EXTENSION BULLETIN 303

# MUCK SOIL MANAGEMENT *for* HEAD LETTUCE PRODUCTION

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# Muck Soil Management for Head Lettuce Production

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The possibility of increased production of head lettuce on Michigan's muck soil has aroused considerable interest in recent years. The quality of the crop produced on the state's muck soil in favorable seasons has proved satisfactory to both buyers and consumers, who have found it to compare favorably with head lettuce shipped in from western states. Reasons for its acceptance lie in the development of new varieties which are more adapted to Michigan's climate, in a better knowledge of the needs of head lettuce as regards fertilizers and minor elements, and in improved methods of handling and marketing the crop.

Several muck farmers, notably in the Hudsonville muck area, began about 1915 the raising of head lettuce. The fall crop was grown mostly, but production was discontinued in the early twenties. This was mainly due to the fact that the varieties, largely of the Big Boston type, which were grown at that time, produced fairly well in cool summers but "bolted" in hot seasons, so that seed stalks were produced prematurely. At best, these varieties produced rather loose heads, so that "tipburn", a physiological disease occurring in the fairly compact heads of present day varieties under adverse conditions, was not a serious disease at that time.

Since a number of factors enter into determining whether head lettuce growing will prove profitable to any muck farmer, it should be pointed out that these factors make production more or less of a gamble. Among these determining factors are the varieties grown, the possibility of physiological and other diseases, and of insect pests, adaptation for head lettuce of the particular muck to be cropped, possibility of water and frost control, use of necessary fertilizers and minor elements, proper cultural practices and possibility of a marketing outlet. This bulletin is prepared for the purpose of giving the grower a more complete knowledge of these factors and of the means of controling them.

## VARIETIES

With the discontinuance of head lettuce production in the early 'twenties, trials at Michigan State College showed no new varieties suited to our conditions until the advent of two U. S. D. A. varieties, Imperial 44 and Imperial 847 about 1930. These varieties formed more solid heads, were not so likely to bolt and had some resistance to "tipburn", so that a fair crop might be obtained if the spring season was rather cool, if the varieties were grown for a fall crop, or if the planting were located near one of the larger lakes. A few growers in favorable locations in Michigan started head lettuce production on muck with one or both of these varieties.

With the introduction of two other head lettuce varieties more recently, Great Lakes and Cornell (Imperial) 456, production of the crop on Michigan's muck soils has considerably increased, both as a result of increased acreage and better yields. Generally, Cornell 456 has proved superior to Great Lakes for the spring crop on the inland muck fields, but in cool springs or on mucks located adjacent to some of the larger lakes of the state, Great Lakes sometimes gives better yields. Both varieties are slow in developing seed stalks and are somewhat resistant to development of tipburn, 456 usually showing more resistance than Great Lakes. Great Lakes produces larger heads and generally requires a week or more to reach the cutting stage than does Cornell 456. Thus, when sown side by side in spring planting, both varieties may show no tipburn when 456 is ready to cut but, with an intervening week of hot weather, Great Lakes may be practically a complete loss because of tipburn. As for the fall crop, hot weather is not likely to be a factor at the time of cutting and Imperial 44 and Imperial 847, along with 456 and Great Lakes, should be considered as having characteristics favorable for that season of the year. Cornell 456 sometimes shows slightly more frost injury in the fall crop than occurs on the other varieties. Growers are advised to make planting trials of all four varieties for the fall crop, since geographic location in the state, water and air drainage conditions, and soil characteristics are factors which may make one variety best in one location and some other in another.

Very recent introductions of new selections of head lettuce include such named varieties as Progress, Premier, Pennlake and others. Some

**Fig. 1. Summer-sown field of Imperial 456 head lettuce being irrigated because of danger of frost damage in early fall of 1949. The two rows of smaller lettuce to the right were missed in the first seeding and were resown later. There was little chance of these two rows making heads before killing frost.**

undoubtedly have merit and in time may displace the older varieties. At the present time, however, further work in purification of these selections and further experimental study to determine their respective merits are advisable. Meanwhile growers are advised to obtain seed of their accepted varieties from more than one of the reliable seed growers who have maintained varietal uniformity and quality in their head lettuce seed. In that way the best source of seed can be determined. Obtain small amounts of seed of the new selections and compare them under your conditions, with the variety which is being raised, before replacing the standard variety with one which may prove unsatisfactory.

## TIPBURN

This physiological disease appears as a browning of the edges of the leaves, frequently in the interior of a solid head. Often it is impossible to detect the internal breakdown from the appearance of the exterior surface. Thus, the grower marketing in quantity may find his crop rejected by the prospective buyer, even if only a comparatively small proportion of the heads are found to be affected by tipburn.

Although a crop of head lettuce may be entirely free from tipburn at harvest if the weather remains cool, that same crop may be a complete loss because of the disease if hot, humid weather is encountered

in the last 10 days of growth. Generally when such weather conditions occur, it is advisable to rush the harvest of the crop and to get it into cold storage as soon as possible. Delay of 24 hours in cutting the solid heads in hot weather may mean a complete loss of the crop. The disease is also increased by the presence of an excess of nitrogen and of potash in the fertilizer applied. It does not appear to be increased or decreased by the addition of the needed minor elements except that their application may hasten growth, so that time to cutting is advanced a week, thus sometimes avoiding hot weather and its accompanying tipburn. It is likely to be worse in a field with poor air circulation than in one with good air movement. Because of this, tight wind breaks and too close planting should be avoided. To keep the humidity as low as possible, a dust mulch should be maintained between the rows, and overhead irrigation should be avoided in hot weather during late growth.

## ADAPTATION OF MUCK

With favorable weather conditions most muck soils will produce satisfactory yields of head lettuce if the soil is properly drained and properly fertilized with the required minor elements included in the fertilizer mixture. Some mucks may need a lime or a sulfur application for best results. Very acid mucks (pH 4.6 or lower) are likely to require three or more tons per acre of ground limestone thoroughly disked into the surface soil. Highly alkaline mucks (pH 7.5 or higher) can best be made productive with 1000 pounds or more per acre of agricultural sulfur, applied and thoroughly disked into the soil after plowing and leveling.

Location of the muck near one of the Great Lakes or the larger inland lakes is likely to insure better crops of head lettuce under more adverse weather conditions. This is due largely to the effect of the lake in modifying excessive temperatures. On the east side of the lake, this ameliorating effect may extend from 2 to 8 miles or more and on the west from one-half to 3 miles, the distance depending on the topography of the intervening land and the size of the lake. The benefit is seen in an elimination or reduction in amount of tipburn in hot weather and in partial or complete prevention of injury to the crop on frosty nights.

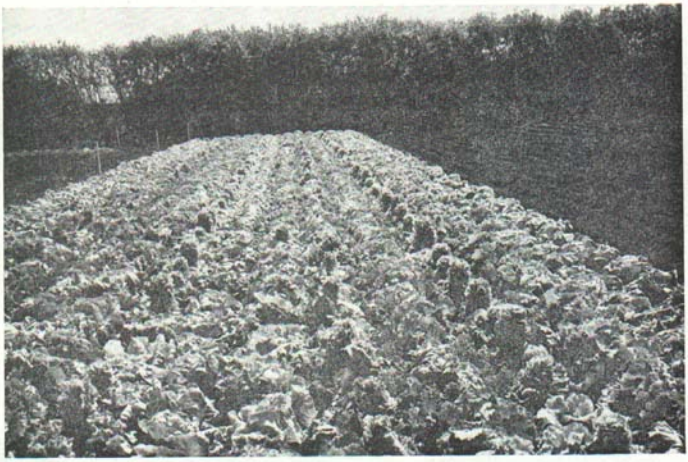

Fig. 2. Variety trials on College muck plots, East Lansing, spring of 1941. Rows 1 and 2 (right) are Imperial 847; 3, Imperial 44; 4 (showing premature bolting), White Boston; 5, Imperial F and 6 (premature bolting), New York 12.

## DRAINAGE AND IRRIGATION

Most mucks which are properly but not excessively drained are satisfactory for the production of head lettuce. The optimum range of water-level for the crop appears to range between 18 and 28 inches, although it may be slightly nearer the surface at seeding. Sub-irrigation by use of water control is highly desirable where there is sufficient water in the ditches during dry weather when it would be needed. Overhead irrigation is advisable on the better drained mucks when applied on the dry soil (muck) before seeding in order to obtain uniform germination and an even stand. An inch or more of water may be required for this purpose. It is also effective during droughty periods, especially for the fall crop, and can be used to prevent frost injury in spring or fall or occasional severe summer frosts. Overhead irrigation should not be used in hot weather when the heads are approaching the cutting stage because of the danger of increasing tipburn.

## FERTILIZATION

Since excessive applications of nitrogen and potash may increase tipburn in head lettuce, it is advisable to use a mixture rather low in these constituents and to make a moderate application. Rate per acre required will depend on the reserve fertility in the soil. If the land has been recently broken or has received very little fertilizer, an application of 2000 pounds per acre of a 3-18-9 or a 4-16-8 mixture may be needed but, with fairly good past fertilization, 1000 pounds per acre of a 3-12-12 mixture is likely to be sufficient. If the muck has been heavily fertilized for such crops as celery and onions, the soil may be sufficiently fertile so that none may be needed and, at the most, not more than 500 pounds should be applied.

Generally the initial application of fertilizer should be broadcast and disked in. On mucks well supplied with moisture, the fertilizer

Fig. 3. Fertilizer and variety trials of head lettuce at the Michigan Muck Experiment Farm in 1945. Fertilized with 1000 pounds per acre each of 0-20-0 in foreground, 0-20-10 just beyond first stakes and 0-10-10 just beyond second stake, the Imperial 456 (left four rows), Imperial 44 (center three rows) and Great Lakes (right four rows) were field sown in May. With proper fertilization the last two gave very similar yields but 456 gave more than 80 percent higher yield than the other two and showed less tipburn.

can be applied in the row 2 inches directly below the seed, but the rate of application should be reduced to half to two-thirds the amounts recommended for broadcast applications. On the drier mucks a broadcast application is less likely to injure the germination and stand. When spring and fall crops are to be grown on the same land, it is advisable not to apply all the fertilizer in the spring but to make a second application of half to two-thirds the spring application before sowing the second crop. Detailed recommendations regarding fertilization are given in Table 1.

Although the previously mentioned applications of fertilizer generally are sufficient for good yields of lettuce, conditions sometime arise which make advisable a side-dressing before or about the start of head formation. If the head lettuce field has been subjected to a period of continuous leaching rains, application of 150 to 250 pounds per acre of a 10-10-10 mixture will improve the growth. This is also true on very acid mucks, recently limed, where a side-dressing with 10-6-4, at the same rates, is likely to increase yields, even if the crop has been subjected only to normal rainfall.

## USE OF MINOR ELEMENTS

Head lettuce is one of the most responsive crops to copper on acid muck and to manganese and sometimes copper on alkaline muck. It is also likely to respond to boron, in the form of borax, on alkaline and sometimes on acid muck. An initial application of 100 pounds of copper sulfate per acre is advisable, supplemented with about 25 pounds each year until a total of 250 pounds per acre has been applied. The amount of manganese sulfate and of borax required will depend on the degree of alkalinity. Two or three annual applications of borax of around 25 pounds per acre are likely to be sufficient on acid muck. On alkaline muck a heavier initial application of borax followed by 25 pounds per acre annually over a period of years is likely to be needed if head lettuce is grown, unless sulfur is applied. Excessive applications of the minor elements are not advisable.

Applications of 1000 pounds per acre or more of sulfur is recommended on highly alkaline muck (pH 7.6 or more) and frequently of 500 pounds on the less alkaline muck. When sulfur is used, the rate of application of manganese sulfate and borax generally can be reduced. Table 1 presents the recommendations for use of the minor elements under different soil conditions.

TABLE 1—*Fertilizer and minor element recommendations for head lettuce on muck soil*

| Range in soil pH (acidity or alkalinity) | Drainage conditions | Time of application of minor element and fertilizer after reclamation | Fertilizer analysis and lbs. per acre recommended under different soil conditions for broadcast application | | | | Percentage of salt of minor element in fertilizer | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Analysis* | Amount of past fertilization† | | | Copper sulfate | Manganese sulfate | Borax |
| | | | | Light | Medium | Heavy | | | |
| | | | | Amount for head lettuce | | | | | |
| Slightly to strongly acid (pH 6.3 or less) | Good | First Crop | 3-12-12 or 0-12-12 | 1500-1800 | 1000-1200 | 0-800 | 5 to 10 | 0 | 2½ |
| | | Succeeding crops | 3-12-12, 0-12-12- or 0-10-20 | 1200-1400 | 1000 | 600-1200 | 2½-5 | 0 | 2½ |
| | Poor | First crop | 3-18-9 or 3-12-12 | 1800 | 1200-1400 | 300-900 | 5-10 | 0 | 2½ |
| | | Succeeding crops | 3-18-9, 3-12-12 or 3-9-18 | 1400-1600 | 1200 | 800-1200 | 2½-5 | 0 | 2½ |
| Very slightly acid to neutral (pH 6.4-7.0) | Goood | First crop | 3-12-12 or 0-12-12 | 1500 | 1000-1200 | 0-800 | 5-10 | 0 | 2½ |
| | | Succeeding crops | 3-12-12, 0-12-12 or 0-10-20 | 1200-1400 | 1000 | 600-1200 | 2½ | 0 | 2½ |
| | Poor | First crop | 3-18-9 or 4-16-8 | 2000 | 1400-1600 | 600-1000 | 5 | 5 | 2½ |
| | | Succeeding crops | 3-18-9, 3-12-12 or 3-9-18 | 1400-1600 | 1400 | 800-1200 | 2½ | 5 | 2½ |
| Slightly to medium alkaline (pH 7.1-7.5) | Good | First crop | 3-12-12 or 0-12-12 | 1500 | 1000-1200 | 0-800 | 2½ | 10 | 5 |
| | | Succeeding crops | 3-12-12 or 0-12-12 | 1200-1400 | 1000 | 600-1200 | 2½ | 10 | 2½ |
| | Poor | First crop | 3-18-9 or 4-16-8 | 2000 | 1400-1600 | 600-1000 | 2½ | 10 | 5 |
| | | Succeeding crops | 3-18-, 4-16-8 or 3-12-12 | 1200-1400 | 1400-1600 | 800-1200 | 2½ | 10 | 2½ |
| Highly alkaline‡ (pH 7.5 or more) | Good | First crop | 3-12-12 or 0-12-12 | 1500 | 1000-1200 | 0-800 | 2½ | 10 | 5 |
| | | Succeeding crops | 3-12-12 or 0-12-12 | 1200-1400 | 1000 | 600-1200 | 2½ | 10 | 2½ |
| | Poor | First crop | 3-18-9 or 4-16-8 | 2000 | 1400-1600 | 600-1000 | 2½ | 10 | 5 |
| | | Succeeding crops | 3-18-9, 4-16-8 or 3-12-12 | 1200-1400 | 1400 | 800-1200 | 2½ | 10 | 2½ |

‡If soil is highly alkaline (pH 7.6 or more), a 1000-pound-per-acre application of agricultural sulfur, thoroughly disked in before fertilizing, is advisable in addition to the recommended fertilizer and minor elements. If sulfur is not applied, 5% borax application should be repeated. Check pH of soil after plowing down sulfur to determine if more is needed.

*In some cases other analyses are obtainable rather than those recommended. Thus a 4-16-8 may be substituted for 3-18-9, 0-20-20 for 0-12-12, or a 4-16-16 for a 3-12-12. When such substitution is made, the rate of application should be decreased or increased in proportion as the mixture is of higher or lower analysis than the one recommended.

†The rate of fertilization of the muck in the preceding two or three years should be taken into consideration in deciding on how much is likely to be needed for head lettuce. If none has been applied previously, a fairly heavy application should be used whereas, with heavy previous fertilization as for celery, none may be required for lettuce.

## CULTURAL OPERATIONS

In the production of head lettuce on Michigan mucks in the past few years, by far the greater proportion has been grown from seed sown in the field and only a small part from plants produced in the greenhouse. Greenhouse plants for the first planting will advance the harvest of the first crop by one and sometimes two weeks. Growers using greenhouse plants should have overhead irrigation for use at transplanting and again for frost protection if needed. Seed should be sown in greenhouse March 1 to 20, the time depending on the location in the state, the temperature at which the greenhouse is kept and the probable date of transplanting. Transplanting can be done by hand or by use of a celery transplanter.

Transplanting or seeding of the crop should proceed at intervals as soon in the spring as the soil can be worked, for which reason the first land to be sown should have been fall-plowed. Since this first planting is likely to bring the best prices, it should be located on land somewhat sheltered from direct winds but not so completely protected as to offer a "frost pocket." At the same time, the muck should be fairly moist as an added precaution against frost injury. If the lettuce is to be on new land, the muck should have been broken 12 to 18 inches deep in the spring of the preceding year and summer fallowed for the remainder of the summer.

Seeding of the spring crop should be continued up to May 15 or even to June 15, the last date of planting depending on the location in the state and the amount of lake protection against high temperatures. Seeding of the fall crop should be made around July 1 in the northern part of the state to July 30 in the southern part, with the last seedings more or less of a gamble from the standpoint of freezing in some localities. In all cases, the acreage sown should not exceed what the grower can harvest before the next seeding is ready. (See section on marketing.)

The plowed muck should be disked over, leveled if necessary, fertilized and disked again, rolled to produce a fairly firm seedbed and the lettuce transplanted or seeded. Rate per acre of seeding in the field will depend on the percentage germination of the seed, on the size of the seed, on distance between rows and on whether the seed is pelleted.[1] With unpelleted seed, 2 to 3 pounds of seed per acre is sufficient.

[1]Pelleting of head lettuce seed is still in the experimental stage. At Michigan State College, Dr. Robert L. Carolus of the Horticultural Department is conducting pelleting studies which should be closely followed by head lettuce growers.

In deciding on spacing between rows and between plants in the row, the variety to be grown, the size of heads desired, the distance between the tractor treads, when tractor sown, and the desirability of having good air circulation around the plants (discussed under "Tipburn") are factors to be considered. Generally, a 20- by 20-inch spacing is desirable for the large-headed Great Lakes, while an 18- by 18-inch is sufficient for Imperial 456. Some growers prefer wider rows and closer spacing, as 20-inch rows with 16-inch spacing for 456 while others, who find the heads larger than desired, may space the plants 14 inches in the row. When tractor sown, a space 24 to 30 inches is left for each tractor wheel and the row spacing may be further decreased. These wider spacings are advantageous later in cultivation and harvesting.

Small lettuce plants are very easily destroyed by strong winds in May and June. For that reason interplanting between every two rows of lettuce with a fairly thick drill of spring rye or barley is advisable. Rye has the advantage that it is not destroyed by frost as easily as is

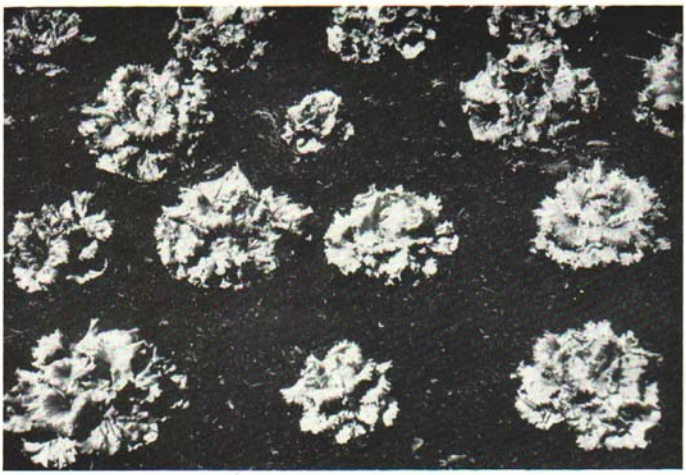

**Fig. 4. Aster yellows on Cornell 456 on well fertilized soil at the Muck Experimental Farm in 1943. The middle plant in the front row and the second plant from the right in the second row were badly affected while the right plant in the front row and the very small plant (a replant) in the third row were showing the first stages of the disease.**

barley. It is preferable not to place these drills of grain in the spaces used by the tractor wheels since they are pressed down by the wheels during cultivation and for some time do not give much protection. In addition, on badly windswept fields, sowing of winter rye in the fall, in strips every 25 to 40 feet apart, with 6 to 12 drills per strip, offers early and additional protection to the head lettuce spring sown between the strips.

Cultivation of head lettuce in cool weather should be for the removal of weeds alone and should be shallow, in order to avoid the greater damage from frost injury which is likely to result when a thick mulch is maintained on the surface. In case of a decidedly wet period which leaves the soil saturated and soggy, deeper cultivation is necessary but damage to the roots near the plants should be avoided. Maintenance of a mulch is desirable in hot, wet weather in order to reduce the amount of tipburn.

## DISEASE AND INSECT PESTS

The most important disease effecting head lettuce is aster yellows, a disease attacking many weeds and crops and carried by the six-spotted leaf hopper. Control can be obtained only by the elimination of this leaf hopper and should begin with the burning in early spring, while the soil is well filled with water, of all weeds, grass on ditch banks and crop refuse. Some control in the field can be obtained by dusting with DDT at frequent intervals up to the time the plants start to form heads, but the applications should be discontinued then in order not to exceed the tolerance for DDT on the heads permitted in government inspection of the crop when it reaches the market. During the heading of the crop, application of DDT along ditch banks, on adjoining crops and on nearby weed patches, is likely to further control this leaf hopper. Pyrethrum dust is also effective, applied either throughout growth or after the DDT is discontinued.

Another disease, which has not been serious on Michigan lettuce fields thus far but which is reported serious in some out-of-state districts, is a bottom-rot which attacks the underlying leaves. Best method of control consists of prevention by means of crop rotation, by wider

[2]This statement follows the recommendations made by Dr. Ray Nelson of the Botany and Plant Pathology Department and Prof. Ray Hutson of the Entomology Department of Michigan State College and is published with their approval. Head lettuce growers are advised to follow closely the studies made by these men in order to obtain information regarding the latest advances in the use of fungicides and insecticides.

spacing of rows and plants to permit air circulation, and by maintenance of a mulch on the soil surface.

Other insect pests likely to attack head lettuce include wireworms and cutworms. Wireworms, generally present for two or three years following breaking of a sod, can be destroyed by the use of Chlordane or Parathion mixed in the fertilizer. Growers are advised to contact the Entomolgy Department, Michigan State College, or maufacturers of the insecticides for directions regarding the use of their products.

## MARKETING

In the production of head lettuce, the marketing of the crop should be taken into consideration at the time of seeding. No larger acreage should be transplanted or sown at one time than the marketing facilities of the grower can accommodate. Plantings should be made at intervals of 5 to 7 days in sufficient amount so that a uniform volume of dependable lettuce can be supplied the buyer for as long a period as possible. Time between seedings can be varied according to weather conditions, colder temperatures requiring longer, and warm temperatures shorter periods for growth of the crop. Where feasible, any foreseen delay in germination of a seeding because of dry soil should capacity to hold the harvested crop for several days is almost a necesbe prevented by use of overhead irrigation before seeding.

Harvesting of head lettuce is accomplished in some fields by packing in crates on the ground, which are then loaded on tractor-drawn wagons and taken to the road to be loaded into closed trucks and hauled to market or storage. Icing is advisable if the lettuce is to be hauled some distance. In some fields, portable packing racks are pulled through the field and all packing is done by an experienced packer, generally with two cutters for one packer. California crates are being used at present. From some fields the lettuce is put in cold storage or taken to packing rooms where it is graded and chilled before being sent to market.

All growers should have facilities for cooling the lettuce before sending it to market. Where a considerable acreage is being produced, a cold storage to cool the lettuce rapidly after harvest, and of sufficient capacity to hold the harvested crop for several days is almost a necessity to assure a smooth, uniform handling of the crop. This is important in the event of a temporary drop in price or of more lettuce

produced than the grower can deliver or the buyer handle in some periods in the growing season.

## SUMMARY

Head lettuce production on Michigan's muck soil is dependent on several conditions of which the seasonal climate is most important. With satisfatory weather good yields of high quality lettuce can be secured, provided several other influencing factors listed below are controlled:

1. **Variety.** Two varieties of lettuce, Cornell 456 and Great Lakes, have thus far proved best adapted to Michigan muck soil, with 456 generally the better of the two. New varieties should be thoroughly tried out in a small way before discarding the established varieties.

2. **Soils.** Muck soil with a pH between 4.8 and 7.2 will produce satisfactory lettuce if properly drained and properly fertilized. Location near a lake will reduce weather hazards. Application of ground limestone on the very acid mucks and of sulfur on the alkaline mucks will improve them for lettuce production.

3. **Water control.** Water levels between 18 and 28 inches below the surface generally prove optimum for lettuce production. Overhead irrigation is advisable for insuring a uniform stand at seeding, for improving early growth during dry weather and for protection from frosts. It should not be used in hot weather after heads are about half-grown.

4. **Disease and insects.** Aster yellows is the most important disease of head lettuce and is carried by the six-spotted leaf hopper. Elimination of the leaf hopper is the only effective control of the disease. Use of DDT or pyrethrum dust in early growth or of pyrethrum after heads form is recommended.

5. **Fertilization.** Application of 3-12-12 or 0-12-12 is generally advisable on well drained muck. If drainage is poor, a 3-18-9 or 4-16-8 is likely to give better results. Rate of application will depend on the amount of previous fertilization and should not be excessive.

6. **Minor elements.** Copper sulfate will be needed for head lettuce on all mucks unless it has been applied for preceding crops. Manganese sulfate will be needed annually on alkaline and on poorly

drained near-alkaline mucks. Borax should be used annually on alkaline mucks and for from one to three years on acid mucks. Sulfur applied to alkaline muck will reduce their manganese and boron requirements. Excessive applications of minor elements should be avoided.

7. **Seeding or transplanting.** Harvest of spring crop can generally be advanced seven to 10 days by transplanting of first crop from greenhouse. Most lettuce is field-sown. Seedings should be made at intervals of 5 to 8 days and only in amount which can be marketed before the next seeding is ready.

8. **Tipburn.** This physiological disease appears as a browning and decaying of the edges of the leaves, often inside the heads. It occurs as a result of hot, humid conditions and is accentuated by excessive fertilization, especially by nitrogen and potash. It may render a good crop of lettuce worthless for market if unfavorable weather occurs just before harvest.

9. **Marketing.** Since the crop is perishable, growers should anticipate their markets before seeding. Where the acreage is considerable, a cold storage to chill the lettuce before shipment and to hold it during a depressed market is an important asset in selling the crop.

Cooperative extension work in agriculture and home economics. Michigan State College and the U.S. Department of Agriculture, cooperating. C. V. Ballard, Director, Cooperative Extension Service, Michigan State College, East Lansing. Printed and distributed under Acts of Congress, May 8 and June 30, 1914.

JUNE 1950—5M