Essentials of Blueberry Culture
Michigan State University
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Stanley Johnston, Late Research Professor and Superintendent of South Haven Experiment Station; James Moulton and Jerome Hull, Jr., Department of Horticulture
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Essentials of

BLUEBERRY CULTURE

By Stanley Johnston,[1] James Moulton and Jerome Hull, Jr.
Department of Horticulture

Bluehaven variety

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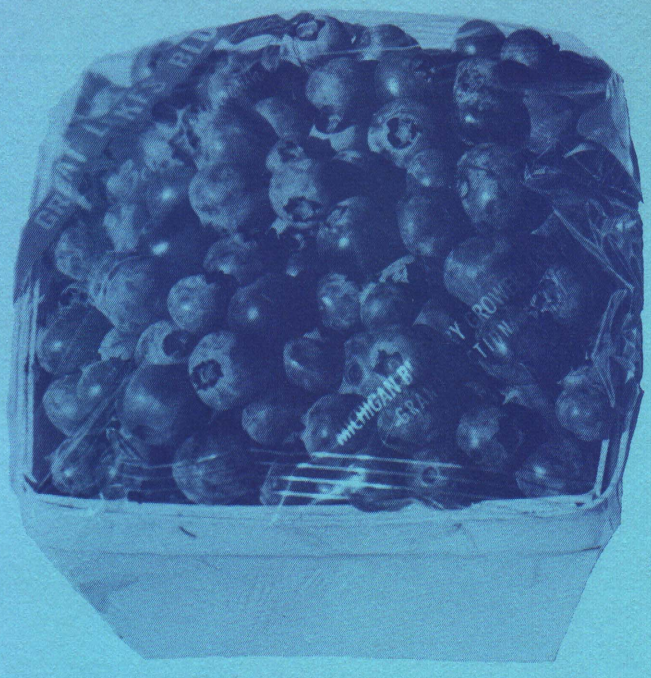


THE BLUEBERRY IS EVEN MORE AMERICAN than turkey for Thanksgiving – it grew abundantly in this country and was highly prized by the Indians before the first white settlers arrived.

Since wild blueberries were abundant, little was done to cultivate or improve the fruit for nearly 300 years after the Pilgrims landed. In 1906, investigations were started by the U.S. Department of Agriculture, under the direction of Dr. F. V. Coville. His work in determining soil requirements of the blueberry and in breeding and selecting varieties of unusually large size was of first important to the development of the cultivated blueberry industry.

Much credit for improving the highbush blueberry belongs to Miss Elizabeth White of Whitesbog, New Jersey, who made selections of outstanding wild bushes and, with Dr. Coville, established the first commercial plantings of hybrid blueberries. While some of Miss White's selections served as parent stock in blueberry breeding work, one – Rubel – has been an outstanding commercial variety.

DISTRIBUTION OF THE BLUEBERRY

Many species of the blueberry are native to different parts of the United States. These can be divided into two general groups or types, highbush and lowbush.

Lowbush species are generally found in the more northern states or highlands further south. Large quantities of wild, lowbush blueberries are harvested for market in many places. However, the supply is decreasing each year.

Most experimental and improvement work with the Blueberry has been done with the highbush type, especially the northern species, *Vaccinium australe*. This species grows natively in Michigan as far north as the southern end of Saginaw Bay, although it can apparently be grown in suitable soil as far north as Ludington or Traverse City. It is also established in central and southern New York; in the New England states, particularly in southern New Hampshire, Vermont and Maine; in the vicinity of Puget Sound in Washington; extensively in New Jersey, and, as far south as North Carolina.

Production of Cultivated Blueberries

The major cultivated blueberry producing states are Michigan, New Jersey, North Carolina, Washington, Indiana and Oregon.

Estimated production of cultivated blueberries in the United States in 1967 was about 67 million pounds. Michigan produced about 33 million pounds, nearly half the U.S. production. Production varies from state to state each year. The estimated gross farm value of Michigan's crop in 1967 was nearly $6.5 million.

There are approximately 9,000 acres of cultivated blueberries in various stages of production in Michigan. The industry is growing steadily. However, establishment of additional new plantings should be made gradually as the market expands.

Other Blueberry Production

Even though lowbush blueberry species are not cultivated, large areas of wild lowbush plants in Maine have been improved in production and quality by yearly systematic burning of a portion of a grower's acreage. This is done to renew the blueberry plants and remove competing vegetation. Other management practices include use of fertilizers, herbicides, and insect and disease control programs. Maine produced about 29 million pounds of lowbush blueberries in 1967.

There are large areas of native lowbush blueberry plants in the Provinces of northeastern Canada. Little has been done to improve most of these areas. In some years, large production of lowbush blueberries becomes an important factor affecting the processing berry market in the United States. Generally, lowbush blueberries are too small to offer serious competition to the larger cultivated berries on the fresh market.

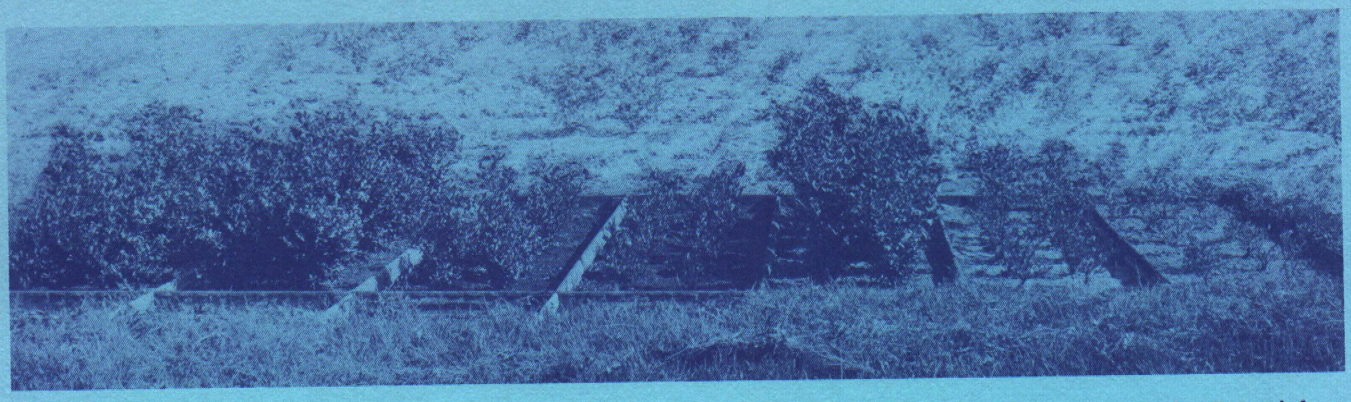


Figure 1 — Blueberries planted in muck and sand soils of various degrees of acidity after 3 years' growth. From left to right: extremely acid, very acid, moderately acid, and slightly acid muck soils (pH 3.4, 4.4, 5.5, and 6.8 respectively) and sand soils of pH 4.4, 5.5 and 6.8. The plants in the slightly and moderately acid sand and muck soils are making poor growth, the leaves are abnormally colored, and they drop prematurely. The plants in the extremely acid muck (pH 3.4) are growing fairly well but not as well as those where the pH is 4.4. Soils testing below pH 4.0 should receive sufficient lime to raise the pH to about 4.4 for best results.

The greatest hazards involved in reclaiming wild lowbush areas are: frequent and severe frosts, droughts which quickly affect the very shallow-rooted plants, and difficulty in obtaining satisfactory insect control. As a result, reclaiming only the most favorable sites in the best locations is advisable. Such areas are not plentiful.

While the blueberry is found in many different parts of the country, plants have very exacting soil and climatic requirements. Prospective growers should be certain that they have these suitable conditions before engaging in blueberry culture.

CHOOSING THE LOCATION

When selecting a location in Michigan, carefully consider:

Climate

The northern highbush blueberry forms the basis for the cultivated blueberry industry. This species rarely succeeds in Michigan north of a line extending from Muskegon to the southern end of Saginaw Bay. This is because the growing season is too short, winter temperatures are too severe, and spring frosts are usually frequent in this northern area.

Most of the blueberry production is located near Lake Michigan in the southwestern part of the state in Berrien, Van Buren, Allegan, Ottawa and Muskegon counties.

The MSU Department of Horticulture has been hybridizing the best highbush varieties with outstanding lowbush selections found in northern Michigan.

Figure 2 — Left: A blueberry plant after growing for 6 years where the soil was too acid (pH 3.2). Right: A 2-year-old plant growing in the same area after the soil had been treated with limestone at the rate of 2 tons per acre, raising the pH from 3.2 to 3.8.

One variety, Northland, was released from this project in 1967. It has a successful record in northern areas. Other varieties for northern areas should be released in the future. (Suggestions for Growing Blueberries in Northern Michigan can be found on page 6.)

Markets

Nearness to markets, both for fresh use and commercial processing, is a distinct advantage in growing and disposing of a perishable fruit crop.

Labor Supply

Blueberry growing has become mechanized to a great extent, but many seasonal workers are still needed to harvest, clean and pack the crop. An adequate supply of labor is a prerequisite for large-scale commercial growing.

SELECTING THE PLANTATION SITE

A good site for a blueberry plantation should have a suitable soil, and be as free from frost as possible.

Soil Requirements

Soil pH – The blueberry plant requires a soil that is very acid, preferably within the pH range of 4.0 to 5.1 (Fig. 1). The prospective grower should have his soil tested by his county agricultural agent or the Michigan Agricultural Experiment Station Soil Testing Laboratory.

Soils testing below pH 4.0 can be made suitable for blueberry production by applying finely ground dolomitic limestone at the rate of 1 to 4 tons per acre, depending upon the degree of soil acidity to be corrected (Fig. 2). If possible, cultivate the limestone into the soil before planting. Use limestone of high magnesium content.

Several other materials may be used to increase soil acidity, including sulfur, sulfate of aluminum, and acid peat. Sulfur is most commonly used. Acidifying soil for commercial blueberry culture is suggested only if the necessary change in soil reaction is slight. If confronted with this problem, consult your county extension agent or the Agricultural Experiment Station.

Moisture Content – Highbush blueberries grow best where the water table can be maintained from 14 to 22 inches below the soil surface. This ideal condition is not always possible, but for practical purposes, the water level in the soil should not be lower than 10 to 12 inches from the surface during the spring months. Insufficient soil moisture results in lack of flower bud formation, and, if the deficiency is great, injury or death to the plants. Too much water, especially during the growing season, can be even more injurious than not enough (Fig. 3).

Figure 3 – Rubel plants with water table maintained constantly at different depths. Above: Plants soon after setting. Below: The same plants after 4 years' growth. From left to right: Water table maintained at 30, 22, 14 and 6 inches. The 30-inch water table did not furnish sufficient moisture, while the 6-inch water table was too near the surface.

Figure 4 — Blueberry plants in their fourth growing season, in a white sandy soil having very little organic matter (left), and in a soil well supplied with organic matter (right). The pH of both soils is about the same.

Figure 5 — Blueberry plants growing vigorously (left) in a soil having a high clay content (31.8%) and a pH of 4.87; and failing (right) in a soil having a slightly lower clay content (28.8%) but a considerably higher pH reading of 6.08. This indicates that proper degree of soil acidity is more important in the successful growth of the highbush blueberry than clay content of the soil.

Figure 6 — Northland — Recommended for trial in northern areas on locations with suitable soil and reasonably free from frost.

Organic Matter — An ideal blueberry soil consists of sand with a high organic matter content (Fig. 4). Plants growing in muck soil, consisting mostly of organic matter, tend to grow too late in the fall because of the gradual release of nitrogen from the decomposing organic matter during the warm summer and early fall months. Be careful not to apply too much nitrogen fertilizer to muck soil and do not cultivate such soils after July 1. Sow a cover crop if there is insufficient weed growth to serve as a cover crop. Cover crops, competing for nutrients and soil moisture, help prevent late fall growth.

Texture — Blueberry plants usually grow natively on soils ranging from sand to peat. This suggests that plants will not grow on a clay soil. However, experiments have shown that blueberry plants grow well on clay soil provided it is sufficiently acid and well-supplied with organic matter (Fig. 5).

Avoid Frost Injury

Freezing temperatures during the blossoming season occasionally result in considerable crop losses. Carefully determine this potential hazard when selecting the plantation site.

It is usually necessary to establish the plantation on comparatively low land, more subject to frost than higher land, to obtain adequate soil moisture. Suitable blueberry soil with adequate moisture conditions can sometimes be found at higher elevations. Such sites may be nearly frost-free. If lower land must be used, select wide, open areas permitting as much movement of air as possible. Avoid valleys or depressions with hills close by. Nearness to large bodies of water is added insurance against frost.

BLUEBERRIES IN SOUTHERN MICHIGAN

Varieties

The following varieties are recommended for that part of Michigan south of a line extending from Muskegon to the lower end of Saginaw Bay:

Bluecrop — The leading early variety in Michigan, Bluecrop begins to ripen about July 15 at South Haven. Bush is hardy and productive. Berries are medium-large, firm, bright blue, and have an excellent picking scar. Quite tart if picked too soon, but otherwise a very good variety. Bush is suitable for machine harvesting.

Bluehaven — Introduced by MSU in 1967. The bush of Bluehaven (see cover) is upright and attains a height of about 5 feet at maturity. It is vigorous,

hardy and productive. Low temperature of -22°F in 1964 and -24°F in 1966 at the South Haven Experiment Station did not injure the plants or appreciably reduce the crop. Little crop reduction occurred after a temperature of 17°F on May 10, 1966, when blossoms were partially open.

Berries begin to ripen about July 15 at South Haven, or as early as Bluecrop. Bluehaven berries are large, round, light blue, remarkably firm and of excellent flavor. The picking scar is very small and dry. Because of the unusual firmness and ability to remain on the bush a long time after ripening, this variety can be harvested over a period of 4 to 6 weeks. It may be harvested completely in two pickings.

Rubel – An older variety that performs well on ideal blueberry soils. Berries are of medium size, firm, ship well, and are outstanding for processing. Ideal bush for machine harvesting. Begins to ripen about 10 days after Bluecrop.

Jersey – Begins to ripen about a week after Rubel. Harvest season extends until the middle of September, or even later, in southwestern Michigan. Jersey has been the leading variety in Michigan for about 20 years, but has not done well in some years since 1960. It blossoms late, during the last half of May, and unfavorable weather has been common in this period in recent years. Perfect blossoming season weather prevailed in 1967 when Jersey produced a bumper crop. There is no satisfactory new variety to replace Jersey and a majority of growers expect to continue to plant it until a better variety is available. The bush and berries of Jersey are usually excellent and it is satisfactory for machine harvesting.

BLUEBERRIES IN NORTHERN MICHIGAN

Cultivated blueberries in Michigan are the result of crossing wild highbush varieties native to southern Michigan. Thus, it is not surprising that the center of blueberry culture is in the southern part of the state. Trial plantings of highbush varieties have generally been unsuccessful in northern Michigan beyond the range of the native highbush species.

An intensive breeding program was started in 1933 at the MSU South Haven Experiment Station to create a new blueberry hybrid to be grown on favorable sites in northern Michigan and the Upper Peninsula. Thus, species of highbush and northern lowbush types were crossed. Each has certain desirable characteristics needed in the new varieties adapted to the north. Low stature and supple stems are traits inherited from the lowbush, and hybrids possessing these features are generally protected from severe winter injury by snow cover. Another important characteristic inherited from the lowbush species is early maturity, a necessity for survival in the short growing season. The highbush type has contributed a number of good qualities, including large and attractive berries.

Varieties for Trial

The following varieties are recommended for trial in Michigan north of a line extending from Muskegon to the lower end of Saginaw Bay, including the Upper Peninsula. Blueberry growing in this area is definitely experimental. Growers should make only small plantings in carefully selected locations and on the most favorable sites.

Northland – Introduced by MSU in 1967, Northland is the first lowbush-highbush hybrid to be named. While it has made an excellent record in northern trial plantings, it is recommended only for trial in the northern half of Michigan's Lower Peninsula and in the Upper Peninsula.

The bush of Northland (Fig. 6), is vigorous and spreads moderately, attaining a height of about 4 feet at maturity. It is very productive and hardy. Low temperatures in the winters of 1964 and 1966 did not injure the bushes or reduce the crop of this variety (see description of Bluehaven). No crop reduction occurred after a temperature of 17°F on May 10, 1966, when blossoms were partially open.

The wood of Northland is pliable, and breakage under the weight of heavy snow accummulation in northern Michigan has not been serious.

Fruit maturity is very early (earlier than Bluecrop), or about July 10 in an average season at South Haven. Early maturity is important in northern Michigan because of a short growing season.

Berries are medium in size, round, medium blue, moderately firm and of good flavor. The picking scar is medium – small and dry, if the berries are picked soon after ripening. Berries ripen at about the same time.

Northland can be harvested with hand vibrator machines, if the lower branches are removed each year to prevent them from bending to the ground with the weight of the crop. The bush is not suitable for harvest with large, over-the-row harvesters. However, harvesting machines could be developed for use on the lower-growing, spreading-bush types.

Rancocas – An old variety developed by the U.S. Department of Agriculture and introduced in 1926, Rancocas ripens about with Northland. It has some lowbush blueberry in its parentage which may account for its ability to withstand the cold climate of northern Michigan better than most varieties. In some seasons, however, the tops have been killed to

the snow line. The leaves are subject to a physiological leaf spot often causing severe defoliation. The bush is highly resistant to Fusicoccum canker, a blight more prevalent in northern than southern Michigan. Berries are medium-small, but of good flavor. They usually crack in rainy weather. Despite its faults, this variety may provide some cultivated blueberries for northern areas until varieties with better fruit characteristics are available.

Caution – Plant sparingly all new varieties, or those with questionable weaknesses, until learning how well they will perform under local conditions. More hybrids will be suggested for trial when recent promising selections have been more thoroughly evaluated.

Selecting the Plantation Site

Over the past 35 years, 70 trial plantings have been observed in northern areas, many of them in the Upper Peninsula. The most successful plantings have been (1) near one of the Great Lakes, (2) where snow cover is deep and (3) at elevations with good air drainage. Such sites are relatively free from late spring frosts and extreme cold in winter. Trial plantings inland, away from the moderating effect of the Great Lakes, and on flat lands at low elevations are subject to repeated crop losses from frost and cold injury.

Data from the United States Weather Bureau and observations made at three trial plantings illustrate the close relationship between the frequency of freezing temperatures during bloom and the productiveness of blueberries in different areas of northern Michigan. Plantings in the Houghton area on the Keweenaw Peninsula, which is almost surrounded by Lake Superior, have suffered only minor injury from frost. From 1949 to 1959 there was an average of only three dates each year during the period from May 16 to June 15 when temperatures were 32°F or lower. These dates were selected because blueberries would blossom sometime during this period. Weather Bureau thermometers are located 5 feet above the ground and temperatures near the ground may be 5 degrees colder on frosty nights than at the 5-foot level.

Trial plantings south of Grand Marais, near Seney, and at the Lake City Experiment Station were abandoned because of repeated crop failures resulting from frost and winter injury. Freezing temperatures occurred 10 times at Grand Marais and 5 times at Lake City compared to 3 times at Houghton in the interval when blueberries can be expected to bloom. Also, temperatures dropped much lower at Grand Marais and Lake City than at Houghton. This greatly increased chances of crop loss.

Soil Requirements

Soil requirements for blueberry varieties for northern Michigan are the same as those discussed on page 4 of this bulletin. It is emphasized again that these plants must have a very acid soil with a constant and sufficient moisture supply.

Spacing the Plants

Plant spacings recommended for southern Michigan are too wide for best yields further north where plants are relatively small at maturity. Three feet between plants in the row is suggested for northern Michigan. Distance between rows will depend upon the size of the equipment used in cultivation. A spacing of 10 x 3 feet is satisfactory where large tractors are used, but the distance between rows could be decreased to 6 or 7 feet if smaller equipment were used.

Conclusion

Successful culture of blueberries in northern Michigan requires special care in the choice of site and soil. Plant only varieties recommended for this area. In general, cultural practices employed in southern Michigan should be followed in northern Michigan. Since comparatively little is known about growing blueberries in northern Michigan, plantings should be small at first until more is known about culture in the north. Also, improved varieties for northern Michigan should become available in the future.

PROPAGATION

The blueberry is not easy to propagate by ordinary methods and requires special treatment and careful attention. Until recent years, plants were so

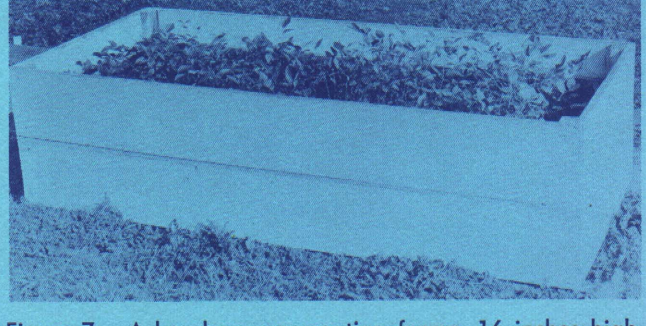


Figure 7 — A low box propagating frame, 16 inches high. See Figure 8 for more details of construction.

expensive that there was considerable incentive for users of even comparatively small numbers of plants to attempt to propagate their own. Unless one intends to grow large acreages, it will probably be easier and cheaper to purchase plants from nurserymen.

The following outline of propagation methods is given for those desiring to propagate their own plants:

Building the Propagation Frame

A propagating framebox, measuring 6 feet long, 30 inches wide, and 12 to 16 inches high, is recommended. Dimensions for length and width may be changed to accommodate glass sash of various sizes that may be on hand. The cutting tray is made of 4-inch lumber with ⅜- or ¼-inch mesh hardware cloth stapled on the underside. This tray rests on braces nailed on the inside of the frame 8 inches from the top. It can be removed without disturbing the cuttings, which facilitates handling. After the cuttings are planted, the glass sash and shade are placed on top of the frame. (See Figs. 7 and 8 for construction details). Burlap, similar to that used for bran sacks (7½ ounce), makes the best shading material since it provides the right amount of light. Do not use materials that are woven closer or looser than burlap.

Plastic Covers on Propagating Frames

Various plastic covers have been evaluated as a substitute for glass on propagating frames. Temperatures in the test frames covered with clear plastic were higher during hot days in June than under glass. Temperatures in frames covered with clear plastic, reinforced with a fine wire mesh, were nearly the same as under glass sash. Extremely high temperatures in late spring, before the cuttings have become well rooted, can be fatal.

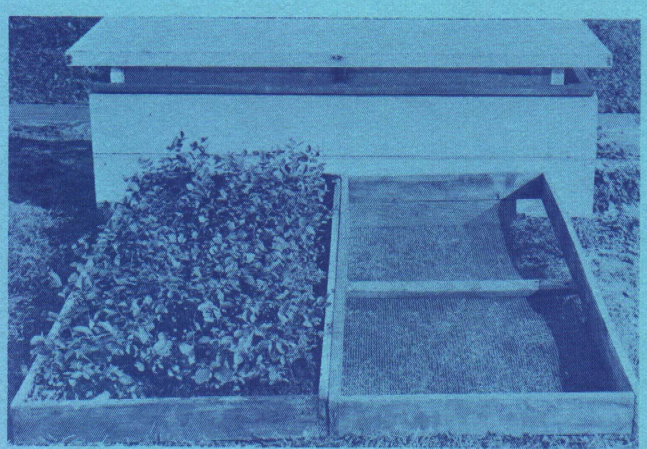


Figure 8 — Low propagating frame with glass sash and burlap shade in place. In foreground is an empty cutting tray and one filled with rooted cuttings. These trays set in the top of the propagating frame (see Figure 7), and, being movable, provide a convenient way of handling cuttings prior to planting in the nursery.

Try only the wire mesh plastic in a limited experimental way in comparison with glass until more is known about this material. Advantages of plastic mesh are: (1) less expensive, (2) light in weight, (3) easier to handle, and (4) more resistant to breakage.

There is some evidence that it is best to use fresh plastic covers each year. Old ones become badly stained, restricting the passage of sufficient light, and they also become brittle and are likely to crack. Propagating frames should be located in the open sunlight, well removed from buildings and trees.

Making and Storing Cuttings

Blueberries are commonly propagated from cuttings made in late winter or early spring from shoots produced the previous season.

Use sound shoots of medium to medium-large size for cuttings. Avoid winter-injured wood or wood with fruit buds (Fig. 9).

Make the cuttings about 4 inches in length, the lower cut at a slant just behind the lowest buds, and the upper cut just above the top bud on the cuttings.

Make cuttings with a sharp knife or pruning shears adjusted for this work. Ordinary pruning shears are likely to injure the cuttings. However, the blade can be removed from a pair of snap-cut shears and ground much thinner. Replace the metal bumpers with wooden ones. Properly adjusted shears make cuttings without injury, with greater comfort and speed for the operator. The wooden bumpers will need to be replaced occasionally.

To make planting easier, cuttings can be bunched in groups of 50 with all butts pointing in the same direction.

If stored before planting, place the bundles of cuttings in shallow flats or propagating trays of clean peat moss which has been soaked in water and then pressed until just damp, but not too wet. Keep in this condition and store in a cool place until ready to plant. Many cuttings have been ruined by storing in peat moss that is too wet. Cuttings can be satisfactorily stored for several days in plastic bags when handled properly. Do not put moss or other material into the bags with the cuttings. After placing the cuttings in the bag, squeeze out the air and tie the top of the bag. Place bags of cuttings in a cool, shaded

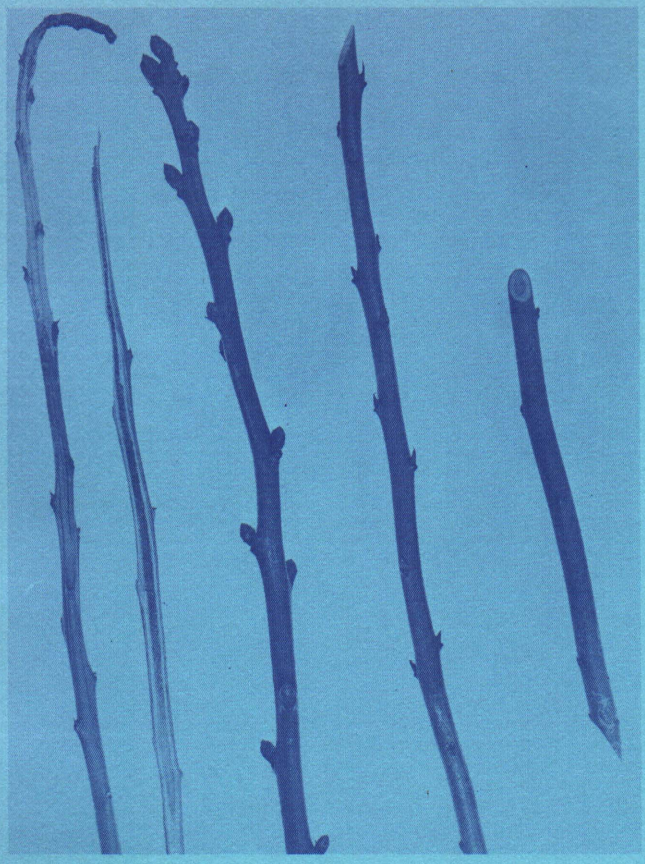


Figure 9 — Shoot at left shows winter injury; beside it is another shoot showing the extent of the injury. Shoot in center is undesirable for cuttings because of the prevalence of flower buds. Shoot at second right illustrates best type of wood for hardwood cuttings. At the extreme right is a hardwood cutting ready for planting.

place. Best results are usually obtained by eliminating the storage period or reducing it to a very short time.

Material in Which to Root Cutings

Ground sphagnum peat moss appears to be the best material in which to root cuttings. Tests indicate that the best peat moss sources for propagation are northern and western Europe, and British Columbia, Canada. Do not use moss from local peat beds unless it has been carefully tested and found satisfactory.

Do not add soil, fertilizers or other materials to the ground sphagnum peat moss (Fig. 10).

Plant Cuttings

Cuttings are usually planted about the middle of April in Michigan, or as soon as danger from severe freezing has passed.

Submerge the peat in water before placing it in the propagating frames. This soaking period will range from 2 or 3 hours to several hours. Some peats become saturated with water quickly. Soaking too long does not seem to injure the peat from northern Europe or British Columbia. After soaking, fill the trays to the top to allow for settling. Do not pack or firm the peat.

To plant, push the cutting into the peat at a slant to about two-thirds of its length. The slant position prevents the butt of the cutting from resting against the wire bottom or going through it. Plant in rows 2 inches apart and space the cuttings slightly more than an inch apart in the row.

Sprinkle thoroughly after the cuttings are in place.

The sash and burlap shade should be placed over the cuttings and kept there, except for watering periods, until the cuttings are well rooted, which is usually about mid-July in Michigan. Sufficient ventilation may be obtained by permanently blocking the sash open about 3/16 inch on one side.

Watering

Examine the peat daily to determine if it is sufficiently moist. If water can be readily squeezed from the peat between the thumb and finger, it is moist enough.

If needed, apply water with a sprinkler in the morning before the cuttings become warmed by the sun. Use only water from which the chill has been removed. Never water the cuttings during the heat of the day or in the evening.

Sanitation

Loss from fungus infection after planting is sometimes serious if the cuttings are not properly handled.

Examine the cuttings every morning, preferably, and immediately remove all those showing signs of dying. Weak cuttings will not form roots and are a source of infection.

When a fungus is observed, remove foreign matter of all kinds and any leaves showing signs of fungus infection.

If fungus infection becomes established in the cutting bed, increased ventilation will assist in controlling it. Be careful not to increase ventilation to the point where the cuttings wilt.

Spraying cuttings in the frame with fungicides usually produces poor results. Severe spray injury has resulted from this practice because of the warm, humid atmosphere inside the frames. However, good

results have been obtained by watering the cuttings with *Pano-drench*, using one teaspoonful in a gallon of lukewarm water. Apply at the first sign of infection. Repeated applications can be made if necessary at intervals of about one week. Other satisfactory materials may be found as tests continue.

Ventilation

When it is certain that nearly all cuttings are rooted, gradually block up the sash a little higher each day for about a week or 10 days until the cuttings are fully ventilated. Then, remove the sash but leave the burlap shade over the cuttings until about the middle of September when it can be removed to permit the cuttings to harden properly for winter. Water the cuttings when necessary, which may be frequent once the sash has been removed.

Fertilizer in Propagating Frames

Serious injury has resulted from mixing fertilizer with the peat in propagating frames just before planting (Fig. 10). Likewise, watering cuttings with fertilizer in solution before they are rooted is hazardous.

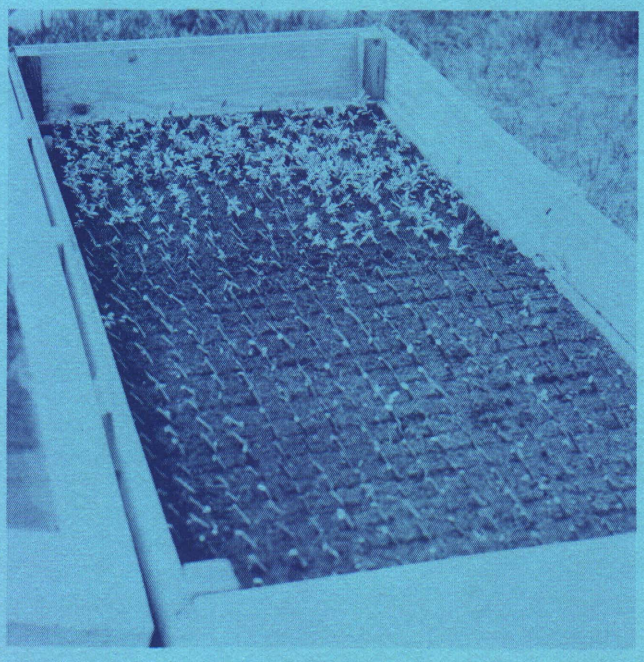


Figure 10 — Cuttings in the foreground of the propagating frame that have failed to start new growth were killed by fertilizer mixed with the peat. In the background, where no fertilizer was added, the cuttings are alive and growing.

As soon as the cuttings are rooted and the sash removed, an application of nitrogen can be beneficial. Apply an ounce of sulfate of ammonia dissolved in one gallon of water to an area of about 18 square feet – the equivalent of the area of cuttings in a 6 x 3 ft. propagating frame. Stir the solution well before applying. A stock solution can be prepared if desired.

Wash the fertilizer from the leaves with clear water. This is very important. If not done, the leaves on the cuttings will probably be burned.

One application should be sufficient. Do not use too much nitrogen, or cuttings may grow too late in the fall and be susceptible to injury from low temperatures in fall or early winter.

Storing Cuttings Over Winter

In October or early November, lift the cutting trays from the frames and place on a well-drained piece of land. Bank soil around the sides and ends of the trays. Place a closely woven wire fence around the trays to exclude dogs, cats and rabbits.

The trays of cuttings dry out quickly, especially in the fall. Examine the cuttings frequently and water if needed. The same situation may occur in the spring if planting the cuttings in the nursery has to be delayed.

Lath and Plastic Propagating Houses

In some states where spring weather is warmer than in Michigan, lath propagating houses are used with cutting beds either suspended a few inches above the ground or placed in the ground. Spring temperatures are too low in Michigan to use this type of propagating house.

A few Michigan growers of large quantities of blueberry plants are experimenting with rather large, plastic-covered propagating houses. These appear to be promising, but should only be used by nurserymen who are engaged in blueberry propagation on an extensive scale.

Planting and Care of the Nursery

The following spring, remove the rooted cuttings from the trays and plant them in the best available piece of suitable soil in rows 18 inches or more apart, depending on the method of cultivation. Rows 4 feet apart are about right for tractor cultivation. Plant cuttings 8-10 inches apart in the row.

About 2 weeks after planting the cuttings in the nursery, apply fertilizer as a side dressing along the

rows. Use 16-8-8 blueberry fertilizer, or 12-12-12, at the rate of about ½ pound per 100 square feet. A second application in July may sometimes be beneficial.

Caution: *Do not apply fertilizer unless the leaves are perfectly dry.* Fertilizer on wet leaves is likely to cause serious injury.

Cultivate and hoe the nursery thoroughly until September, and then sow a cover crop of oats.

PRODUCTION

Fruit production begins in a small way the year after planting, although it is best to remove the blossoms to prevent bearing. The second-year crop is too small to be of importance and all of the strength of the bush might better be put into growth.

Yields vary greatly with soil conditions and care. But, an average of 400 to 800 pints per acre may be harvested the third season and 1,400 and 2,000 pints the fourth summer. Plants reach full production in about 8 years. Average yields of full-bearing blueberries, under good conditions, should range from 4,000 to 7,000 pints per acre, although occasionally much higher yields are obtained.

Blueberry bushes growing under proper conditions are long-lived, some wild plants living more than 100 years. Bushes in commercial plantings often become too tall for economical handling at 10 to 12 years unless properly pruned. If old canes are systematically removed or bushes renewed as suggested (see pruning, page 14), bushes of desirable blueberry varieties can probably be maintained in profitable production for more than 50 years.

FIELD PLANTING

Spring is usually the best time to plant blueberries in Michigan. Fall planting can sometimes be successful if the field is well-drained and large plants are used. Small plants are likely to heave from the ground over winter.

Plants 2 or 3 years old are best for field planting. It is doubtful if older plants are worth a higher price. More labor is required to plant them and tops will need to be pruned back considerably to compensate for the loss of much of the root system. Do not use very small plants since they will make a poor growth after planting, especially in an unfavorable growing season, and many plants may be lost.

A planting distance of 10 x 4 feet has been used in Michigan since the beginning of the cultivated blueberry industry. Some growers use wider distances, such as 11 or 12 feet between rows and 5 feet between plants in the row. Wider planting distances utilize fewer plants per acre, usually resulting in lower yields per acre. Planting distance can be influenced by variety. Bluecrop, Rubel, and Bluehaven should do well at 10 x 4 feet, while Jersey might benefit from wider spacing such as 10 x 5 feet or 12 x 4 feet. For large mechanical harvesting equipment, a spacing of 11 x 4 appears desirable. See the section on Plant Spacing for Northern Michigan (p. 7) for a discussion of planting distance in that area.

Ridge moderately wet areas and set plants on the ridges. Use tile draining to remove excess water from some exceptionally wet places, or it may not be advisable to plant such areas.

Leave as many roots and as much earth on the plants as possible when transplanting from the nursery row to the field.

Set plants an inch or two deeper than they were growing in the nursery.

Do not put fertilizer or other chemicals into the plant holes. If the soil lacks organic matter, a shovelful of peat mixed with the soil in each planting hole will be helpful.

Prune off all fruit buds on the plants either before or soon after planting. This is all the pruning required on plants of small or medium size. For large plants, cut tops back to 8-12 inches from the ground to compensate for the loss of a considerable part of the root system in digging.

Replanting in Old Fields

Removing old plants and setting new plants in the same row results in poor growth unless the land has been rested for at least three years. New plants will grow quite well if planted in the area between the previously established rows (old row middles). If this is impossible because of interference with remaining rows of old plants, do not set the new plants until the resting period has been completed.

If entire fields of old plants are removed, they can be replaced immediately, provided the new rows are planted in the row middles of the previous planting.

Provisions for Pollination

MSU experiments have shown that Rubel and Jersey are self-fertile. Later tests showed that other varieties now recommended for planting are also self-fertile. Thus it is possible, in Michigan at least, to plant varieties in larger blocks than was formerly considered advisable. Larger blocks of a single variety simplify cultural operations somewhat, especially har-

vesting. However, plant more than one variety — probably three or four — to extend the harvesting season and distribute any risks that might be involved in planting only one variety.

OTHER CULTURAL PRACTICES

Cultivation and Cover Crops

Since the blueberry plant is shallow-rooted, cultivation should be shallow. Cultivate frequently enough to keep down heavy weed growth. If the season is dry, continue cultivation through the harvesting season. Bushes heavily loaded with ripe berries cannot be cultivated without knocking off a considerable amount of fruit unless cultivated immediately following a picking when all ripe fruit has been removed. Green berries are not easily shaken from the bushes.

If soil moisture is sufficient, and the plants have become well established, cultivation is often eliminated. Row middles are kept mowed and weeds in the rows are controlled chemically. Mowing should not replace cultivation on soils subject to drought or on plants less than three years old.

Young plantings should be sown to a cover crop by September 1, unless a drought is in process. Sow cover crops in bearing plantations immediately after harvest, unless a cover crop of weeds or crabgrass is present. If a natural cover crop is not present, sow oats at the rate of ¾ bushel per acre. Few cover crops do well in such highly acid soil, but oats give excellent results. Do not use a cover crop that will live over winter, such as rye, since these crops are too difficult to subdue the following year.

Other Weed Control Measures

An automatic rotary hoe, used regularly, does an acceptable job of keeping weeds down in the blueberry row. This requires several cultivations during the season and is difficult to perform when bushes are heavily loaded with ripe berries. Herbicides can effectively and economically replace cultivation in the row (Fig. 11). Several chemicals are available for application in the spring before the buds break. While they must be applied annually, they offer season-long weed control. Plants should still be hand or mechanically hoed the first two years in the field.

A heavier rate of chemical application is usually suggested for heavier textured soils and for areas of plantings with extensive weed infestations. A lower rate can frequently be utilized once the weed infestation is subdued or eliminated. Do not cultivate the treated area following herbicide application.

Apply herbicides at low pressure (40 pounds), using off-center swivel type nozzles (such as ¼-inch TOC-12 or -16) mounted at a height to produce a 2½- to 3-foot spray band. Spraying along each side of the row results in about a 5-foot weed-free band in and along the row. Chemicals available for weed control in blueberry plantings and limitations upon their use vary from year to year. Consult Extension Bulletin No. 433 for annual revisions of herbicides for horticultural crops.

Adding Organic Matter

Increasing the organic matter of the soil by applying 2 or 3 inches of sawdust or acid peat and working it in by cultivation has produced favorable results. This practice is economical only when these materials can be obtained and worked into the soil at a reasonable price. Chopping the prunings with brush-cutting equipment and leaving them in the planting will add some organic matter. Where Fusicoccum canker is known to exist, prune the plantings in the fall, remove the prunings from the field and burn them. Infected cankers on prunings can serve as a source of inoculum for this disease for several years after removal from the plant.

Irrigation

While the highbush blueberry is grown on rather moist soils, inadequate soil moisture frequently reduces growth and production. Many Michigan plantings have been profitably irrigated to increase soil moisture supply at critical times and to protect them against frost during bloom. Begin irrigation before plants show symptoms of water deficiency or berries

Figure 11 — An annual application of a herbicide has replaced cultivation in the blueberry row. Shallow cultivation is utilized to control vegetation between the rows.

Figure 12 — Cultivation has been eliminated in this blueberry planting. Herbicides control vegetation in the plant row and sod established between rows is mowed. Note irrigation system in row on right side.

Figure 13 — Collect leaves for nutritional analysis from the mid-position of lateral shoots on fruiting canes.

show indications of inferior quality (spongy and not plump). Usually about one inch of water per week is necessary during the growing season. Irrigate if rainfall is not sufficient to furnish this amount. Sandy soils require more frequent applications of water than heavy soils.

Most Michigan plantings are irrigated with overhead irrigation systems. An adequate water supply is necessary to make irrigation feasible. Since irrigation can be expensive, obtain expert advice through your fieldman, local Cooperative Extension Service Office, or Soil Conservation Service before investing in an irrigation system.

Sod Culture

Blueberry culture in a natural sod cover has been questionable unless supplementary soil moisture is provided through irrigation. Trials with Sea-Side and Highland bent grass for sod cover between the rows have been encouraging. An established sod between rows provides more satisfactory travel conditions for large equipment. Even with irrigation, the cover should be mowed occasionally to reduce competition for nutrients with the blueberry plants and to make conditions more favorable for pickers during harvest (Fig. 12). The mummy berry disease, which can be more serious in non-cultivated fields and where sod culture is practiced, requires extra care for control.

Some plantation growers permit natural grasses (primarily annual bluegrass) and weeds to become established during the early part of the growing season. This allows for use of heavy harvesting equipment. If these are mowed during the summer and roto-tilled or disced early the following spring, they will tend to reseed themselves. Success with any of these methods of handling sod covers will probably depend upon how much they compete with the blueberry plantings. Sod covers appear more necessary for plantings on organic soils.

USE OF FERTILIZERS

Fertilizers containing nitrates and chlorides are sometimes toxic to blueberry plants. Do not apply nitrate forms of nitrogen or chloride forms of potassium. A special grade of fertilizer is often formulated for blueberries. Currently it is 16-8-8-4. (The first number refers to the nitrogen; second to phosphorus, expressed as available phosphoric acid; the third as potassium given as water-soluble potash and the fourth to magnesium expressed as magnesium oxide). Nitrogen is often the only fertilizer element needed in Michigan blueberry plantings. When this is the case, apply ammonium sulfate if the soil pH is above 5.0 and urea if the soil pH is below 5.0. A leaf analysis collected in late summer will readily indicate the need for additional fertilizer elements.

When and How To Apply

On newly set plants, apply fertilizer about 4 weeks after planting. Sprinkle it by hand lightly around each plant, 12 to 18 inches from the crown. Starter

solutions have not been beneficial for blueberry plants.

After the first year, apply fertilizer in late April when the soil has dried sufficiently to support application equipment. Delay ground applications of fertilizer if the soil is not dry enough to avoid excessive soil compaction. If you apply powdery fertilizers after bud break, be sure the plants are dry so that the fertilizer will not damage the buds.

Determining Fertilizer Needs

Leaf analysis is the best method for determining fertilizer needs of established blueberry plantings. Collect leaf samples in late July or early August. Remove leaves from the mid-position of lateral shoots on fruiting canes (Fig. 13). Do not take leaves from either fruiting or sucker shoots, and take no more than two leaves from one shoot. Select leaves from various sides of the bush and sample at least 12 to 15 bushes. Utilize only one variety for each sample. Contact your fieldman or county agricultural agent for details on where to have the sample analyzed.

Fertilizer Rates

Nitrogen – Basic applications of nitrogen on mature plantings should be at a rate equal to about 50 pounds of actual nitrogen per acre on good blueberry soils and 65 pounds on poorer soils. For mature plantings, over 8 years of age and on good soils, this means about 250-300 pounds of ammonium sulfate, 110-150 pounds of urea, or about 300-400 pounds of the special blueberry fertilizer mentioned above. For younger plantings, apply nitrogen at a rate equal to about 12-16 pounds of actual nitrogen per acre for each 2 years of age.

Figure 14 – Left: A mature bush before pruning. Right: The same bush after receiving the type of pruning recommended for the average Michigan plantation. Low branches, an old stem and a few of the largest clusters of fine, bushy wood have been removed. Plants growing on light soils poorly supplied with organic matter will probably require somewhat heavier pruning than shown above.

Potassium – Apply 75 to 100 pounds of potassium sulfate per acre or use the special-grade blueberry fertilizer (16-8-8-4).

Phosphorus – Phosphorus applications are seldom necessary on an annual basis. When necessary, apply concentrate superphosphate (0-46-0) at 200 pounds per acre. Phosphorus could also be supplied by using the special-grade blueberry fertilizer (16-8-8-4).

Calcium – When leaf analysis indicates low calcium content and soil pH is below 4.5, apply 500 to 1,000 pounds per acre of pulverized or hydrated dolomitic lime.

Magnesium – When a need for magnesium occurs, apply 16 pounds of magnesium per acre utilizing a complete fertilizer containing 4 percent magnesium or apply an equivalent amount of magnesium sulfate or magnesium oxide.

Nursery beds – Nursery beds may be fertilized about one month after the rooted cuttings have been planted, using the recommended complete fertilizer at the rate of ½ pound per 100 square feet and exercising extreme care not to place fertilizer on the plants.

PRUNING

Blueberry plants need not be pruned until the end of the third year in the field. Then remove only the small, bushy growth near the base of the plant.

Experiments at the South Haven Experiment Station show that the heavier mature blueberries are pruned, the (1) smaller the crop, (2) larger the berries, and (3) higher the percentage of berries maturing early.

Remembering these basic principles, each grower can determine what type of pruning best meets his needs. If he desires larger, earlier-maturing berries, his pruning should be rather heavy. If he wants larger crops of somewhat smaller and later-maturing berries, his pruning should be light. Modifications of the two extremes can be adopted (Fig. 14).

A moderate pruning each year is recommended for Michigan blueberry plantations to:

1. Remove dead and broken branches and the large clusters of very thin, bushy wood that accumulate in mature bushes. These clusters of bushy wood can be removed with only a few pruning cuts. High labor costs make it impractical to remove small, thin shoots individually.
2. Remove bearing branches close to the ground.

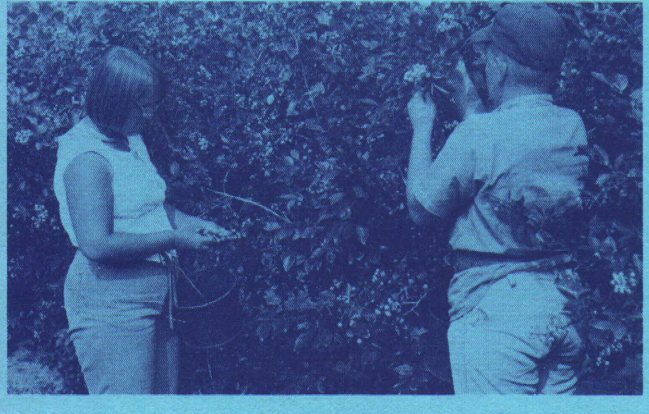
Berries on these branches usually get very dirty and pickers dislike handling them.

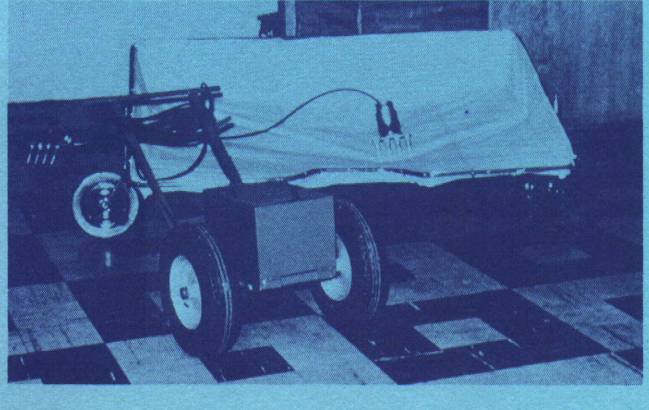
3. Reduce the number of old stems (sometimes called canes) to three or four. These old stems can be easily identified since the bark becomes grayish-black with age. Remove those that have the fewest buds – at the crown, rather than by heading them back to a side branch. It is very important to prevent bushes from having too many old stems.
4. Serve as insurance against dry years when berries on unpruned bushes are small and poor in quality.

Plantations on light soils deficient in organic matter must be pruned more severely than those on better soils due to the inability of the lighter soils to furnish sufficient moisture to properly mature large crops of fruit.

Pruning may be started as soon as leaves drop in the fall and continued through blossoming time or slightly after if necessary.

Pruning requires many hours of hard labor, much of it during cold, snowy weather. Because of scarce farm labor, studies have been in progress to determine the advisability of dehorning to the crown, a certain percentage of bushes in the plantation each year that are more than 10 or 12 years of age. After that age, blueberry plants decline in production, unless a plentiful supply of new wood can be developed in the bush each year.





HARVESTING

Harvesting begins in southern Michigan in early July. In a normal season it extends to about the middle of September and sometimes later. Peak production is usually reached during the first few days of August.

The fruit of cultivated blueberries is borne in clusters made up of 5 to 10 berries. Berries in a cluster ripen in succession, usually over a period of several weeks. Pick every 7 to 10 days to remove berries as they ripen (Fig. 15). From 3 to 5 pickings are needed to harvest all the fruit depending on the variety and season.

Pick only those berries which are fully ripe. Blueberries which have a reddish tinge are not yet ripe. Be sure all of the ripe fruit is removed so that there will not be over-ripe berries in the next picking. About five or six pickers are necessary to harvest an acre of berries in full production.

Hand-held vibrating units harvest blueberries efficiently and economically. These units have four picking fingers mounted on a vibrating head (Fig. 16). The vibrating fingers shake the berries free from the cane and berries are collected in a portable canvas-frame placed at the base of the bush. Two men usually harvest a row, picking opposite sides of the bush. An industrious operator will pick an acre in 35 to 40 hours. Fatigue can be minimized by switching the vibrator from hand to hand. Training and supervision of operators results in most satisfactory picking performance. Permitting the vibrator to run too long in one place on a cane can result in serious girdling of the stems.

The hand vibrating units also remove some leaves, twigs, and immature fruit during the harvest operation (Fig. 17). This trash must be cleaned from the fruit prior to packaging or processing. One of the available pieces of cleaning equipment contains an air blast unit for blowing out trash, leaves, and small immature berries, and includes a sorting table. A conveyor belt moves the fruit over the sorting table for visual inspection and hand removal of immature and undesirable fruit. One cleaning unit will handle the fruit from 8 to 10 hand vibrating units.

Figures 15 & 16 – (Top) Berries are gently separated from the cluster with the thumb rolling them into the palm of the hand. Fully colored, ripe berries are easily removed. Pail attached to picker's waist is a convenient and efficient container for harvesting. (Bottom) Electrically powered vibrating fingers are held against fruiting canes to shake berries free. Harvested fruit is collected in canvas frame at base of bush.

Large, self-propelled, over-the-row harvesters are available for blueberry harvesting (Fig. 18). These machines are designed for continuous harvesting since the machine straddles and moves over the row. The berries are vibrated from the bush, deflected by collecting pans beneath the bush onto conveyors, conveyed to the rear of the machine, and collected in standard field lugs for transportation from the field (Fig. 18). The machines require a three-man crew – a driver and two men to position empty lugs and remove filled lugs. They harvest about ¾ acre per-hour, but size of bush, amount of crop, length of row, and amount of turning influence the machine's performance.

The large harvesting machines will harvest fruit as rapidly as 2 to 3 cleaning units can handle the harvested fruit. Growers must provide for sufficient cleaning capacity to handle mechanically harvested blueberries. Do not machine-harvest bushes until they are dry to prevent leaves and debris from sticking to harvested fruit. Clean the fruit the same day it is harvested.

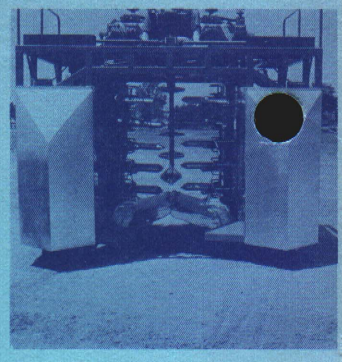
Provide ample turning space at the end of rows for the machines, approximately 20 to 25 feet. Level headlands facilitate rapid turning. Long rows minimize turning time. Prune bush from the bottom of the bush since the machines cannot harvest berries within about 2 feet of the soil surface. Prune to eliminate interlaced canes in the bush.

Do not delay initial harvest when machine harvesting, especially in considerable acreages. Otherwise, overmature fruit may be harvested with the last part of the field to be harvested. Vigorously shake the canes during the first picking to remove all the berries that are blue so there will be no overripe berries in the second harvest. Operators should provide for ample drag of the cane against the vibrating fingers to shake mature berries from the bush.

MARKETING

About 40 percent of the average Michigan cultivated blueberry crop is sold on the fresh market. The balance is processed.

Berries for the fresh market are usually packed in pint cups filled to rounding full. A cellophane sheet (page 2) is fitted tightly around the pint cup and held in place by a rubber band. This makes a clean attractive package. Berries for processors are put in lug boxes and 30-pound cans.



Figures 17 & 18 – (Left) Mechanical harvesting removes leaves and debris which must be separated from fruit after harvest. (Right) Mechanical fingers vibrate berries from canes onto collecting pans and conveyors beneath the bush.

The large, cultivated blueberry has been favorably received as a fresh fruit and for canning and quick-freezing. Fresh blueberries may be used in many ways – served with sugar and cream, as an attractive addition to fruit salads, and on ice cream. Canned or quick-frozen berries are famous for pies, muffins and puddings.

CONCLUSION

Establishing a blueberry planting is expensive and requires considerable time. Blueberry culture, with exacting soil and climatic requirements, is a highly specialized type of fruit growing. Consult successful blueberry growers, the Cooperative Extension Service or the Agricultural Experiment Station for advice before proceeding with a blueberry planting. Do not attempt blueberry growing if you lack proper conditions as outlined in this bulletin.

The development of Michigan's blueberry industry is an excellent example of good land utilization. Soils not considered valuable for agricultural crop production have been found well-adapted to blueberry culture. However, these soils must meet the exacting requirements of the blueberry plant.

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