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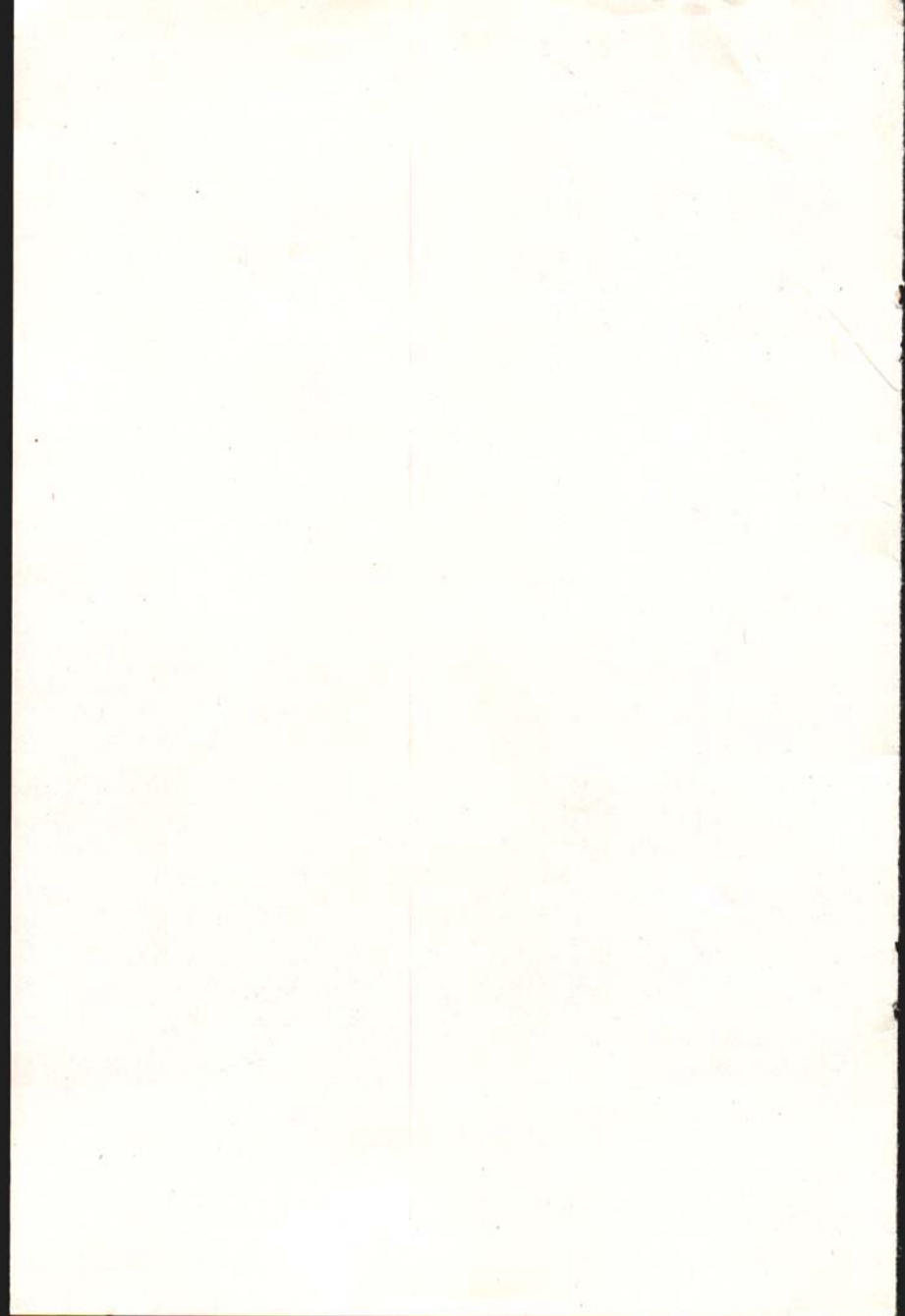
By Paul M. Harmer



MICHIGAN STATE COLLEGE :: EXTENSION DIVISION

EAST LANSING

Cooperative Extension Work in Agriculture and Home Economics,
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Department of Agriculture Cooperating.



WARTIME PRODUCTION OF VEGETABLE CROPS ON MUCK LAND

By PAUL M. HARMER

The present crisis calls for all Americans to keep themselves in the best possible state of health. Science has shown us that, in addition to proper exercise and proper habits, the human body can best be maintained in good health by proper nutrition. Science has shown further that the most health-giving diet is one which contains a considerable proportion of nutritious vegetables. There is even evidence to prove that, the more healthy those vegetables are during growth, the higher will be their vitamin content when they are eaten.

The present emergency requires high yields of high-quality vegetable crops, produced under a farm management program which will require the least possible number of labor hours in its production. Since vegetable production has a high-labor requirement, the present extreme scarcity of labor must be considered from the standpoints both of producing the crop of 1943 and of keeping out the weeds and weed seeds which would increase labor requirements in 1944 and for many years afterward. It is thus evident that the whole matter of vegetable production on muck soil urgently needs immediate careful study, with detailed planning on each farm for the purpose of producing maximum yields and quality, with a minimum of labor. Since the muck soils of Michigan will be called upon to produce a considerable proportion of these much-needed vegetable crops, it seems advisable that we consider briefly various factors which may improve both yield and quality, insofar as possible with fewer hours of labor.

THE PROBLEM FIELD

As the first step in planning the farming operations in this emergency, the different fields in any muck farm should be considered as to their adaptability for the production of different crops. If a maximum of return is to be obtained with a minimum of labor, it is possible that certain fields, which are more or less problem fields, may well be eliminated, insofar as consideration of their use for crop production this coming year is concerned. It is frequently true that a farmer will make more money on three acres properly farmed than if he spreads his labor over four acres and does not make a satisfactory job on any of it.

Several factors may be the cause of unproductivity of that fourth acre, or fourth field. It may be unproductive because of an excess of water. If it is impossible to obtain satisfactory drainage, probably the best thing to do is to abandon it temporarily for vegetable production

and to seed it down in the spring to some cover crop to prevent weed seed production during the coming growing season. If the field is one which is already badly infested with weeds, so that the problem of keeping the weeds out will be very serious, in view of the restricted supply of labor, that field likewise may well be retired to the production of a green manure crop in 1943—which green manure will help a 1944 crop on that field if labor conditions are favorable enough that year to justify planting. It may be that the crop on this “problem” field has failed through no known reason, insofar as the grower is concerned. Here is a case, in this crop shortage, in which the cause for that unproductivity should be determined. It may be that this problem field is so acid that it should be limed and seeded down for the “duration”, because a very acid field, even when limed, ordinarily does not produce very well for several years. Michigan State College will test the soil and report to the grower if any special fertilizer treatments are necessary to make the soil productive. Samples of such soil should be taken as directed below* and sent to the College or taken to some of the county muck-testing meetings which may be held in your community.

SELECTION OF CROPS

NATIONAL FEDERAL CROP RECOMMENDATIONS

In the selection of crops for the various fields, the first matter of consideration concerns the federal government requirements for 1943. The government has approved, for the United States as a whole, a 12-per cent increase in the 1943 acreage of table beets over the acreage of 1942, a 4-per cent acreage increase in early cabbage and an 8-per cent increase for the late crop. A 35-per cent increase over the 1942 acreage is recommended in the acreage of carrots while a 10-per cent increase is advised in the late crop of onions over the 1942 acreage, and a slight increase in acreage of spinach.

FEDERAL RECOMMENDATIONS FOR MICHIGAN

The suggested acreages for Michigan, as made by the United States Department of Agriculture, are given in Table 1, along with the har-

***SAMPLING MUCK SOIL FOR SOIL REACTION TESTS:** In obtaining samples for testing, care should be taken to avoid old “burnouts,” places where brush or refuse has been burned, old vegetable storage pits, trenches, tile lines, ditch banks, or any other place at which some disturbing factor may have affected the soil reaction. Scrape off the surface and take the first sample at a depth of 4 to 6 inches. Since the soil reaction often changes somewhat below the plowed layer, it is advisable to take a second sample with spade or posthole auger at a depth of 18 to 24 inches. Care should be taken that none of the plowed layer falls into the second sample. Keep the samples separate and properly labeled. If part of the field has been burned over at some time or if the muck or the native vegetation varies considerably in different parts of the field, more than one set of samples may be required. Draw a map of the field and keep it for your own information: Locate the points of sampling by number (1, 2, 3, etc.) and number the samples [1A (above), 1B (below), 2A, 2B, etc.] accordingly. Half-pint samples should be sent in moist condition in clean cans. Complete information regarding the muck, as to location in state, depth, years under cultivation, drainage conditions, fertilization, yields and condition of crops grown in the past years, as well as names of crops to be grown, should be sent in a letter attached to the package. Address: MUCK SPECIALIST, SOILS DEPARTMENT, M.S.C., EAST LANSING. In the busy part of the year, reports on the samples may be delayed from three to six weeks.

Table 1. Recommended acreage of several special crops as made by the United States Department of Agriculture, together with the harvested acreages for 1941 and 1942 and the average for the preceding five years.

Crop	Suggested Acreage	Harvested Acreage		
	1943	1942	1941	Average 1936-40
Cabbage.....	7,800	7,200	7,500	6,510
Carrots.....	1,100	900	670	750
Celery.....	5,500	7,400	7,650	6,330
Onions.....	9,700	8,400	8,100	10,700

vested acreages for 1941 and 1942 and the averages for the five preceding years. The government recommends a decrease in acreage of celery in Michigan of approximately 2,000 acres less than the 1941-42 average and a decrease in the United States in acreage of head lettuce. Governmental recommendations are more in favor of production of green celery than of the yellow variety. Inasmuch as both celery and lettuce are crops which are eaten in the uncooked condition, in which condition science reports the highest proportion and greatest availability of vitamins to the human being, it would seem that those two crops should be of special importance in maintaining the nation's health. Lack of sufficient nitrogen for proper fertilization is an argument in favor of some reduction in the acreage of celery in Michigan. On the other hand, head lettuce does not require so much nitrogen and, because of the scarcity of this crop and the inability of western producers to ship head lettuce in large quantities eastward, it would appear that, where local markets warrant, it would be well worthwhile for growers to produce a few acres of this crop.

THE CROPPING SYSTEM

Many farmers of muck land in the state produce, for the most part, only one crop. This is to a considerable extent true of the mint, celery and onion farmers. This one-crop system of farming is not always economical from the standpoint of labor, especially in certain parts of the year, as at the time of harvest. Instead, diversification will frequently distribute labor through the season, so that farming operations can be carried on with the help of a smaller number of individuals. In some localities in which extra labor is available at certain periods during the growing season, crops may be selected whose labor requirements are greatest during those periods of extra labor supply.

Selection of additional crops to be produced on a given farm this year should include those which will fit into the government's program and into the management program on that particular farm. The first factor in the selection of a crop for a given farm should be its adaptation to the moisture conditions on that farm. Ordinarily Michigan's celery

farms have a higher water level than do those which are producing onions. Crops which can be produced on the wetter celery fields include lettuce, spinach, table beets, Swiss chard, broccoli, radishes and pasture. Where the drainage is a little better, carrots, onions, potatoes, sweet corn and tomatoes can be added. The onion grower generally has ample storage facilities and crates, so that the potato and carrot crops fit well into his program. On his better-drained land, he can also readily produce any of the crops previously mentioned, as well as cabbage, field corn, parsnips, sugar beets and turnips.

FACTORS AFFECTING CROP PRODUCTION

Production of high yields of high-quality vegetable crops with a low-labor requirement is dependent upon several factors. Among the most important are proper drainage, proper fertilization, a good stand of the crop, proper equipment for raising the crop and for the harvesting operations so that a minimum of labor will be required.

DRAINAGE

A perfectly drained muck soil is one in which the water level remains uniformly at the distance below the soil surface, which is ideal for the crop being grown, no matter how heavy the rainfall or how severe the drouth. The more independent the grower of muck crops can be from weather conditions, the greater the likelihood of a maximum crop yield.



Fig. 1. The outlet drain on this muck was insufficient to take care of the excess water in a wet season, consequently a complete loss of the crop resulted. Take care of the drainage needs on your muck land now and be ready for producing good yields in any weather.



Fig. 2. The owner of this large muck farm has a number of dams located in the ditches on his farm so that he is able to hold up the water level in drouthy periods and thus obtain maximum yields.

For that reason the muck farmer, with sufficient ditches and tile lines to remove the excess water rapidly and with dams in his ditches to hold up the water to maintain the proper level in time of drouth, is much more likely to get a good yield each year than is the one who has little or no control over the water level.

Productive muck soil generally contains from 2 to 3 per cent nitrogen, which is ample to supply the needs of the majority of the crops



Fig. 3. This large muck area, not many years reclaimed, but now properly drained and well fertilized, is producing each year large yields of high-quality vegetables.

grown, provided the muck is properly drained so that the air can penetrate and make the soil's nitrogen available. At this critical time in the production of vegetable crops, when nitrogen fertilizer is likely to be entirely insufficient to supply the crops and soils which need it, it is highly important that every muck farmer who has a poorly drained field should, during this winter, improve the drainage of that field so that he can produce crops on it without the need of nitrogen in his fertilizer mixture. Poor drainage also is certain to require a greater amount of labor for producing the crop grown under those conditions. It likewise delays planting in the spring, which, with a large proportion of our muck crops, means a lower yield than will be obtained if the planting is done at the proper time.

FERTILIZATION

Proper fertilization of muck soil includes the proper mixture of phosphate and potash, sometimes also with the inclusion of nitrogen, of manganese sulphate, copper sulphate, borax, ordinary salt, or a combination of these materials which will suit the needs of the soil and the crop to be grown. The exact proportion of these various materials which should be used on a given muck for a certain crop can be determined only by careful testing of the soil, as described previously. In order to be sure to obtain the needed materials, it is advisable that soil tests be made and fertilizing materials ordered as soon as possible. General recommendations regarding application of the regular fertilizers and of the minor plant food materials are presented in Table 2.

Since the greater part of the higher-grade phosphates are now being shipped to other members of the Allied Nations, it becomes necessary for Michigan growers to use more of the lower-grade materials. The spring of 1943 will see a considerable amount of 18-per cent phosphate available and little of the higher grades. From the standpoint of the potash supply, the Michigan muck farmer is very fortunate in this war. In the first world war, American potash was almost unknown, and German and French potash was virtually unobtainable. That war resulted in the opening up of American potash mines, with the result that the nation probably now has ample domestic potash for all the needs of agriculture. A possible "bottleneck" lies in the matter of transportation of that potash from the mines to the consuming areas.

If this delay in transportation should result in congestion at the mines such as to delay the refining of the potash, or the demand for the refined materials should result temporarily in exhaustion of the available supply, it may be necessary for muck farmers to use some of the so-called manure salts containing 22 to 25 per cent potash and about 50 per cent ordinary salt. Inasmuch as such crops as sugar beets, table beets, and celery give marked increases in yield from the use of ordinary salt along with the regular fertilization, it is quite possible that this lower-grade potash may be used in making up fertilizer mixtures which will prove very satisfactory for the fertilization of the salt-responsive crops. Using 18-per cent phosphate and 25-per cent mine-run potash, a mixture containing 889 pounds of the phosphate and 1,920 pounds of the potash would contain the equivalent of 2,000 pounds of 0-8-24 fertilizer which was formerly used for celery and sugar beets.

Table 2. Fertilizer analysis and rate of application for important vegetable crops on muck soil, together with initial percentage of minor element plant foods which should be included in the fertilizer mixture.

Salt (lb. per acre)	Acid Muck Soils (pH 6.5 or less)				Crop and Rate of Fertilization*	Alkaline and Faintly Acid Muck (pH 6.6 or more)					Salt (lb. per acre)
	Fertilizer analysis for mucks of good and poor drainage. Percentage minor plant foods in fertilizer mix- ture.					Fertilizer analysis for mucks of good and poor drainage. Percentage minor plant foods in fertilizer mix- ture.					
	Per cent in fertilizer		Fertilizer analysis			Fertilizer analysis		Per cent in fertilizer			
	Borax	Copper sul- phate	Poor drain- age	Good drain- age		Crop	Pounds per acre	Good drain- age	Poor drain- age	Manga- nese sulphate	
0	0-5	2.5-5	3- 9-18	0- 9-27	Broccoli.....	400-600	0-10-20	3-12-12	15	5	0
100	0-5	5	3- 9-18	0- 9-27	Cabbage.....	500-1000	0-10-20	3- 9-18	5-10	5	100
0	0	5	0- 9-27	0- 9-27	Carrots.....	400-800	0- 9-27	3- 9-18	15	0	0
500-1000	2.5	0	3-12-12 3- 9-18	0-10-20 0- 9-27	Celery { Early..... Late.....	1200-1800	0-10-20 0- 9-27	3-12-12 3- 9-18	10	5-10	500
0	5	10	3- 9-18	0- 9-27	Lettuce.....	500-800	0-10-20	3-12-12	15	5	0
0	0	5	3-12-12	0-10-20, 0-12-12	Onions.....	800-1400	0-12-12	3-12-12	10-15	0	0
0	5	2.5	3- 9-18	0- 9-27	Parsnips.....	600-1000	0- 9-27	3- 9-18	5-10	5	0
0	5	10	3- 9-18	0- 9-27	Spinach.....	500-800	0-10-20	3- 9-18	10-15	5	0
0	5	0	3-12-12	0-10-20	Sweet corn.....	400-800	0-10-20	3-12-12	10	5	0
500-1000	2.5-5	5	3- 9-18	0- 9-27	Table beets.....	600-1000	0-10-20	3- 9-18	10-15	10	500
0	0	5	3-12-12	0- 9-27	Tomatoes.....	600-1000	0-10-20	3-12-12	5-10	0	0
500	2.5-5	5	0-10-20	0- 9-27	Turnips.....	300-500	0- 9-27	0-10-20	10-15	5	500

*For recommendations regarding the fertilization of other crops, see Michigan State College Special Bulletin 314, "The Muck Soils of Michigan" which can be obtained by writing the Bulletin Room, Michigan State College, East Lansing, and inclosing 15 cents for each copy desired.

An application of 1,800 pounds per acre of this mixture (equivalent to 1,280 pounds 0-8-24) on celery would contain approximately 900 pounds of salt, while 600 pounds applied for sugar beets (equivalent to 427 pounds 0-8-24) would contain about 300 pounds of salt. Mixtures containing the 25-per cent potash preferably should be stored in a very dry place until applied. It is expected that some fertilizer companies will have these manure salts for sale before spring.

In the application of fertilizer on muck land, the best results with the majority of crops are obtained with the fertilizer applied by a regular fertilizer drill which places the fertilizer at a depth of 3 to 4 inches in drills 7 inches apart. This method generally gives considerably better results than if the fertilizer is applied on the surface of the soil and disked in. In the case of onions, sown on muck which is not drouthy and not very acid, the greatest return on the fertilizer investment can be obtained by placing the fertilizer in the row directly below the seed. Experiments have shown that 400 to 500 pounds per acre of fertilizer, applied about 2 inches below the onion seed, will give as good a yield as will 800 to 1,000 pounds applied by any other method. With most crops on muck soil, however, the maximum return on the investment in fertilizer is more likely to be obtained with a fairly generous than with a light application of fertilizer.

EQUIPMENT

In general, there will be a scarcity of implements for use in planting, caring for, and harvesting crops during the coming growing season. It is the patriotic duty of every muck farmer who has any implements which he is not going to use to see that the acreage of crops planted by his neighbors, and their care during the growing season, shall not be limited by the lack of any implements which he possesses and is not using. The farm tractor, double disk, cultipacker, multiple seeder, garden tractor, and transplanting machine are implements which save considerable hand labor on muck land. These implements, as well as all others to be used on the farm, should be thoroughly inspected during the winter and put in a good state of repair, so that no cracked bearing, loose spring, or other weak part in the machine will result in the loss of a single hour during the growing season.

For several months, Michigan growers have faced a scarcity in new onion and potato crates, such as are used for the harvest of those crops and also frequently for cabbage, carrots, parsnips and table beets. Growers who lack sufficient crates should make an early attempt to replenish their supply. In some localities second-hand cloth bags are still obtainable which may be used for the storage of these vegetables in the field and for potatoes in the storage. Ordinarily potatoes are stored on the floor in storages or in pits, while carrots and parsnips may be stored in pits in the field until they are to be graded for market. Growers who may wish more storage space next fall still are able to obtain materials which may be used for insulating buildings constructed for some other purpose. In some localities, sawdust may be obtained for this purpose.

In general, the greatest labor shortage is likely to occur at the time of harvest of the crops. If one is to get the potatoes dug and graded

and the onions, carrots, table beets and parsnips pulled, topped and graded—and get all crops under cover and protected from wet weather or freezing temperatures—every hour of labor becomes exceedingly valuable. The grower who is well equipped with potato digger, onion topper, and mechanically operated graders is in a favorable position, especially if he has lighting arrangements, so that the equipment can be kept in operation early and late. Mechanical elevators for stacking crates of onions in storage save considerable labor and may be built on the farm if unobtainable.

In addition to digging potatoes, some types of potato diggers have been used with fair success in harvesting onions, carrots and table beets. The shorter rooted red-cored Chantenay carrot and the globe type of table beets are better adapted to its use. To use the digger for the narrow-rowed crops, it is advisable to plan the spacing of the crop rows to allow room for the tractor wheels pulling the digger. Thus a tractor with 68-inch space between wheel centers can straddle four 13- or 14-inch rows, with a space of from 24 to 30 inches left between each four rows for tractor wheels, down the center of which one or two rows of grain may be sown in the spring for wind protection. With slight adjustment, most onion-topping machines may be used for topping carrots and table beets, especially if the crop is consigned to the canning factory. Generally the toppers do better work if the beet and carrot tops have been allowed to mature down or dry out to some extent. Some canning companies have table beet harvesters which take the beets from the row, and top and elevate them into a truck driven alongside.

STAND

A good stand of a vegetable crop on muck soil is dependent on uniform seeding of seed which has a good germination, followed by the prevention of injury from spring frosts, winds in May and June, and by crop diseases and insect pests. Every grower of vegetable seeds should know accurately the germination of that seed before the seed is sown. County agricultural agents are glad to give instructions regarding the making of germination tests, while some high school agricultural instructors will make germination tests as a part of their class work.

SEEDING

Spring planting of the small seeds can be accomplished most economically by the use of a multiple seeder which many plant from three to 12 rows at one operation. The garden tractor may be equipped with seeders to sow three or four rows at a time, but the farm tractor is generally used for the larger multiple seeding machines.

Uniform distribution of the seed in the row is dependent on having a seeder which will properly distribute the seed and on having seed which runs fairly uniform in size. Occasional large seed in a drill set to sow seed of an average size may clog the openings into the seed spouts at intervals and thus cause "breaks" in the distribution of the seed. Time spent in grading the seed, when necessary, and in oiling and carefully adjusting the seeder so as to get a uniform flow at a rate adjusted to obtain the right stand for the particular crop and adjusted

for the percentage germination of the seed, will be paid for many times over in increased yields of the harvest. In this emergency, a thick stand should be avoided in order to avoid the labor of thinning.

FROST INJURY

Injury by spring frosts frequently results in a loss of some of the plants, with a poor stand as a result. Keeping the soil moist by packing it and by maintaining the water level high enough so that the surface soil does not become dried out offers partial protection against such injury. On all loose muck it is advisable to roll the muck immediately after disking, preferably with a heavy concrete roller. Directions for making such a roller will be furnished on request.

Following seeding, it is advisable to practice shallow cultivation again for the purpose of keeping the surface soil moist, since a moist soil is never so frosty as a dry one, nor a compact soil so frosty as one that is loose. If a hard frost results in the killing of a considerable portion of the crop, so that it may be advisable to reseed, the decision should be reached promptly with most crops, and especially with onions. The onion grower with sufficient seed on hand to reseed immediately without loss of time in case of frost, has his new seeding coming along so that it sometimes does as well as the earlier seeding. Where considerable time is lost in deciding whether to reseed, the resewing generally produces a lower yield of most crops. Where seed is kept on hand for the purpose of reseeding in an emergency, its storage in an air-tight container generally will maintain germination of the seed better than if the seed is stored in a cloth bag.

WIND INJURY

Injury by winds in May and June is responsible for more losses in stand than any other cause. Besides destruction of the crop, top soil and even the fertilizer are likely to be carried away. Most muck farmers have established rows of trees of the green willow, box elder, Chinese elm, golden willow, Austrian pine, white pine, arborvitae, or shrubs such as spirea, along the borders of their fields to partially check the wind. Interplanting with spring rye, between every three rows of such crops as onions, spinach, carrots, table beets, parsnips and sometimes cabbage, is advisable on the better drained muck soil, especially where they are so located that the wind has a chance for a long sweep across the field. Barley and oats may also be used, but spring rye is best because it is not injured by sharp spring frosts as easily as are the other two grains. In order to save the labor required to sow the grain with hand drills, these drills may be attached between, but somewhat behind, every three units of a multiple vegetable seeder. This interplanted grain should be cut off just below the surface of the ground when it is about 10 inches high and before it shades the adjoining rows too much. If cut too deeply, the grain is likely to take root and grow again. If cut before it gets too large, the growth may be allowed to lie between the rows and thus offer additional protection to the crop. If allowed to stand until the grain heads out, its removal by hand becomes a matter of considerable labor.



Fig. 4. This muck area is protected by occasional tree windbreaks, supplemented by highway fence set up at intervals across the field and by drills of grain between every six crop rows. The grain had been cut with a wheel hoe shortly before the picture was taken.

DISEASES

The most important disease affecting the stand of several crops is damping-off, a disease which causes a constriction in the stem of the plant at the surface of the ground, with the result that the upper portion of the plant falls over and dies. This disease sometimes affects the crop before it has emerged from the ground, immediately following germination of the seed. Seed treatment, before planting, with yellow copper oxide dust on such seeds as carrots, celery, onions, spinach, table beets and tomatoes, is highly effective on control of the "pre-emergence" damping-off. It produces little benefit on stand of broccoli, cabbage, lettuce, radishes and turnips. Frequently, however, the disease attacks the plants shortly after they are up. In the field the best treatment lies in the placing of the hoes of the wheel-hoe close together, so as to cultivate very close to the row and in that way break the crust on the surface. Another implement which helps is the small weeder which attaches to the garden tractor.

Other diseases which may reduce the stand include black leg of cabbage, cauliflower, broccoli, turnips and other members of the cabbage family, which can be controlled by the "hot water" treatment.* Control of diseases of onions and of celery is covered in Michigan State College bulletins.† Two other diseases which frequently affect

*The hot water treatment for seeds of members of the cabbage family consists in the immersion of the seed in water at a temperature of 122° F. for 25 minutes, with constant control of temperature. The seed is then cooled by putting in cool water, then spread and dried rapidly. The method may injure seed germination unless accurately followed.

†Extension Bulletin 123, "Muck Land Management for Onion Production," and Circular Bulletin 165, "Celery Production in Michigan," may be obtained on request to the Bulletin Room, Michigan State College, East Lansing. A Dutch translation of the celery bulletin will be sent if requested.

the stand of crops are celery yellows and cabbage yellows. Both diseases are soil borne and can be combatted only by the planting of disease-resistant varieties. Since they are hot-soil diseases, they are more serious on well-drained muck than on that with a good moisture supply. Most cabbage growers feel that the yellows-resistant varieties do not have the quality of those which are not resistant, so they use them only as a last resort.

Insect pests which greatly affect stand of crop include wireworms on various crops and maggots of onions and cabbage. Wireworm injury is likely to follow the plowing under of a June grass sod and may continue to be serious for two or three years. Partial protection may be obtained by interplanting as for wind injury prevention, using spring wheat, instead of rye, between every two or three rows of the crop. Sometimes a second drilling of wheat is necessary just before the first is removed.

Maggots of onions can best be controlled by the burning or burying of all cull onions in the fields and storages in the vicinity and to the west and southwest for a distance of three or four miles, since the westerly winds of the spring will carry the flies for a considerable distance. Cabbage maggots may largely destroy an early planting of the crop but ordinarily do not appreciably damage the late crop.*

CULTURAL OPERATIONS

Cultivation properly conducted consists of getting the weeds while they are small and before there is any chance for weed seed production. If the soil is well-drained, cultivation of the various crops should be shallow, as previously described. If the soil is one in which drainage is rather poor, it is frequently advisable to cultivate rather deeply in order to aerate the soil, so that decomposition will proceed and the crop will not suffer from lack of air and lack of available nitrogen. In an especially wet season such as 1942, this is true, even for crops on the better-drained soil. It is not advisable suddenly to start deep cultivation, following several shallow cultivations.

To decrease the amount of labor insofar as possible, studies should be made so as to use a farm or garden tractor for seeding the crop, cultivating with the multiple cultivator, spraying with a tractor-drawn sprayer, and harvesting with tractor-drawn harvesting implements. This may mean the omission of every fourth or sixth row in the case of close-planted vegetable crops or the grouping together of every two or three rows which are to be straddled by the tractor in the case of such crops as sugar beets, potatoes and celery. If the tractor owned happens to be one of the crawler type which does not give sufficient clearance for cultivating, spraying or dusting the crops in later growth, the attachment of 4-inch by 4-inch, or 4-inch by 6-inch (on edge) blocks, on the treads will give that much more clearance. If the onion grower possesses land which sometimes becomes very wet at harvest, a set of these blocks, cut 18 to 30 or more inches long, will assist in keeping the tractor from miring in hauling off the produce.

*Michigan State College Extension Bulletin 180, "Chewing Insects Affecting Field and Garden Crops." Recommendations are by the Entomology Department.



Fig. 5. Labor required for harvesting is likely to prove the "bottleneck" in the production of vegetable crops. Plan now to so plant your crops that they can be harvested and marketed with a minimum of labor.

CROP REQUIREMENTS

In the selection of the different crops to be grown and the acreage of those crops on any farm, the requirements of those crops must be considered.* Likewise, the requirements of the market as to varieties and the possibility of government regulations regarding varieties to be grown must be studied.

Growers of broccoli and late cabbage have the choice of transplanting from a seedbed or sowing directly in the field. Transplanting has the advantage that a weedy field can be kept clean for a longer period in the spring. On fields which are not especially weedy, direct seeding has the advantage in this emergency of saving many hours of hand labor.

BROCCOLI

This crop is not grown to any large extent in Michigan, but when properly fertilized does very well on our muck soil. The Italian green-sprouting variety is the one most used. The crop is sown in the field in rows about $2\frac{1}{2}$ feet apart and thinned to 6 to 8 inches between plants. Six to eight ounces of seed per acre are required when the crop is to be transplanted from the seedbed and three to four pounds when sown in the field.

*A more complete discussion will be found in Michigan State College Special Bulletin 314 which may be obtained by writing the Bulletin Room, Michigan State College, and inclosing 15 cents.

CABBAGE

Acreage of cabbage grown on Michigan muck land has increased during the last several years. The crop has a wide range in tolerance of different reactions, producing fairly well down to a pH of 4.6 provided copper sulphate is applied to the soil, while it does well on the alkaline muck, even without the application of manganese sulphate which sometimes slightly increases the yield. It prefers a fairly well-drained soil and ordinarily does not do very well under wet conditions. Four to six ounces of seed are required when sown in a seedbed and two to three pounds per acre when sown directly in the field.

Ferry's Hollander is probably the most popular of the ballhead varieties for the late crop, while Penn State Ballhead is another very good variety. Of the early varieties, Golden Acre is most popular, with Copenhagen Market also grown. For the soils which are infected with cabbage yellows there are resistant strains of Golden Acre and Copenhagen Market, of the early crop variety, Marion Market, of the mid-season variety, Bugner and All Seasons of the kraut type, and of Wisconsin No. 8 and Wisconsin Ballhead of the ballhead type. Growers generally agree, however, that the yellows-resistant strains do not have the quality of those which are not resistant.

CARROTS

This crop has a wide range of tolerance insofar as drainage conditions are concerned, but the longer types, when grown on poorly-drained soils frequently extend up out of the soil to such an extent that the root-tops are discolored by weather conditions and thus do not find favor in the market. Sometimes poor drainage results in a sprangling type of root development. The crop does well on alkaline soils if manganese sulphate is used, and responds markedly both in yield and in improved color when copper sulphate is included in the fertilizer on acid soils. The roots develop normally down to a pH of about 4.5. The most popular of the carrot varieties is the Nantes Coreless, while the Red-cored Chantenay is also considered to be a very good variety. Emperor, Morse's Bunching and Streamliner are three varieties which are used to some extent for bunching. Good yields of late fall carrots can be obtained with seedings of about 3 pounds per acre, sown in May or June.

CELERY

The government regulations have listed as less essential the yellow celery varieties, which require blanching, but have placed the green varieties in the essential group. Because of this situation it seems desirable that our celery growers raise more of the green varieties. During recent years a number of new varieties of green celery have been developed, among them Summer Pascal and several strains of Utah. Among the yellows-resistant varieties, no green varieties have been developed, but most of the green varieties are naturally much more resistant than the yellow varieties. Florida Golden and Michigan Golden are resistant varieties which have been on the market for several years, while Cornell 19 is a new introduction which is very highly recommended and decidedly resistant to yellows. It is very satisfac-

tory for the late crop but not so desirable for the early and medium crops, since it tends to develop seed stalks very easily. For further information regarding the adaptability of celery to different drainage conditions and different soil reactions, the reader is referred to Special Bulletin 165, "Celery Production in Michigan".

LETTUCE

Leaf lettuce has been placed on the approved list by the United States Department of Agriculture, while head lettuce is listed as less essential. Unfortunately, insofar as this regulation is concerned, head lettuce is very much more popular with the Michigan consuming public than is leaf lettuce. Inasmuch as labor shortage and lack of transportation are certain to curtail the supply of head lettuce, which ordinarily is shipped in from California, there is every indication that there will be a sharp demand for head lettuce in the Michigan market. This crop shows a very marked response to copper sulphate on all acid muck and on many alkaline mucks, and responds very strongly to manganese sulphate on the alkaline muck. On alkaline and sometimes on acid mucks, it is likely to show a response to borax. In raising this crop in Michigan, it is advisable to have a fairly good but not excessive supply of moisture and to space the plants at a distance of about 20 inches each way. This allows more air circulation and less spoilage of the under leaves. It is advisable to maintain a dust mulch between the rows, especially during hot weather. The crop may be started in the greenhouse and transplanted to the field for an early crop, or may be seeded directly in the field as soon as the soil can be worked. It preferably should be grown in a location where there is good air circulation, although it is readily damaged while young in case of a windstorm.

The most dependable variety now on the market is Imperial 44. Great Lakes, a new introduction, developed by the United States Department of Agriculture in cooperation with Michigan State College is not yet on the market, but the Horticultural Department of the College has a limited amount of seed for distribution to persons interested. Cornell 456, a new introduction with considerable merit, is not on the market for 1943, but seed should be available in 1944. All three of these varieties are outstanding, insofar as production of head lettuce under Michigan climate is concerned.

ONIONS

Michigan is one of the leading states in onion production, with a very large portion of the crop being of the Yellow Globe variety. Governmental regulations request a reduction in the production of early yellow globe varieties and an increase in the production of the late varieties. This apparently is because the early varieties of Michigan onions are generally thin skinned and the keeping quality is not so good as that of the later ones. The onion prefers a fairly well-drained soil and shows a marked response to manganese sulphate on alkaline muck. It is also improved both in yield and color by the use of copper sulphate on acid muck. For further information regarding the crop, the reader is referred to Michigan Extension Bulletin 123, "Muck Land Management for Onion Production".

PARSNIPS

Parsnips produced on muck soil are much superior to those produced on mineral soil. The crop prefers a well-drained muck and one which is not too acid in the underlying layers. The crop responds slightly to manganese sulphate on alkaline muck and to copper sulphate on acid muck and sometimes to borax on all types of muck. The Hollow Crown variety is the one which is grown to the greatest extent. For good yields, the crop should be sown in April or early May, at the rate of 4 to 6 pounds per acre, in rows 14 to 16 inches apart. A stand of four to six plants per foot gives better yields and better-shaped roots than will be obtained by thicker or thinner stands.

SPINACH

Muck-grown spinach has an advantage over upland spinach in that it contains no grit. For that reason the muck-grown crop is preferred by the canning companies. The crop does best with a fairly good supply of moisture but, since it is a short-season crop, the spring crop will do fairly well on the better-drained soil. Spinach responds to manganese sulphate on alkaline muck and to copper sulphate on acid muck. It sometimes is benefited by copper sulphate, in addition to the manganese, on alkaline soil. The crop also responds to borax, especially on new ground. The smooth-leaved Giant Nobel variety generally is preferred by the canning companies, while the savoyed-leaved long-standing Bloomsdale is grown largely to supply local markets. The Viking, a slightly savoyed-leaved variety has found favor for both purposes. The crop should be sown in the latter half of April in the locality



Fig. 6. Spinach variety trials on Michigan State College muck plots. Note the difference in amount of growth (2 rows per variety). Select varieties of crops that will produce good yields and satisfy governmental requirements and the demands of the consuming public.

of Lansing for the early crop and about the first of August for the fall crop. From 12 to 15 pounds of seed per acre are required for rows sown 13 or 14 inches apart.

SWEET CORN

Sweet corn produces fairly well on well-drained muck soil. The crop shows little or no benefit from copper sulphate in the fertilizer on acid soil but is improved to some extent by borax, especially on new land. On alkaline muck it is benefited both by manganese sulphate and by borax. Several varieties, including Golden Cross Bantam and Sunshine, have produced good yields of high quality in our trials.

TABLE BEETS

This crop has a wide range in its adaptation regarding drainage conditions. It will yield well on soil which has satisfactory drainage for celery, but it does very well on the better-drained soils. The crop likewise has a wide range in adaptation to the various degrees of acidity and alkalinity and will produce satisfactorily on decidedly alkaline soil, if manganese sulphate is applied, and on soil with a pH as low as 4.6 if copper sulphate is included in the fertilizer mixture. The crop also shows a very marked response to salt, in addition to regular fertilization, and occasionally to borax. The Detroit Dark Red variety is the most popular of all and is the one demanded by the canning companies, who contract for a considerable portion of the table beet acreage in Michigan. The Detroit Dark Red and Crosby's Egyptian are grown for bunching.

TOMATOES

This crop will produce very large yields on muck land, if it is not injured by a summer frost. Fairly well, but not excessively drained soil, is best suited for it. The crop responds to copper sulphate on acid muck and manganese sulphate on alkaline muck. A fertilizer mixture containing a high percentage of potash gives the best quality tomatoes, although an 0-12-12, applied at the rate of about 1500 pounds per acre, will ripen the tomatoes earlier in the season. Muck-grown tomatoes are not so early as mineral-soil tomatoes but are preferred by many housewives for canning and tomato juice because the acid content is not so high as is that produced on mineral soil. When tomatoes are grown on muck, it is advisable to get the plants started and well advanced in greenhouses or hot beds, then transplant them to the muck, without disturbing the roots, the latter part of May if the season is favorable. Morse's Special 498 has proved to be the best on muck of the tomato varieties tried in experimental studies at Michigan State College.

TURNIPS

This crop is sometimes sown in late summer as a fall crop on muck land. The crop does well on virtually all types of muck, except where the drainage is poor. It responds to copper sulphate on the acid muck and to manganese sulphate on the alkaline muck. It also shows a marked response to salt on all mucks and sometimes also for borax. Purple Topped White Globe is probably the most popular variety.

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