizer Treatment	Change in Soil Test Values (Lb./Acre) over Unfertilized Soil K	Ca	Mg	Effect on pH	Yields (55 # bu./A.) No. 1 Roots	No. 2 Roots	Total
1. None	---	----	---	----	226	33	259
2. Added Manganese Sulfate 13.5 lb./A.	0	0	0	none	264	35	299
3. Potash increased to 5% of the cation exchange capacity (C.E.C.) Added 269 lb./A of sulfate of potash	(+25)	0	0	-0.1	299	42	341
4. Calcium increased to 80% of C.E.C. Added 1500 lb./A flour lime	(-25)	+1350	+25	+0.4	232	30	262
5. Calcium increased to 80% of C.E.C. potash to 5% of C.E.C. as sulfate of potash	+39	+650	+20	+0.3	326	39	365
6. Added dolomitic lime 1500 lb./A.	-25	+350	+47	+0.1	195	37	232
7. Added dolomitic lime 1500 lb./A. potash to 5% of C.E.C. as sulfate of potash	+14	+250	+28	-0.1	299	37	336
8. Added dolomitic lime 1500 lb./A. potash increased to 8% of C.E.C. by adding 670 lb./A. of sulfate of potash	+83	none	+21	-0.2	229	38	267
Difference required for statistical significance at 5% level		Treatments 1-4 11.13 Bu./A. Treatments 5-8 19.37 Bu./A.					

*From the statistical viewpoint, this reduction in yield with nitrogen fertilization was significant at the 1% level and the increase in yield with potassium fertilization significant at the 5% level. The K-N interaction (effect of potassium in overcoming the reduction in yield by nitrogen application) was statistically significant at the 5% but not the 1% level.

considered a minimum for satisfactory yields:

Phosphorus (P_2O_5)—250 pounds per acre

Exchangeable potassium—300 pounds per acre

Exchangeable magnesium—200 pounds per acre

Exchangeable calcium—3000-4500 pounds per acre (lower value for light soils).

Any fertilizer required to establish these levels should be plowed down. In addition to the fertilizer required to establish these levels, or for soils already testing above these values, use 400 pounds of 4-12-12 or 3-9-18 as a starter fertilizer. Apply on the surface and disk in before transplanting. Do not apply manure or sidedress with nitrogen.

With the exception of boron on crops with very high boron requirements, trace element deficiencies are not common in most Missouri soils. Where boron deficiency is definitely known to exist, it can be corrected by the addition of sodium borate at the rate of 10 pounds per acre. It should be thoroughly mixed with the other fertilizers for good distribution.

Transplant Early for High Yields

Since the sweet potato plant is easily damaged by frost and, for best development, requires about a four-month frost-free growing period with warm days and nights, it must be transplanted early for highest yields. In most cases the slips should be transplanted the first week following the frost-free date, which for central Missouri is May 10. In the extreme southern part of Missouri, especially in the lowland area of Southeastern Missouri, slips may be transplanted as early as May 1 without much danger from frost. In northern Missouri, planting should generally be delayed until about May 25. A delay of two weeks or longer in transplanting after these dates in most years will reduce the yield of marketable roots substantially.

This loss in yield from delayed planting was shown in an experiment at the Campbell vegetable experimental field during the summer of 1952. (Table 4).

These data also indicate that satisfactory yields of the early-maturing varieties (Early Port, Tango, etc.) can be obtained in a growing season as short as 120 days while approximately 160 days are required for some late varieties. As would be expected, the increase in yield of the early varieties is not proportionally as great as the growing season is lengthened as is the case with the late varieties.

Soil Preparation for Transplanting

Sweet potato land should be plowed at least 7 or 8 inches deep, then thoroughly disked and harrowed as far in advance of planting as circumstances permit. This is particularly important where moisture must be conserved and where difficulty with weeds and grass is expected.

Chemical Soil Treatment for Wireworms. Wireworms are the most common and damaging of the soil-borne insects of the sweet potato in Missouri. In addition to lowered market quality, which results from the feeding of these pests, losses are heavy from secondary soil and storage rots entering through the punctures.

Where difficulty with wireworms is anticipated, use Aldrin or heptachlor at the rate of 2 pounds (4 quarts of 25% Aldrin or heptachlor emulsifiable concentrate) per acre. Apply by the broadcast method and work into the soil *immediately* by disking. If this application is made immediately before transplanting, it also controls cutworms.

Whether to plant on the ridge or on the level depends largely upon the soil characteristics and upon the amount of rainfall expected. On heavy soils in areas with above-average rainfall, planting on the ridge may increase the yield of marketable roots. Usually this ridging also

TABLE 4 -- MARKETABLE YIELDS OF SIX VARIETIES OF SWEET POTATOES WITH VARIATION IN LENGTH OF GROWING SEASON
(Bushels per Acre)

Planting Date	May 15	May 15	May 2	May 2	May 2
Harvest Date	Sept. 2	Sept. 11	Sept. 11	Sept. 26	Oct. 14
Approx. Season (Days)	105	120	133	148	166
Variety					
Early Port	214	397	494		
Unit I Porto Rico	251		337	448	491
Gold Rush			218	248	275
All Gold		266	349	379	
B5941		367	377	376	
Tango		333	395	421	476

lowers the amount of disease in storage by facilitating more rapid drainage of excess moisture. During dry seasons, however, ridging may reduce vine growth and yield by increasing water loss from evaporation and surface runoff.

There are several methods of preparing the ridge. Sometimes a lister plow is used; in other cases, the ridges are thrown up by back-furrowing twice with a turning plow. In any case it is desirable that the ridge should be about 10 inches high from the crest of the ridge to the bottom of the furrow after the soil has settled and is ready for setting. In most cases the ridges are spaced 3½ to 4 feet apart.

If the soil is very dry at transplanting time, and irrigation facilities are available, it should be watered thoroughly before transplanting. Irrigation before planting or "watering-in" the plants at transplanting time will reduce drying injury to the roots and result in quicker growth and a better plant stand. Most mechanical transplanters have facilities for watering the plants as they are set. Where the plants are set by hand and irrigation facilities are not available, they can be watered-in by using barrels and buckets or by using a power sprayer on which the pressure regulator has been released to provide a steady, gentle flow of water.

Planting distances vary with the variety and the cultivation equipment. The most satisfactory spacing for commercial plantings of most varieties is 12 to 15 inches within the row with rows 3½ feet apart. Wider plant spacing generally results in lower yields and a greater percentage of jumbo-sized roots, while closer spacings tend to give undersized roots on most varieties. There is some evidence that the plant spacing on very early vigorous varieties such as Tango and Early Port may be reduced to about 8 inches for maximum yields under irrigation and optimum growing conditions.

Irrigating Sweet Potatoes

Contrary to popular belief, the sweet potato is not a drouth-resistant crop. This erroneous belief probably came from its widely recognized ability to "survive" long periods without rainfall. The "survival" is due to its extensive and deep root system, tapping large reservoirs of soil moisture. But once this supply of moisture is depleted to a point near the soil's permanent wilting percentage, sweet potatoes suffer the same as other plants and water is necessary both for continued growth and for root development.

In other words, sweet potato roots remove moisture from the soil to about the same degree of tension as other plants and use it with much the same degree of efficiency. While the plants can "survive" with very little soil moisture at the expense of vine and tuber development, experiments indicate that about 18 in. of water are required during the growing season for maximum yields.

Response to Irrigation

Because of the large "water tank" under the plants, it takes considerable time to exhaust the available moisture. This explains why large responses to irrigation are not usually obtained during short drouths, and why long irrigation intervals and heavy application rates are the usual practice.

During long drouths, the plant depends on stored soil water to meet its requirements. Experiments at this Station show that the sweet potato crop approaching full vine development and setting on roots (July & August) depletes soil moisture at a rate of 0.15 to 0.2 inch per

TABLE 5 -- RESPONSE OF PORTO RICO SWEET POTATOES TO VARIABLE AMOUNTS OF IRRIGATION
(Campbell, Mo., 1952)

Treatment	Inches of Water Applied	Inches of Effective Rainfall*	Marketable Yield U.S. No. 1 & No. 2 Bu./A.
Unirrigated	None	9.19	308
Moisture kept above 45% of Field Capacity**	7.0	9.19	462
1" of water each week	7.0	9.19	482
1 1/2" of water each week	9.5	9.19	536

(Campbell, Mo., 1952)

*Only a small part of this amount fell in the period May 25-July 27. The soil profile was at field capacity at transplanting time.

**In this treatment, 1" of water was applied when the available moisture dropped to 45% at a depth of 1' as determined by electrical resistance measurements.

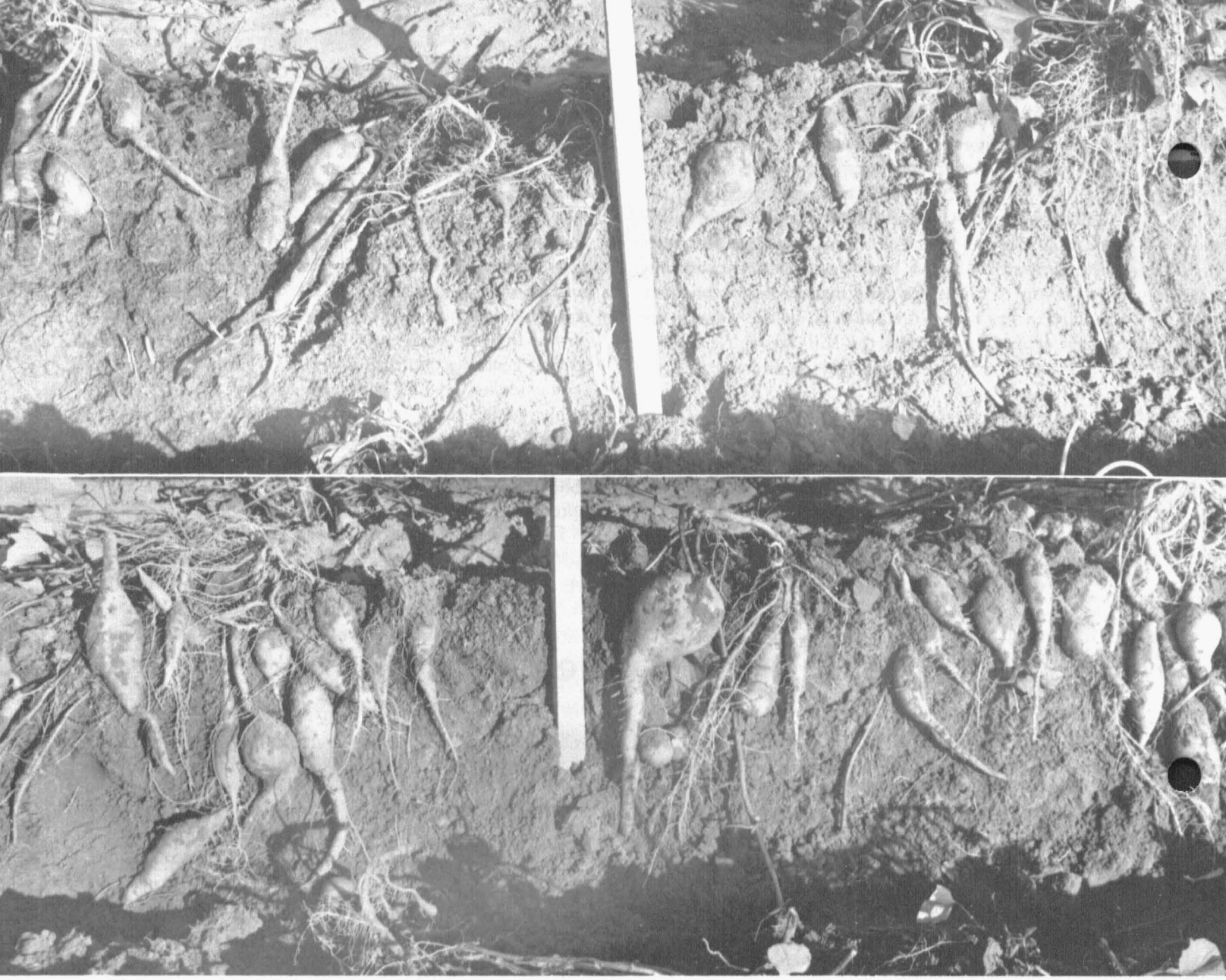


Fig. 3—Non-irrigated Porto Ricos yielded only 141 bushels per acre in 1953. In the same planting, soil kept moist to a 2-foot depth by irrigation produced 352 bushels per acre.

day. Assuming a sandy loam soil with 1.5 inches available moisture per foot of depth and an "effective rooting zone" of 3 feet, about 23 days would be required to exhaust the available moisture. And if the drouth continued, more than 4.5 inches of irrigation water would be needed to replenish the moisture supply.

The marked responsiveness of sweet potatoes to irrigation was well demonstrated during the 1952 season, in an experiment on Lintonia fine sandy loam (Table 5).

Notice that the same amount of irrigation water was applied in Treatments 2 and 3, and the yields were not much different. Moisture readings at depths greater than 1 foot indicated these irrigation applications were not enough to maintain satisfactory moisture levels at lower depths—that is, to keep up with the demands of the plants. This emphasizes the value of "knowing your soil moisture."

Irrigate Soon Enough!

Experiments were made in 1953 to find the level to which the moisture in the effective root zone could be allowed to drop without materially affecting yields. One plot was not irrigated. Available moisture in the other three was allowed to drop to 75%, 50% and 25% of field capacity before irrigating; then enough irrigation water was applied to bring the soil moisture to field capacity to

TABLE 6 -- EFFECT OF MOISTURE LEVELS MAINTAINED BY IRRIGATION ON YIELD OF PORTO RICO SWEET POTATOES
(Campbell, Mo., 1953)

Treatment	Inches of Irrigation Water	Inches of Rainfall	Yield 55# Bu. Per Acre. U.S. No. 1	U.S. No. 2	U.S. No. 1 & 2
Unirrigated	None	3.96	109	92	201
Moisture above 25% of F.C.*	6.5	3.96	152	128	280
Moisture above 50% of F.C.	8.0	3.96	240	174	414
Moisture above 75% of F.C.	11.5	3.96	226	202	428

*F. C. = Field Capacity. (Campbell, Mo., 1953

a depth of 2 feet. (See Table 6).

In the heavier irrigation treatments (50% and 75%), where water was applied more frequently, the soil was more moist at depths greater than 2 feet. These data suggest that irrigation of fine sandy loam soils should commence while the moisture in the root zone is still greater than 25%—possibly 40% to 50% of field capacity.

Electrical instruments for measuring available soil moisture are now available.

It is believed that the maintenance of a favorable and relatively uniform moisture level throughout the entire season will materially reduce losses from growth cracks and other root irregularities. This, however, has not been definitely proven.

Watch Depth of Wetting

The results obtained in 1953 suggested an experiment to learn the effect of maintaining a favorable moisture level to varying soil depths. Using different amounts and frequencies of irrigation, the soil moisture was maintained above 40% of field capacity to depths of 1-2 feet, 2-3 feet and 3-4 feet throughout the entire season. (See Table 7).

The figures suggest there is no advantage, even on the lighter textured soils, of maintaining high moisture levels by irrigation to a depth greater than 2 feet. While the sweet potato may root to depths of 6 feet or more, the subsoil moisture will not usually be depleted to a critical level—if the soil profile was at field capacity at the start and if high moisture levels are maintained in the upper 2 feet at all times.

Attempts to maintain high moisture levels to greater depths on heavy soils and those with impeded drainage may result in oxygen deficiency to the roots and greatly reduced yields.

The "soil moisture approach" to irrigation practice will help the grower avoid the two common and costly mistakes in irrigating vegetables—TOO LATE with TOO LITTLE. For the more "irrigation-minded" grower, it eliminates unnecessary irrigations and reduces the likelihood of over-watering.

TABLE 7 -- YIELD OF PORTO RICO SWEET POTATOES WHEN IRRIGATED TO VARYING SOIL DEPTHS
(Campbell, Mo., 1954.)

Treatment	Inches of Irrigation Water	Inches of Rainfall	Inches of Soil Water	Total In. Water Used 6/19-10/10	Yields Bu./A. U.S. No. 1	Total
Unirrigated	None	5.87	3.43	9.30	91	141
Moisture kept above 40% to depth of						
1' - 2'	9.73	5.87	1.72	17.32	274	352
2' - 3'	12.85	5.87	2.04	20.76	278	362
3' - 4'	14.07	5.87	0.81	20.75	278	363

(Campbell, Mo., 1954.)

Other Cultural Practices

Keep the Planting Free of Weeds

Sweet potato plantings should be kept as free from weeds and grass as practicable. The labor cost for weed control can be materially reduced by planting in soil which has been kept weed-free for several years and by proper preparation of the soil before transplanting. Since the vines interfere with cultivation late in the season, the best use of the cultivator is usually limited to the first few weeks after transplanting. Horse-drawn and power equipment should be used as much as possible to reduce the amount of hand-hoeing and the labor cost of controlling weeds.

Fig. 4—Sweet potato vines are usually so rank that they need to be cut on each side of the row before digging. This can be done with forward or rear-mounted disk-hillers, as shown here.

The two-horse corn cultivator is a very valuable implement for cultivation, since it permits lateral movement of the shovels in between and around the plants when working close. It is generally advisable to hoe out and pull weeds and grass within the row before the vines become large enough to interfere with cultivation. On unridged rows this hoeing should precede the cultivation in which the soil is thrown to the row. The disk hiller can be used to advantage early in the season to eliminate weeds on ridge rows. The disks are set to cut away the edges of the ridges and to throw the soil and weeds into the middles. In later cultivations the soil is then worked back to the ridges with sweeps.

Do Not Prune the Vines

Plants that have "gone to vine" should not be moved or pruned but rather left undisturbed as long as the growing season will permit. The carbohydrates (sugars) which accumulate as reserves in the roots are manufactured in the leaves and are thus only indirectly associated with the fertility in the soil. A moderate amount of foliage is necessary to size the root properly. In the case of plants that have "gone to vine" most of the carbohydrate reserves have been expended for vine growth. Pruning of the vines will reduce the effective leaf area and the manufacture of sugars and limit the proper sizing of the roots.

Handle Carefully During Harvesting and Grading

Careful handling of the sweet potato roots to maintain a continuous protective "skin" will materially reduce losses in transit and storage due to rots and shriveling. Every precaution should therefore be exercised during digging, picking-up, grading and packing to reduce damage to the "skin" from bruising, skinning or cutting of the roots. Moreover, the roots should be properly cured before storage and should never be exposed to temperatures much below 50° F as they are very subject to chilling injury.

Deciding when to dig is a problem of considerable concern to the sweet potato grower. Since the sweet potato root makes it fastest growth in the last four or five weeks before frost, there must generally be some compromise between obtaining maximum yields of marketable roots and taking a chance on frost and chilling injury. This is particularly true for late plantings and for the crop which is to be marketed late or held in storage.

Early varieties transplanted in May can generally be dug in September with good yields and no danger of chilling injury. In any case, as digging time approaches a few hills should be sampled from week to week to determine when the majority of the roots have sized sufficiently for the market. For late varieties it is generally advisable to allow them to grow as late as safety from chilling will permit. But they should be dug before the first hard frost or light freeze of the season. Seed stock should be dug about two weeks before the first killing frost is expected.

A light frost which damages the tender leaves, but does not freeze the crowns of the plants will not generally affect the keeping quality. When frost occurs, it is not necessary to remove the tops before sunrise as formerly believed. However, the occurrence of the first frost should serve as a warning that chilling temperatures are likely to occur and the roots should be dug as soon as possible.

Soil and weather conditions, too, may be decisive factors in regard to the time to dig. Other factors being the same, the roots should be dug when the soil works well and the outlook is for fair weather. If possible, avoid digging when the soil is wet and the weather cool and cloudy, as considerable difficulty with keeping in storage may be experienced.

The vines of most sweet potato varieties are so rank at harvest time that they should be cut on each side of the row before digging. This can be accomplished and the vines thrown to the middles with disk hillers attached to the tractor, a cultivator frame (Fig. 4) or the digger.

Fig. 5—New, improved models of sweet potato diggers and lifters are overcoming the problem of bruising that made early models unsuccessful.

There has been considerable research recently to develop a more satisfactory mechanical harvester for the sweet potato. Early models patterned after the conventional Irish potato digger were unsuccessful because of excessive bruising and skinning by the elevator chain. The newer models, including both plant lifters and diggers with short elevator chains (Fig. 5), have largely overcome this problem. Tractor drawn, moldboard plows (14 to 16 inch size) do a satisfactory job of digging with very little root injury. With smaller-shared plows it is usually necessary to "bar-off" the row on one or both sides to reduce its width so that the entire row can be turned up at one time without danger of leaving part of the roots or cutting into the sides of the hills. Extreme caution must be exercised to prevent cutting the roots when "barring-off" the rows. Generally, plows or diggers should be set just deep enough for the blade or share to pass under the roots without cutting. On power diggers with chains it is desirable that the digger be set deep enough that some soil moves over the elevator chain to serve as a cushion and reduce digging injury.

After digging, sweet potatoes should be left exposed to the sun and air only long enough for the soil clinging to them to dry and for the skin to harden. Where they are plowed out, it is necessary to remove the roots from the loose soil by hand. Pickers should wear cotton gloves and avoid tossing, piling and unnecessary handling of the roots. Sweet potatoes for early market can be graded in the field, each grade being placed in separate containers as they are picked. All unsound roots (cuts, bruises and rots) should be kept separate. Field grading at harvest time will result in more efficient use of labor, reduce container costs and result in less handling (and damage) in storage. Grading of washed potatoes for immediate market is best done at the packing shed.

Hill-Select Seed Stock at Harvest Time

The grower of sweet potatoes has more direct responsibility with respect to the production and maintenance of quality seed stock than with most any other farm crop. His best assurance of quality "seed" is his own selection and production program. This program should include selection from productive hills of roots showing no evidence of disease and which are true to type and have no unfavorable variation in form or color.

Since it is impossible to determine with certainty these factors at the packing shed or storage house, the selection should be made in the field at harvest time. A few bushels of roots selected in this manner can best be utilized by making a separate planting for seed increase. This planting should be isolated from the rest, on clean soil and given the best of care. The following year an adequate supply of good seed stock should be available for the commercial planting. Further selection can be made within the seed increase planting each year to obtain good foundation stock. This program should be a continuing one.

A qualified person should go ahead of the pickers and select desirable hills. During the selection the stems should be split to determine if stem rot is present. The roots from hills showing stem discoloration should not be used as seed stock. When a desirable hill is found, all the roots including the smaller ones should be saved for seed, since the small roots of a productive, disease-free hill are likely to have the same genetic makeup and the same potentialities for production as the larger roots from the same plants. In fact, the smaller sized roots from productive hills are frequently preferred for seed stock because they produce more slips per bushel than the larger roots. Discard the strings. Handle the selected roots very carefully, put in properly marked clean storage crates and place in the curing room.

Fig. 6—Packaging is a far more important step than most growers realize. Attractively crated roots like these command first attention when they arrive at a market. With sturdy packaging they also can be diverted to other markets if necessary.

Cure Immediately After Digging

After digging, the sound disease-free roots that are to be stored should be moved immediately into a heated storage room for curing. Roots which are badly bruised, diseased or which have been chilled should not be stored as they will not keep well and will cause the sound roots to decay more rapidly.

The curing process in addition to healing the wounds through the development of wound cork, favors the formation of a continuous protective "skin" over the entire root. Curing causes a slight loss in weight due to losses of water and carbohydrates, but this results in a "sweeter" potato because of the changing of starch to dextrins and sugar.

Before bringing in the crop, the storage room should be thoroughly cleaned and sprayed or fumigated with a good fungicide to kill the spores of rotting fungi which would later attack the roots. One satisfactory method is to spray the interior of the storage room and the storage crates or containers with a solution of copper sulfate (bluestone or blue Vitriol) made by dissolving 4 pounds of copper sulfate in 50 gallons of water. All exposed storage surfaces, including the ceiling, should be wet thoroughly with the solution.

Prior to bringing in the roots selected for storage, the temperature of the storage house should be brought to at least 70° F. After the crates or baskets are properly stacked, the temperature should be increased to approximately 85° F and held for about 10 days. Curing for longer periods at this temperature is likely to cause excessive sprouting. The ventilation should be adjusted very carefully to maintain a relative humidity of 85 to 90 percent. With inadequate ventilation, the humidity may become so high that moisture will condense on the roots or the walls of the storage room, a condition which growers refer to as "sweating." On the other hand, excessive ventilation, particularly when the relative humidity of the air outside the storage is low, will cause excessive shrinkage.

Care During the Storage Period

After curing, the temperature in the storage room should be dropped to 55° F for the storage period. The relative humidity should be maintained at 80 to 85 percent with a minimum amount of ventilation but always enough to prevent condensation of water droplets within the storage.

The temperature should never be allowed to drop below 50° F as the roots will chill. Chilling increases the susceptibility of the roots to infection by rotting organisms and reduces the ability (of seedstock) to produce sprouts when bedded. Several days' exposure to temperatures much below 50° F is likely to cause internal discoloration and decay.

The roots should not be sorted or disturbed in storage as the handling causes new wounds and spreads the rotting organisms. Experiments show that losses in storage may be doubled by extra handling. Small lots of sweet potatoes for home use can be kept by wrapping sound roots in newspapers and storing them in a partially heated basement or closet in which the temperature is maintained near 55° F.

Preparing Sweet Potatoes for Market

Only clean, sound, properly graded and uniformly sized sweet potatoes, packed in clean attractive packages, consistently bring good prices on the market (Fig. 6). This is true for either early marketing of uncured stock or late marketing of stored roots. Such special packaging pays especially well where there is an over-supply of sweet potatoes on the market. Frequently, a particular market outlet may be overstocked, in which case it is desirable that the quality and packaging be favorable for moving on to other markets.

Because of the increasing emphasis on an attractive product, washing before packing for the market has now become a common practice for both freshly dug and cured sweet potatoes. The conditions at harvest time, quality of the crop and type of market will generally determine whether there is any particular advantage in washing. In contradiction to a rather common belief, carefully controlled tests show that, except where black rot is prevalent, rotting in storage or in transit is not increased by washing. In addition to washing, it may be desirable to wax the highest quality roots to enhance their appearance.

Common Sweet Potato Diseases and Their Control

Fusarium wilt or stem rot (caused by Fusarium batatatis Wr. and F. hyperoxysporum Wr. and sometimes listed only as Fusarium oxysporum) is one of the most prevalent and destructive diseases. It is characterized by yellowing of the leaves, discoloration (browning) of the vascular tissues within the stem and, later, dying of the runners. The discoloration may occur in the vine as far as 8 feet from the roots and may extend downward into the root system. Discoloration of the fleshy roots as a rule is not apparent except in severe cases where the above-ground part of the plant is dead or very severely affected. Infected young plants may develop a rosette appearance, become stunted in growth and later set many small potatoes about the right size for seed.

Indiscriminate selection of small-sized roots at the grading shed will usually include a high percentage of wilt infected seed stock. Root stock for propagation should, therefore, be selected from disease-free plants at digging time. Split the stem and eliminate roots from hills showing discoloration. Certain varieties such as Gold Rush and All Gold carry some resistance.

Plant bed sanitation and four or five-year crop rotations also assist in reducing the prevalence of wilt. Fungicide dips or sprays cannot cure infected seed stock but may be of value in reducing the spread in plant beds.

Black Rot. Black rot, caused by the fungus Ceratostomella fimbriata (Ell. and Halst.) J. A. Elliott, is primarily a storage rot, but also occurs in the field and plant bed. Infected plants first show a yellow, sickly appearance of the foliage and localized black cankers that develop on the under-ground portion of the stem and the roots. The circular sunken cankers vary in size. They are gray-black when dry and dark-greenish black when moist. Decay beneath the surface is usually dry and does not usually go beyond the vascular tissue.

Effective control of black rot is dependent upon selection of sound roots from healthy vines and preventing infection during cultural operations. This includes disinfection of the roots before bedding, use of clean or sterilized soil in the plant bed, planting on clean soil and careful sorting of the roots before storage.

Scurf. Scurf, caused by the fungus Monilochaetes infuscans (Ell. and Halst.) ex Harter, is characterized by a regular brownish-superficial discoloration of the underground parts. Unlike black rot, the fungus does not penetrate deeply into the root tissue but kills only the outermost layers of cells. With the protective cork layer of the skin destroyed, the roots shrivel quickly in storage and become dry and leathery. Clean seed stock and the preventative measures which are effective for other diseases will also control scurf.

Surface Rot. Surface Rot (Fig. 7) is caused by the fungus Fusarium oxysporum, which is very closely related to the stem rot organism. Shallow, circular lesions, brownish in color and sometimes measuring 2 or more inches in diameter develop on the surface. Generally, the decay extends only a short distance into the flesh of the root. As with black rot, the lesion margins are very regular and the margins are not sunken in the early stages of infection. Unlike black rot, however, shrinkage of the lesions continues to a point where the diseased root becomes shrunken and mummified. The disease generally follows periods of wet weather and is more prevalent among sweet potatoes that are not properly cured.

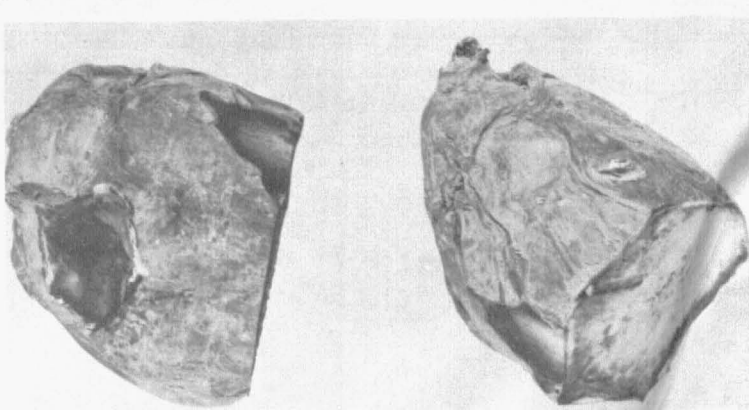
Losses from surface rot can be reduced by digging when the soil is relatively dry and the weather clear so that the roots can dry before they are placed in storage.

Rhizopus Soft Rot. Rhizopus soft rot is one of the most destructive storage diseases. The disease starts as a soft watery rot in the flesh and develops rapidly, often disintegrating the entire root within four or five days after infection. The infected fleshy tissue of the root becomes soft and stringy and water exudes readily when the skin is broken.

Since soft rot infections occur through wounds in the skin, it is essential that injury be kept to a minimum during digging, grading and handling. Digging when the soil is wet and the temperature is low also makes the roots more susceptible to soft rot. After digging, the roots should be cured immediately at approximately 85° F so that wounds through which infection occurs are healed rapidly.

Soil Pox. Soil pox, caused by the fungus Actinomyces batatatis Pers. and Martin, is not a common disease in

Fig. 7—Surface rot is caused by a fungus. Note circular lesions of shallow depth. Lesions are brownish in color and measure up to 2 inches in diameter. Digging when the soil is fairly dry and proper curing will reduce loss.



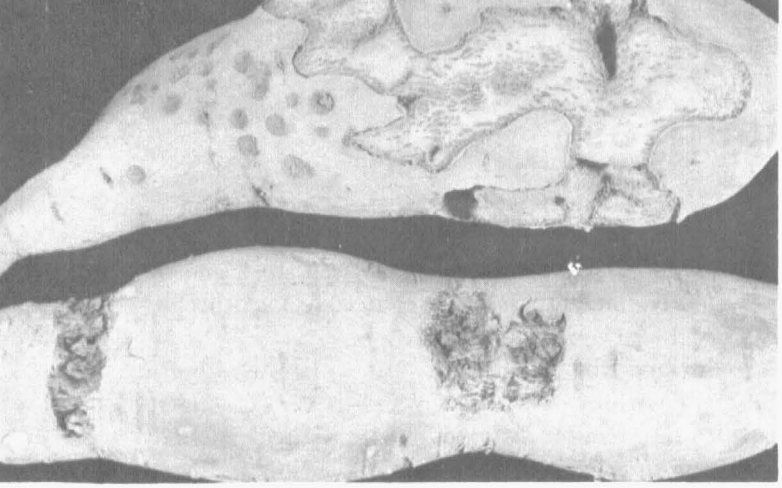


Fig. 8—Soil pox. The fungus causes sunken pits 1½ in. or more in diameter with jagged margins. Roots frequently become dumbbell-shaped.

most areas of the state, but it can be found on some of the older vegetable farms in the St. Louis area.

Damage by the fungus consists of malformation and pitting of the fleshy root and decay of the plant rootlets. The symptoms and degree of damage depend largely on the stage at which infection occurs. Early infection when the roots are small results in constrictions and malformed shapes while infection of more nearly mature roots, presumably through lateral rootlets, causes scurfy lesions but little or no constriction.

Sweet potatoes should not be grown on infected soil as present corrective measures are unsatisfactory. Use long rotations where possible. Maintenance of turnover of organic matter should be by use of green manure crops rather than barnyard manure or carbonaceous materials.

Internal Cork. Internal cork, a virus disease widely distributed throughout the southeastern sweet potato region, is not common in Missouri. Infected plants first show an indistinct mottling of the leaves on most varieties, followed by ring spotting and finally by bronzing and leaf drop. Although the yield is not materially reduced, the disease is of serious consequence to growers because of the development throughout the flesh of dark brown to blackish, hard, corky spots (Fig. 9) which vary in size up to 3 centimeters across and 5 centimeters in length. These corky areas generally increase rapidly in size and number in storage, particularly at high temperatures.

Control of the disease is made difficult because the infected roots appear normal on the outside and can be recognized only by cutting the roots into slices. Hence, it is impossible to cull out all infected roots before bedding even though the ends are "nicked."

The most effective control is to prevent introduction of infected root-stock into the state and its dissemination among growers through infected plants. Plant growers, particularly, when obtaining new root stock should insist on Certified stock and then carefully check it before bedding for evidence of disease. Any infected stock should be destroyed immediately by burning or cooking.

Insect Pests of Sweet Potatoes

Although insect injury on sweet potatoes is not usually severe enough to be a major problem, minor damage may occur from the sweet potato leaf beetle, tortoise beetles and the sweet potato flea beetle. Fortunately, these insect pests are easy to control.

Sweet Potato Leaf Beetle. This insect is a metallic, bluish-green, hard-shell beetle about ¼ inch long that feeds on sweet potato foliage and related plants. The beetles generally start feeding at the leaf margins and continue toward the stem. The larvae or grub is pale yellow, has a light-brown head and three pairs of legs and is about ⅜ inch long when full-grown. It sometimes causes damage to the roots by tunneling into the flesh.

Tortoise Beetles or Goldbugs. These beetles are generally highly colored (golden-hued, spotted, striped or mottled) and have flat tortoise-shaped or oval bodies. The larvae are short, flattened grubs with forked tail-like appendages. Both the larvae and the adult beetles eat small holes in the leaves and may cause severe defoliation. Injury may be severe on newly transplanted plants.

Sweet Potato Flea Beetle. This insect is a black beetle about the size of a cabbage seed with a bronze cast and reddish-brown legs. It attacks sweet potatoes late in the spring, cutting irregular channels in both surfaces of the leaves and may cause sufficient injury to young plants to necessitate replanting.

Control Measures for Insects

These insects, together with certain others occasionally causing trouble, can be controlled by dusting with 3 to 5 percent DDT or by spraying with 2 pounds of 50 percent wettable DDT powder in 100 gallons of water as soon as the beetles or larvae are found.

Fig. 9—Internal cork is a serious virus disease. It is not yet common in Missouri but is threatening the sweet potato industry in the Southeast. Internal cork is spread through use of infected seed-stock and plants.