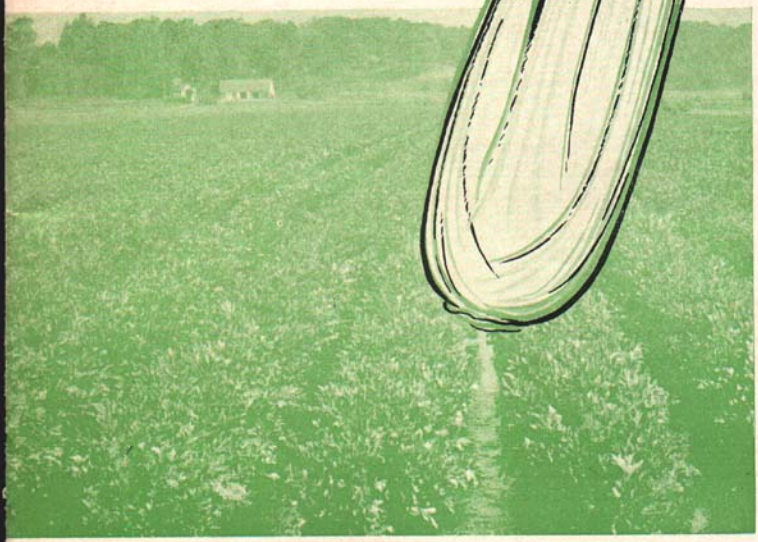
Extension Bulletin 339

Celery Production in Michigan

By R. E. Lucas
and S. H. Wittwer



Cooperative Extension Service
Michigan State University
East Lansing

TABLE OF CONTENTS

Celery Production in Michigan

By R.E. LUCAS[1] and S. H. WITTWER[2]

Celery was first offered in the United States as a curiosity and food delicacy in Kalamazoo, Michigan, as early as 1856. From that historical beginning 100 years ago, an industry has grown in the United States, the product of which is valued annually at about 60 million dollars.

Celery production has expanded in recent years, especially in Florida and California. Meanwhile, the Michigan acreage increased slowly to a high of about 7,000 acres in 1940-41. Since then, production has fallen to about 3,200 acres. Average yields in Michigan are about 450 crates per acre, with a gross sale value of 3 to 4 million dollars.

To regain lost markets and realize a profit, Michigan growers must use varieties that will compete successfully, adopt the latest in management practices, and offer an attractive pack. This bulletin describes those three steps in boosting sales and profits.

VARIETIES

Most celery varieties are classified either as green or golden (self-blanching). The green types include Utah Pascal and Summer Pascal; Golden Pascal and Golden Plume are self-blanching types. In view of market demands, general appearance, and eating quality, the production of Utah Pascal and Golden Pascal is best for Michigan growers.

Green Types

1. *Utah Pascal* is the most popular green celery, being preferred by most markets. It requires more moisture and fertilizer and takes longer to mature than do most golden varieties. The heavy foliage and large plants also require more spray or dust for good coverage in disease control.

Varieties that have done well in Michigan include Utah 10B, Utah 52-70, Utah 52-70 H, Utah 16, and Utah 16-11. Other well-known varieties in this group include Sluis' Utah, Utah 15, Utah 6, Utah

[1]Associate Professor (Extension) of Soil Science.
[2]Professor of Horticulture.

Jumbo, Utah Special, Pascal Superb, Utah Top Ten, and Utah Ten Grand.

2. *Summer Pascal* is extensively grown in Florida as a winter and spring crop, but increased acreage of this type is not encouraged for Michigan. The stalks are generally short and heart development is poor. Most varieties bolt to seed easily. Varieties include the Waltham Strain, Tall Summer Pascal 259-19, Tall Fordhook, and Florida Green Pascal. Most green celery varieties show resistance to fusarium yellows disease.

Golden Types

1. *Golden Pascal* is the standard for market quality in a golden celery. Buyers would ask for more self-blanching celery if only Golden Pascal were sold. Cornell 19 is the recommended variety. A slower bolting strain should be available within a few years from the Michigan Agricultural Experiment Station for early spring plantings. It will be resistant to fusarium yellows.

2. *Golden Plume* and *Golden Self-Blanching Types,* while still widely grown for market, should be used only for processing. Suitable varieties are Resistant Golden Plume, Supreme Golden (Hadley), and Early Fortune.

Grow either fully green or golden celery. Avoid the half green or easy-blanching green types. There is also a decreasing demand for Golden Plume and Golden Self-Blanching celery. While such types will stand rougher handling and more distant shipping, the quality is not good. This lack of quality has been largely responsible for the decreasing demand for the once-famous Michigan golden celery. Furthermore, early plantings of Golden Plume often mature when the market is weakest.

The early crop is expensive to grow. Even under the best conditions, it often bolts to seed prematurely. Growers anxious to prevent further losses then rush it to market before it is mature. Once mature, immediate harvest is necessary because it turns pithy in a few days. This discourages orderly marketing.

Celery plantings in greenhouses and fields should be delayed slightly until Golden Pascal (Cornell 19) and Utah Pascal varieties can safely be grown. A high quality product begins with a good variety.

PRODUCTION AND SOIL MANAGEMENT

Seeding and Plant Growing

Two ounces of celery seed produce enough plants to set an acre when transplanted 6 inches apart in 32-inch rows.

For the early crop, sow 1 ounce of seed on each 100 square feet of greenhouse bed surface 10 to 12 weeks before you plan to transplant to the field. Broadcast seed or sow in rows 2 inches apart. Cover the seed with a thin layer (⅛ inch) of muck or vermiculite (No. 2 grade). After 4 to 5 weeks, transplant seedlings 1¼ to 1½ inches apart into flats or beds in greenhouses or into hotbeds (Fig. 1).

For the late crop, seed directly in outdoor frames during April and May, using a muslin or glass substitute cover. Use a lighter rate of

Fig. 1. Transplanting celery in 1¼-inch squares results in uniform plants and earlier maturity.

Fig. 2. Lifting celery plants from bed in greenhouse for transplanting in field. Notice the well-formed roots.

seeding than for the early crop, since you will move plants directly to the open field.

Celery seed germinates slowly and the seedlings are subject to "damping-off". Use steam-sterilized muck, mixtures of fine sand and muck, or disease-free new muck soil for seedbeds. Keep beds warm and moist until seedlings appear.

For good growth in seedlings, water periodically with solutions containing ½ to 1 ounce per gallon of an all-soluble complete fertilizer; use one that is high in phosphate, such as 10-52-17. Maintain greenhouse temperatures around 65 to 70 degrees (Fahrenheit). After seedlings emerge, a temperature of 60 to 65 degrees F. is best for steady growth.

Prior to field transplanting, keep the plants at a height of 4 to 5 inches by periodically clipping the top leaves of the celery plants. This results in greater uniformity and plants more suitable for handling in mechanical transplanters. (See Figs. 2 and 3.)

Soil for sowing new seed should be fertile but not high in soluble salts (Fig. 4). Test all soils and fertilize them accordingly. An adequate level for growing celery plants is 150 pounds of available nitrogen, 30 pounds of phosphorus, and 400 pounds of potassium per acre (Spurway active test). Where soil fertility is low, add 4 to 5 pounds of 5-20-10 fertilizer for each 100 square feet of bed space. Mix thoroughly in the soil and apply water before seeding. Do not use fertilizers containing borax for small seedlings.

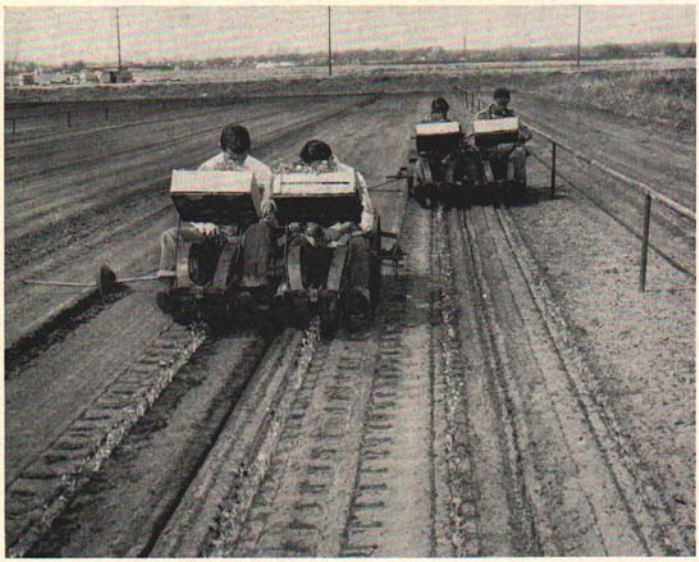


Fig. 3. Two-row engine-driven celery transplanters. These machines give even spacing and press the soil firmly around each plant.

Fig. 4. The effect of fertilizer on the growth of celery transplants. Amount equivalent to tons per surface acre of a 3-9-18 fertilizer: No. 1 = 1 ton; No. 2 = 2½ tons; No. 3 = 5 tons; No. 4 = 8 tons.

(Photo by J. F. Davis)

Soil Requirements

Celery in Michigan is grown on organic soil with a pH of 5.2 to 7.5. When the pH is above 6.5, apply 300 to 500 pounds per acre of sulfur or 20 pounds per acre of manganese. If the pH is less than 5.2, add lime.

Drainage should be good but not excessive—celery requires a relatively high water table. Where you can control the water level, keep it at 20 to 28 inches below the surface.

Crop Rotation

Intensive growing of celery on the same land for many years has reduced production in some areas so much that the crop is unprofitable. The main cause of low production is a buildup of soil-borne

pests such as nematodes, blight spores, and fusarium wilt ("yellows"). On some mucks, soil compaction has become a problem.

Crop rotation or growing green manure cover crops will help maintain high production. Rye is good winter cover crop. Late summer cover crops are Sudan grass, oats, or drilled corn. Cash crops suggested for rotation are onions, sweet corn, potatoes, mint, and carrots. Because of the large amounts of fertilizer commonly used, it is often not necessary to fertilize the crop following celery.

Growers with limited acreages should consider leasing more land. They can then practice crop rotation and still maintain celery production at a profitable level. It may be advisable to farm new areas. Michigan has plenty of muck land suitable for celery production. Furthermore, there is a trend away from small farms to larger ones. Production has become more mechanized and growers are using more seasonal labor.

Fertilizers

For the early crop, broadcast or drill in 5-10-20 at the rate of 1,500 to 2,000 pounds per acre. Use 5-10-20, 5-10-30, or 0-10-30 at similar rates for the late crop. For soils low in potassium, plow down 500 pounds per acre of salt (sodium chloride).

Virgin mucks or those low in fertility require 5-10-30 at the rate of 2,000 pounds per acre. After 3 years of continuous cropping in celery, use 1,500 pounds per acre of 5-10-20. Sidedress all early plantings with nitrogen fertilizer or with 14-7-7 within 4 to 6 weeks after transplanting.

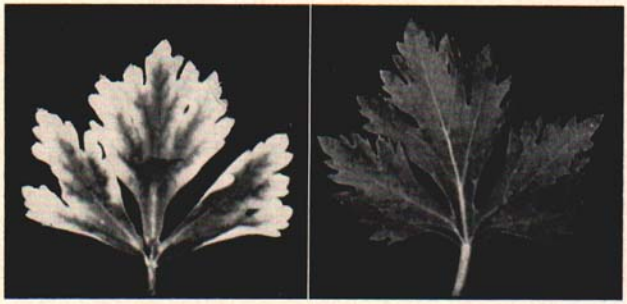


Fig. 5. Magnesium deficiency of celery. Left: leaflet showing magnesium deficiency symptoms. Right: normal leaflet.
(Photo by J. F. Davis)

Fig. 6. Blackheart of celery caused by a calcium deficiency. Trouble appears in hot weather with rapid plant growth and where soils are high in fertilizer salts.

On soils with a high water table, or for old compact soils, it may be necessary to apply as much as 100 pounds of nitrogen per acre as a sidedressing. Ammonium nitrate or urea is a good form of nitrogen. Avoid excessive use of nitrogen, particularly late in the growing season —it may cause celery not to hold up well on the market.

Magnesium deficiency or yellowing of the leaves may be a problem, especially with Utah Pascal (Fig. 5). Varieties which often show serious yellowing are Utah 10B, Utah Top Ten, Utah Ten Grand, Pascal Superb, Superior Pascal, Utah 16 and Utah 16-11. You can prevent this deficiency by spraying with magnesium sulfate (Epsom salts) at the rate of 1 pound per acre per day. You can apply it weekly in regular fungicide sprays at the rate of 7 pounds per acre.

Blackheart is a disorder caused by calcium deficiency. The growing tips in the heart die and turn black (Fig. 6). Florida horticulturists recommend weekly sprays throughout the season of 5 to 10 pounds of calcium chloride or 10 to 20 pounds of calcium nitrate[3] per acre. A

[3]Geraldson, C. M. (1955). Control of blackheart in celery. Fla. Agr. Expt. Sta. Cir. S-83.

coarse spray should be directed into the heart (Fig. 7). Spraying the outside leaves is not effective.

Many Michigan celery growers had serious losses from blackheart during the summer of 1955. High temperatures, rapid growth, and a lack of water were the main causes of calcium deficiency. High soil levels of sodium, potassium, and nitrogen are also believed to favor blackheart.

To prevent "cracked stem," you must apply boron. For soils above pH. 6.0, use 0.25 percent boron in fertilizer. (This is supplied by applying about 45 pounds of borax per acre.) Soils more acid than pH 6.0 need only about half this amount. You can also prevent boron deficiency with spray applications containing 1.0 to 2.0 pounds of borax per acre. You can include boron, manganese, and magnesium in regularly applied organic fungicide sprays.

For soils above pH 6.5, use 1 to 2 percent manganese in the fertilizer or apply it as a plant spray at the rate of 3 to 5 pounds of water-soluble manganese sulfate per acre.

Copper may be helpful in acid soils recently brought under culti-

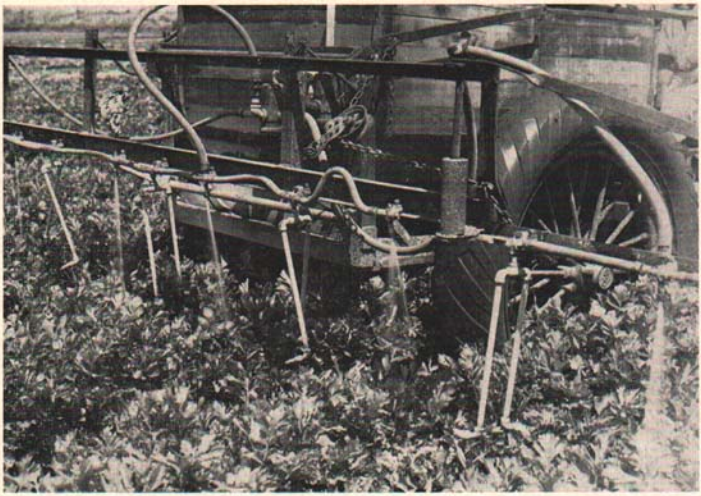


Fig. 7. Applying calcium solution to the heart of celery plants. The extended nozzles between the rows are blocked off.

(Photo courtesy of C. M. Geraldson)

vation. Use 0.5 percent copper in the fertilizer if you do not use copper in the fungicide spray.

Field Planting

Transplant celery during April and May for the early crop; transplant from June 1 until July 15 for the late crop. Spacing depends upon variety, the intended market, and size of plants desired. Celery for processing is usually spaced 4 inches apart in 32-inch rows. Market celery should be spaced at 5 to 6 inches.

Paper Covers

Growers use paper covers in some western Michigan areas for transplants set in the field during April and early May. Place parchment paper over each row as a continuous tent (Fig. 8). Paper covers

Fig. 8. Early celery protected from cold weather by paper in the Hudsonville area. Wire arches 3 feet apart support the paper. Soil laid on edges protects the paper from blowing.

give considerable wind and frost protection and may decrease premature seeding. Celery grown under paper will mature earlier. Its use also frees valuable greenhouse space. Punch holes for ventilation in the paper 7 to 10 days before removing.

The paper is usually removed in late May to prevent excessively high daytime temperatures underneath and to allow unrestricted plant growth. Less paper has been used each year because of the high cost of material, the extra labor, and the smaller premium paid for early celery.

Premature Seeding or "Bolting"

Exposure to cool temperatures (below 50 to 55° F.) for 2 weeks or longer either in the plant house or field is likely to result in premature seeding. Continuous frost or near-freezing temperatures for long periods after transplanting are hazardous. To help cut these losses, use slow bolting varieties, delay plantings of susceptible varieties, protect seedbeds, and cover early plantings with paper.

Many celery plantings bolt because of too low temperatures while still in the greenhouses. Often some parts of the greenhouse are much colder than others. Inadequate heating facilities and poor heat distribution are a frequent cause of premature seeding. Greenhouse temperatures should not fall below 60° F.

Irrigation

Celery, especially the new Pascal types, requires a soil high in moisture if it is to grow uniformly and rapidly. Irrigation is especially needed right after transplanting. Wetting the soil surface with overhead irrigation helps to reduce frost and wind damage. Where you observe nematodes, keep the soil quite moist. Fields that are excessively drained need about 1.5 inches of water per week. You can irrigate by: (a) subirrigation, (b) overhead irrigation (Fig. 9), and (c) surface trench flooding (see front cover).

Subirrigation is accomplished by backing water up through tile drains or open ditches. This requires dams in open ditches or control box structures in tile outlets. Maintain the water level in the field at 20 to 28 inches below the soil surface. For effective subirrigation, space the tile lines about 40 feet apart. Water for subirrigation may come from streams, ponds, springs, or wells.

Fig. 9. Overhead irrigation aids faster growth for young transplants and gives frost protection.

Overhead irrigation or surface trench flooding is used when subirrigation is not practical or the water supply is limited. Overhead irrigation on established plantings may increase leaf blights because the spores germinate quickly at high humidity. About 28,000 gallons of water are required to apply 1 acre-inch. An efficient irrigation system must allow for the area to be watered, distance the water is moved, well capacity, pressure needed, pump type, and kind of power.

Consult a competent engineer before buying an irrigation system. You can get more information in Extension Bulletin 309, "Supplemental Irrigation in Michigan", and Extension Bulletin 338, "Tractor Power for Power-Take-Off Driven Pumps." Your county agricultural agent can give you a free copy of each, or you can write to: Bulletin Office, Michigan State University, East Lansing, Michigan.

Cultivation and Weed Control

Oil sprays such as Stoddard Solvent have been successfully used for weed control on young plants in field seedbeds (one- to three-leaf stage). Rates of 50 to 80 gallons per acre are satisfactory. Do not use oil sprays after transplanting except on very young plants.

Cultivate to control weeds and to loosen compact soils. Additional cultivation is not recommended as celery is shallow-rooted and roots are easily destroyed. For the first cultivation, use knives which move close to the plants. Use discs or sweep attachments between the rows. For later cultivations, set the knives shallow for weed control or use a single sweep between the rows.

DISEASE CONTROL*

Seedbeds

Use soil not previously planted to celery and related vegetables or infested with weed seeds. Old soil may be used if it is steam sterilized at 180° F. for at least 1 hour. If soil is steamed, do not seed until the soil has rested for 10 to 14 days and excess soluble salts are leached out by heavy watering. Fumigating greenhouse beds with methyl bromide is not recommended.

Seed Treatment

To prevent seed-borne diseases, coat the seed thoroughly with one of the following:

Arasan (50%)—coat seed thoroughly.

Cuprocide (80%)—0.5 teaspoonful per pound of seed.

Plant Treatment in Seedbeds

To control damping-off, spray or drench with a fungicide at 4- to 7-day intervals. Apply at the rate of 12 gallons per 1,000 square feet of seedbed. Use one of the following materials:

Fungicide	Amount per 10 gallons
Spergon (48%)	5.0 ounces
Thiram (50%)	1.5 ounces
Captan (50%)	3.0 ounces

You can apply Captan (7 percent) as a dust at the rate of 1½ pounds per 1,000 square feet. After transplanting into beds, increase dosages of Captan to 2 pounds per 1,000 square feet.

Early and Late Blight

Failure to control celery blight is one reason for poor quality and low yield. Early blight *(Cercospora apii)* spreads fastest during periods of high daytime temperatures followed by heavy night dews or rain showers. Workers should keep out of celery fields when the plants are wet.

The early blight organism can live in diseased plant refuse and in the soil. Under favorable conditions, the spores are produced in great

*This section prepared under the supervision of Dr. Ray Nelson and other members of the Department of Botany and Plant Pathology.

numbers and are carried by air currents onto the leaves of growing celery.

Early blight appears first as small, circular, pale yellow spots on the leaves. When the spots are numerous, they merge to form large, irregularly shaped lesions. The color of the spots changes from yellow to brown, and, in advanced stages, to an ash gray.

Late blight *(Septoria apii)* is generally considered a cool weather disease. It is capable of living over in the seed and in diseased celery refuse. The disease can easily be spread by shattering, by windblown rain, and by workers in the field. Late blight is especially destructive when present in stored celery. Watery soft rot and bacterial soft rot enter through late blight lesions easily and can cause serious market decay of affected plants.

There are two types of late blight, the small spot form and the large spot form. The small form is more common. When this disease is general, the spots cause large brownish-black areas (Fig. 10) and show numerous black pinpoint-size fruiting bodies.

Once blight has taken hold, it is very hard to control. To control both early and late blight, treat seedbeds and field plantings every 4 to 7 days. The interval will depend upon weather and the degree of blight infection. For large plants, use spray equipment having four to five nozzles per row. Make certain that some of the spray is directed upward to cover the underside of the leaves.

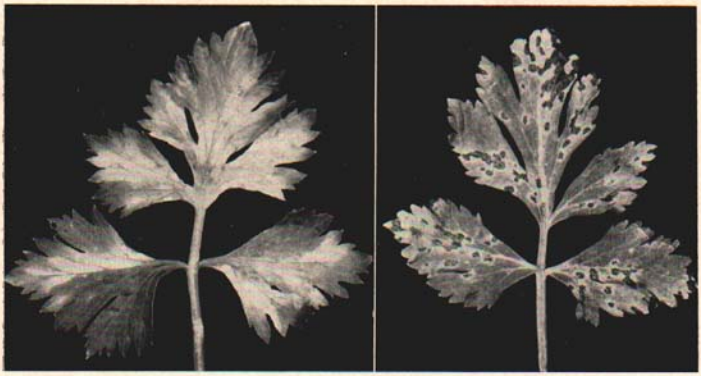


Fig. 10. Leaf blight in celery. Left leaflet shows early blight in beginning stages. In later stages the small circular spots enlarge and form large irregular lesions. Right leaflet shows typical late blight symptoms.

Use one of the following fungicides:

Fungicide	*Amount required per acre (regardless of quantity of water applied)*	
	Small Plants	*Large Plants*
Nabam plus zinc sulfate	2 quarts plus 1 lb. zinc sulfate	4 quarts plus 2 lb. zinc sulfate
Maneb	1½ lb. (powdered)	3 lb.
Zineb	2 lb. (powdered)	4 lb.
Fixed copper (50%)	4 lb.	8 lb.
Bordeaux	8 lb. copper sulfate plus 8 lb. hydrated lime	16 lb. 16 lb.

Nabam, maneb, and zineb have a legal maximum tolerance of 7 parts per million (by weight) on harvested celery. The safe period for making the last application is no later than 7 to 10 days before harvest. Bordeaux and fixed copper materials are exempt from a tolerance requirement if applied in accordance with good agricultural practices.

Some growers alternate the application of one of the organic fungicides with copper. Dust formulations at 30 to 40 pounds per acre are about equally effective used as sprays if applied while the foliage is damp. In general, use about 7 pounds of fungicide per 100 pounds of dust. The use of dust, either copper or zineb containing 20 percent sulphur, is especially recommended.

Aster Yellows

Aster yellows is a virus disease. Infected plants are undersized and light yellow or white in color. The heart is considerably twisted and may show decay (Fig. 11). This rot may attract maggot flies. Infected plants are usually scattered all over the field but generally are more numerous around the borders. (For control, see section on insects.)

Blackheart

(See section on fertilizers.)

Fusarium Yellows

This disease is commonly called "yellows". It is caused by a fungus which lives in the soil. It will persist for a number of years, even in

Fig. 11. Celery affected with aster yellows. Notice twisting and decay in heart of plant. This disorder is a virus disease and is spread by the six-spotted leafhopper.

the absence of a celery crop. A number of resistant varieties have been developed (see Varieties). The most noticeable symptom is a general yellowing of the leaves, together with a dwarfing and stunting of the plant. Veins of the leaves either remain green and the tissue between the veins turns yellow, or the veins turn yellow and the tissue stays green. Diseased plants develop crown rot and root rot, and they later wilt and die.

Pink Rot

This disease of many vegetable crops is often called watery soft rot and sclerotinia rot. The organism lives over in infected plant refuse and in the soil. Under favorable moisture and temperature conditions, the organism grows out through the soil to attack young plants. It forms small mushroomlike structures at the surface of the soil. Numerous spores are then produced which are discharged and carried by air currents to healthy plants.

The presence of moisture is necessary for the growth of spores. Fresh wounds and frost damage favor infection.

There is no way of completely controlling "pink rot." Celery harvested from fields where the disease is present should be carefully inspected and then sold for immediate use. Move the celery in a dry, cool condition.

Miscellaneous Diseases

Gray mold, phoma root rot, bacterial soft rot, bacterial blight, and mosaics are other diseases that attack celery. For help in controlling them, see your county agricultural agent.

NEMATODES

Nematodes are microscopic eel-shaped roundworms. Several species feed upon celery and are found either on root surfaces or inside the root. One serious species, called root-knot nematode, produces small galls (Fig. 12). The presence of other types can only be confirmed

Fig. 12. Young celery plants infected with root-knot nematodes. Notice root galls on numerous branching roots.

by microscopic examination. Damage by these parasites is first suspected when plants lack vigor and do not respond to fertilizer. Infested plants wilt easily during hot, dry weather. The roots are brown instead of white. The root-knot species causes a heavy, dense growth of fibrous roots that die prematurely.

Sanitary cultural methods are necessary for nematode control. Normally, they do not move far in the soil. They are spread by using infected transplants or by moving contaminated soil. Surface trench flooding will also spread nematodes by soil erosion. Crop rotation including grass or a corn crop will help control root-knot nematodes, but it may not be effective against other types.

Since celery is a high value crop, growers should fumigate if a possibility of nematodes exists. Use "DD" at the rate of 45 gallons per acre or ethylene dibromide at the rate of 6 gallons (100 percent EDB) per acre. Soil fumigation is possible only when fields are not in crops. Generally, fall fumigation is best for early planted celery.

INSECT CONTROL *

A satisfactory insect control program is necessary for successful celery production. Insects spread both mosaic and aster yellows to celery. The following table lists the important celery insects and control materials. USE ONLY ONE OF THE MATERIALS LISTED FOR EACH INSECT. *(W. P. indicates wettable powder.)*

TABLE 1—Insect control recommendations for celery

Insect	Sprays (amount per acre, usually in 100 gal. of water)	Dusts (percent strength)
Aphids	Parathion: 1 lb. 15% W.P. or equivalent	Parathion 1%
	Malathion: 2 lb. 25% W.P. or equivalent	Malathion 5% (or 4%)
	Nicotine Sulfate: 1 pt. plus 4 lb. laundry soap	Nicotine Sulfate 4%
Tarnished plant bug	Parathion: 1 lb. 15% W.P. or equivalent	Parathion 1%
	Pyrethrum: ½ pt. of 1%	0.2-0.3% Pyrethrins

* Prepared by Gordon Guyer and Ray Janes, members of Department of Entomology.

Insect	Sprays (amount per acre, usually in 100 gal. of water)	Dusts (percent strength)
Celery leaf tier	DDT: 2 lb. 50% W.P. or equivalent (apply only in seedbed)	DDT 5% (apply only in seedbed)
	Malathion: 2 lb. 25% W.P. or equivalent	Malathion 5%
	Pyrethrum: ½ pt. of 1%	0.2-0.3% Pyrethrins
Leafhoppers (Treat field margins)	Parathion: 1 lb. 15% W.P. plus 2 lb. 50% DDT W.P. or 1 qt. of 25% DDT emulsion	Parathion 1% plus DDT 10%
(on plants)	Parathion: 1 lb. 15% W.P.	Parathion 1%
Cutworms	Toxaphene: 3 lb. 40% W.P. or equivalent	Toxaphene 7½%
Wireworms	Chlordane: 20 lb. 40% W.P. for muck soils. Do not exceed 10 actual pounds of chlordane over a 3-year period. Apply to surface of soil and disc into top 3 or 4 inches.	
Carrot rust fly	The carrot rust fly has been found on celery in the northern section of the lower peninsula. If you suspect that this insect is causing damage, contact your county agricultural agent.	

Insect control by sprays or dust depends on correct timing and proper coverage. Increase application rates as the plants increase in size. Apply a dust at the same rate of actual insecticide as for the spray. For example, instead of spraying 2 pounds of 25 percent malathion wettable powder per acre (a total of ½ pound of actual malathion) to control aphids, you could apply 10 pounds per acre of 5 percent malathion dust. To prevent injury, use the wettable powder formulations on young plants.

Take care to prevent poisonous residues on the plant at the time of harvest. Do not apply DDT and Toxaphene after the bunch begins to form. The safe period before harvest for other materials is: parathion, 21 days; malathion, 7 days; nicotine sulfate, 5 days; TEPP, 3 days; and pyrethrum, 1 day.

Six-spotted Leafhopper (and Aster Yellows)

To prevent aster yellows disease, you must control the six-spotted leafhopper which transmits the virus. Treat field margins before celery is planted and each 7 days thereafter until four treatments have been made. Treat the growing crop for these leafhoppers when transplants are first set in the field and five times at 7-day intervals. Seedbeds also need treating.

Aphids

Aphids spread mosaic. By controlling aphids, you can control the disease. Most growers wait too long before attempting control. For best results, apply insecticides when the aphids first appear. Be sure the spray comes in direct contact with the body of the aphid.

Other Insects

The celery leaf tier usually appears within a few weeks of harvest. Pyrethrum and malathion are the only materials which you can use safely at that time.

The carrot rust fly is an insect which has appeared in scattered areas in northern Michigan. The larvae destroy the fibrous roots and sometimes bore into the crown of the celery plant.

Always read carefully and follow the *instructions* and *precautions* printed on the package label. Detailed instructions for control of celery insects are contained in Michigan State University Extension Bulletin 312, "Insect and Disease Control on Vegetable and Truck Crops."

HARVESTING AND MARKETING

Blanching

The use of self-blanching varieties, as well as an increased market demand for green celery, has largely eliminated the use of boards or paper for blanching. Some blanching of Golden Pascal (Cornell 19) is generally needed, however, to bring out its best flavor and market appeal. Boards and special paper are useful for producing celery hearts, for a more erect stalk, and for early celery. Boards used for blanching are about 1 foot wide, 1 inch thick, and 14 feet long. You can buy special paper which is held by wire spanners, spaced 5 feet apart, that straddle the row.

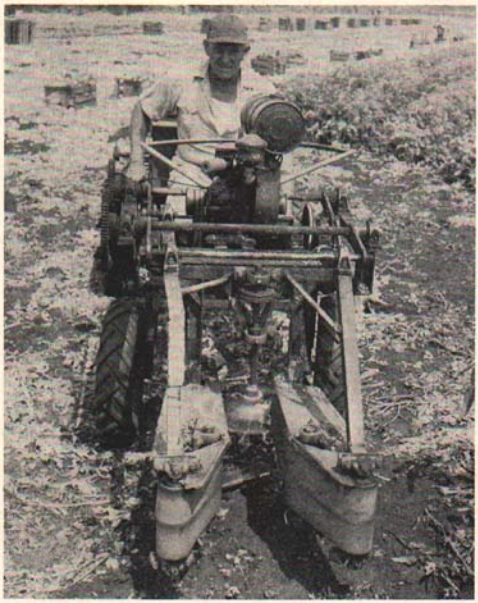


Fig. 13. Mechanized pushknife and top trimmer in operation in Muskegon County.

Harvesting

Celery is generally cut 1 or 2 inches below the surface with special knives or with bar attachments mounted on tractors. Several mechanical harvesters are now in use which cut the roots below the crown and also cut off the leaves at a uniform height above the ground (Fig. 13). Marketable stalks should be trimmed to remove sucker growth and old outside leaves. Growers with packing and washing facilities generally haul the celery loose to the shed on wagons.

Nearly half of the labor required for celery production is used in harvesting and packing. A study of harvesting methods in Florida shows that an average of 46 hours of labor is required in the field and 36 hours at the packing house for each 10,000 stalks. An acre of celery has about 40,000 stalks. This means that more than 300 man-hours are required to harvest an acre of celery.

In spite of many attempts to mechanize celery harvesting, the handknife method of cutting and stripping is still popular. The method is fast because the worker performs several operations while the stalk

is being held. The root is cut with a slice of the knife; the knife is then palmed while the stalk is stripped. The position of the hand that holds the stalk is never changed until the stalk is placed in a pile or placed on a harvester conveyor belt (Fig. 14).

In hand-cutting, the stalk should be grasped low. Do not bend the stalk as this cracks the petioles or ribs. Do stripping by hand, not by knife; a knife may leave rib stubs around the base of the stalk.

Celery is often cut with a machine-propelled push knife. An objection to the push knife is that plants are often cut too short, causing the stalk to shatter. If the push knife is set too deep, the strippers have to remove the roots. The operation then becomes more difficult than if the stalk were cut by hand.

In organizing harvesting operations, growers must decide whether to strip in the field or at the packing shed. In the Florida study, it was found best not to attempt stripping in both places since this required double handling. Workers can remove three to four ribs (petioles) about as easily as one or two ribs.

Packing and Marketing

Most celery for local and distant markets should be clipped to 16 inches and packed in wirebound standard crates. The old "Half-

Fig. 14. Florida-built celery harvester in operation in a Kent County field. All operations—cutting, trimming, washing, grading, and packing—are included. It requires nearly 100 man-hours to pack 10,000 stalks.

Crate" is no longer acceptable in modern merchandising. More careful grading and packing is essential if Michigan celery is to compete with western and southern-grown celery which is gradually moving into markets formerly supplied by Michigan.

Pack celery of U. S. No. 1 grade in clean crates with suitably colored liners (green for golden, cherry for Pascal). Mark each container with the name and address of the grower, the count (or manifest), and the type. Large sizes giving counts of 2½ to 3 dozen per crate are desirable for green Pascal types. These sizes are possible only when recommended varieties are grown with adequate fertilization, irrigation, and spacing, and by allowing the crop to mature before harvesting.

Precool celery to at least 45° F. Under certain conditions, short term cold storage may be advisable. Celery should always be carefully trimmed, washed, sized, and precooled before shipment on a refrigerated carrier. Precooling by passing the crates through ice water (Fig. 15) followed by adequate refrigeration keeps celery crisp and fresh and prolongs its shelf life.

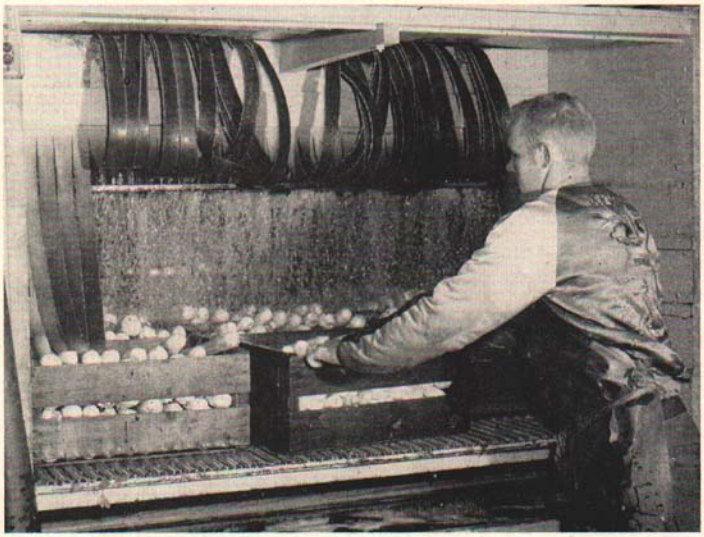


Fig. 15. Celery is cooled with ice water for about 20 minutes to remove field heat. Celery is packed after cooling.

A new development in the West which is attracting considerable attention is the packaging of celery in fiberboard cartons. The most common dimension of the carton is 16 inches by 11 inches by 10½ inches. Each carton may contain 12 to 18 stalks.

With carton-packed celery, water cooling cannot be used because the container would absorb water. Likewise, shipments cannot be top-iced. Carton-packed celery for long-distance shipments is vacuum cooled and freshened with cold water before displaying.

The advantages of carton-packed celery are: freight costs less because of a lighter package; it can be unloaded faster; no repacking is necessary for small orders; and it encourages better packing and more uniform sizing.

Celery for processing is usually packed in the field. Strip off outer leaves that are old and damaged. You can then ship it in bundles or in crates. If you ship it in crates, place the stalks in layers and pack them tightly so that there is no shifting during transit.

Trim celery close for retail trade and pack two or three stalks together in an attractive transparent film bag (Fig. 16). Large stalks may also be put up in attractive individual packages.

Fig. 16. Celery must be attractively packaged to bring the most profit from the best cultural practices.

Cooperative extension work in agriculture and home economics. Michigan State University and the U. S. Department of Agriculture cooperating. Paul A. Miller, Director, Cooperative Extension Service, Michigan State University, East Lansing. Printed and distributed under Acts of Congress, May 8 and June 30, 1914. 5:56—7.5M