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To the Graduate Council:

I am submitting to you a thesis written by Joe S. Alexander entitled "Some Factors in the Rooting of Ilex". I recommend that it be accepted for twelve quarter hours of credit in partial fulfillment of the requirements for the degree of Master of Science, with a major in Horticulture.

Major Professor

We have read this thesis
and recommend its acceptance:

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Accepted for the Council:

Dean of the Graduate School

SOME FACTORS IN THE ROOTING OF ILEX

A THESIS

Submitted to
The Graduate Council
of
The University of Tennessee
in
Partial Fulfillment of the Requirements
for the degree of
Master of Science

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by

Joe S. Alexander

March 1953

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CHAPTER I

INTRODUCTION

The Hollies constitute one of the more important groups of plants in Ornamental Horticulture. The Genus Ilex is of value to the commercial nurseryman, the home owner as landscape material, and to those who wish to conserve our native trees. Since Hollies are becoming more important in the nursery industry, satisfactory methods for increasing the best selections should be developed. Male as well as female plants should be made available for planting since most of the genus is dioecious. Better methods of propagation for the more difficult to root species must be developed to make this possible. This work was designed to test some of the external factors which affect the rooting of Hollies. The factors tested were mediums and watering methods under controlled humidity and bottom heat.

The mediums selected were those which had proved useful to nurserymen as well as those which some experimental papers recommended for Hollies.

The watering systems were selected for ease of installing, adaptability to propagating benches already in operation, relative low installation cost, and ease of operation.

All Ilex species of which cutting wood was available in quantity were tested in these experiments. These species were aquifolium, cassine, cornuta, cornuta clon Burford, crenata clon Spreading, crenata clon Convexleaf, crenata clon Roundleaf, decidua, opaca, and vomitoria.

CHAPTER II

REVIEW OF LITERATURE

In 1877 Burbidge(1) stated that Hollies are readily multiplied by cuttings of hardened growth inserted in autumn on a north border. Hollies may also be propagated by budding[1].

Zimmerman and Hitchcock(14) multiplied several species of Ilex while making a study of the amount of rooting of different plants. Ilex opaca cuttings taken at the same time, but from four plants, showed differences of as much as 40 percent in the number of cuttings rooted. When the cuttings were taken from the same plant, the number of cuttings rooting were about equal.

Zimmerman and Hitchcock(14) also found that between August and January, Ilex opaca cuttings rooted equally well. Chadwick(2) reported that Ilex opaca rooted best when the cuttings were taken in August and September. Lindberg(6) found Ilex opaca cuttings rooted best taken the latter part of August if placed in an environment of high relative humidity and high temperature. Kirkpatrick(5) reported good results with Ilex opaca cuttings at any time of the year with the exception of early spring when new growth was developing.

The effect of rooting mediums on the number rooting and the type of root system has been fairly well established(7). Since the introduction of techniques which permit the close control of relative humidity and other factors, this phase of the work has received considerable review.

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[1]Numbers in parentheses refer to literature cited.

Zimmerman found Ilex cuttings to respond to peat moss as a part of the rooting medium, although he stated that sand would always be the standard medium. The pH of the medium did not seem to be a vital factor for proper rooting. Of five mediums tried with Ilex, a 50-50 mixture by volume, of peat moss and sand was generally best(13). A peat and sand mixture was also found to be a good medium for Ilex aquifolium(8).

Recent experimental evidence points to the use of coarse silica sand, a half and half mixture of coarse silica sand and vermiculite, and coarse vermiculite as rooting mediums for Ilex opaca(2,4,6). A mixture of sand and vermiculite also proved to be good when used under high relative humidity(11).

It has been known for a long time that a partial control of humidity in the propagating house aided in the survival of cuttings. Such methods as wetting the walks, and spraying the foliage have been used by many propagators. More recently other methods have been tried.

Fisher(3) reported excellent rooting of cuttings under a spray that kept the foliage wet. Stoutemyer indicated that prolonged wetting of the foliage was undesirable. He used a mechanical humidifier that produced a fine mist. It was found that some species of plants rooted much better when cuttings were placed under this high relative humidity(10).

The best relative humidity has not been established. Many plant species differ in the level of relative humidity necessary for best rooting.

Seventy-five percent relative humidity was found to be satisfactory during summer(4). Lindberg(6) was able to get good results

with Ilex opaca cuttings during August and September using a relative humidity of 92 percent. Stoutemyer and O'Rourke found the amount of moisture in the air to be important at night during the winter months when the greenhouse was heated. They also found high relative humidity hardest to maintain on cold days. Ilex opaca, Var. Toner, gave good results under 85 percent relative humidity. Some advantages of maintaining a high relative humidity are:

1. Permits rooting at comparatively high temperatures during summer months.

2. Increases the rooting percentage of the more difficult to root plants when other necessary factors are supplied.

3. Prevents wilting of cuttings with large leaf areas.

When relative humidity was high, cuttings rooted in a shorter time. Some method of maintaining a high relative humidity can be used to advantage by propagators(12).

Automatic or manually operated watering systems reduce the labor necessary to care for benched cuttings. Labor saving is the main advantage over the normal hose and sprinkler. Chadwick(2) found manual subirrigation satisfactory for Ilex opaca cuttings stuck in a half and half mixture by volume of sand and vermiculite. A spray humidity system was also found to be a suitable watering method provided the spray fell on the cutting bench(10, 5). Post and Scripture(9) report that perforated copper tubing is an excellent watering method for cuttings.

CHAPTER III

EQUIPMENT, MATERIAL AND METHODS

These experiments were conducted in a 28 x 30 foot evenspan greenhouse with light shade from October to April and heavy shade the rest of the year. The house was equipped with a Standard Centrifugal Humidifier Model 31-A. This humidifier was capable of dispersing, as a fine mist, one gallon of water each hour. The humidity was controlled by a Standard Humidistat, Model 31.

Concrete benches were used with bottom slabs placed approximately one inch apart. Electric lead sheathed cables 120 feet long were placed on the slabs in each bench, and covered with 1/4-inch mesh hardware cloth. A thermostat was placed on one end of each bed and the control element inserted in peat-vermiculite medium. One bench was watered with a standard hose and sprinkler head. Another bench was watered with two lines of copper tubing .625 inch in diameter with .0385 inch holes every 12 inches (Figure 1). The third bench was watered with Monarch .175 air conditioning nozzles. These nozzles were mounted on 30-inch risers set 36 inches apart. When so set they covered a bench 42 inches wide (Figure 2).

The mediums were medium-coarse river sand, coarse vermiculite, german peat mixed with medium-coarse river sand half and half by volume, and german peat mixed with coarse vermiculite half and half by volume.

The room humidity was checked with a sling psychrometer. It was found to range between 88 and 94 percent relative humidity.



Figure 1. The copper tubing system of watering with peat-vermiculite as the medium.



Figure 2. The mist watering system as it appeared before mediums were placed in the bed.

The night temperature of the greenhouse was maintained at 65° F. during the cool months. A temperature of 70-75° F. was maintained in the rooting mediums during the winter months. The propagating house temperature during some summer days was as high as 105° F. This temperature was somewhat lower than the air temperature outside of the house.

Strong terminal cuttings of one year old wood were selected. Four to five inch cuttings with a slanting cut 1/2 to 3/4 inch long at the base were used. Twenty or 25 cuttings were used in each group. It was not possible to get all cuttings of any one species from one stock plant. While it was not always possible to place a group in all mediums or under all watering systems, each set was completed in so far as possible. Watering systems were favored over other treatments. Groups were placed in the cutting bench in the fall, mid-winter, spring, and mid-summer. All cuttings were treated by dipping the lower inch in water, tapping off excess water, and then coating with a layer of .8 percent indolebutyric acid in talc.

The cuttings watered manually appeared to require somewhat different amounts of water. The cuttings in sand were watered more often than those in the other mediums. This bed under manual watering was watered as the cuttings appeared to need it. The copper tubing system was turned on one hour each day during clear weather. This gave approximately one gallon of water for each square foot of bed space. On cloudy days this was cut in half. The mist system was turned on eight hours each day during clear days from April to October. During cloudy days of the summer months and during the winter months, it was turned

on for one hour each day. This watering system gave .175 to .225 gallons of water an hour per square foot of bed space.

When the majority of cuttings in a set[1] were rooted, all sets of that group[2] were removed from the mediums. The cuttings in each set were rated as heavy, medium, and light rooting. Figure 3 shows the type of root system for each of the ratings. The length of time cuttings remained in the mediums ranged from 47 to 215 days depending upon species and time of taking cuttings.

The results were analyzed by using the method outlined in the Washington Agricultural Experiment Station Circular No. 102, entitled Significance of Differences Between Percentages by Vernon Davies.

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[1] A set refers to 20 cuttings placed in one medium under one watering system.

[2] A group refers to all sets of a plant placed in the mediums on the same date.

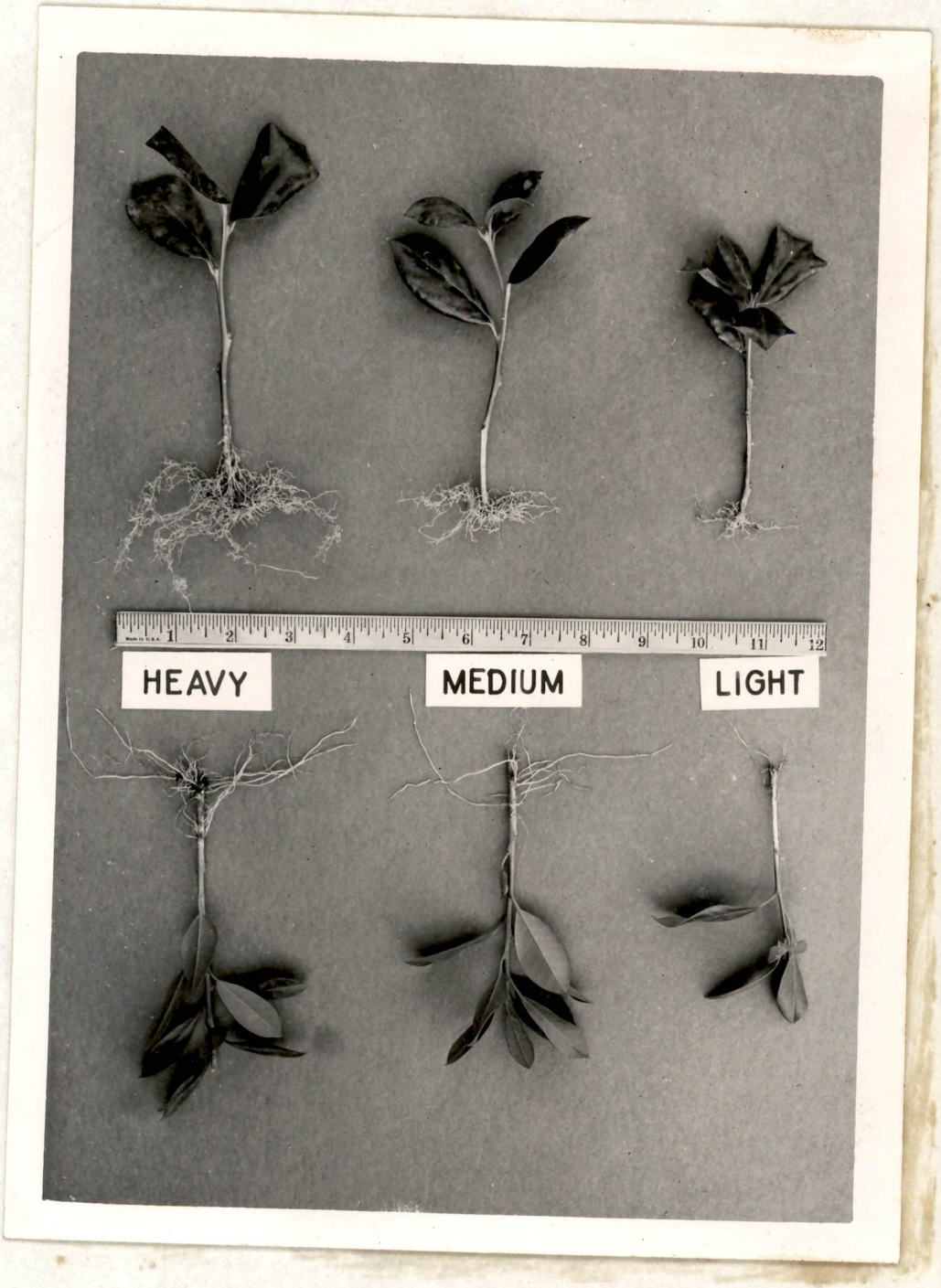


Figure 3. The type of root system necessary to be rated as heavy, medium, and light. At the top is Ilex cornuta clon Burford, and the lower plants are Ilex opaca clon East Palatka.

CHAPTER IV

DISCUSSION OF RESULTS

TABLE I

SUMMARY OF WATERING METHODS

Mediums	Average Percent Rooting		
	Mist	Copper tubing	Manual
Peat-Vermiculite	80	88	81
Peat-Sand	79	83	76
Vermiculite	56	64	60
Sand	56	63[a]	52
Average	68	74	67

[a]Better than manual.

TABLE II

COMPARISON OF WATERING METHODS WITH
PEAT-VERMICULITE AS THE MEDIUM

Plant	Cuttings under each method	Percent Rooting		
		Mist	Copper tubing	Manual
Ilex aquifolium	20	75	80	70
" cassine	60	77	80	80
" cornuta	40	93	90	83
" cornuta clon Burford	80	95[a]	95[a]	83
" crenata clon Spreading	20	95	100	90
" crenata clon Convexleaf	40	98	95	93
" crenata clon Roundleaf	40	95	85	98
" decidua	20	60	90	90
" opaca	40	85	95	75
" vomitoria	40	25	65[b]	45

[a]Better than manual.

[b]Better than mist.

TABLE III

COMPARISON OF WATERING METHODS WITH PEAT-SAND AS THE MEDIUM

Plant	Cuttings under each method	Percent Rooting		
		Mist	Copper tubing	Manual
Ilex aquifolium	20	80	85	75
" cassine	60	83	77	77
" cornuta	40	90	83	83
" cornuta clon Burford	80	96[a]	90	78
" crenata clon Spreading	20	90	85	85
" crenata clon Convexleaf	40	95	90	83
" crenata clon Roundleaf	40	93	85	75
" decidua	20	50	80	75
" opaca	40	83	88	78
" vomitoria	40	28	63[b]	53[b]

[a]Better than manual.

[b]Better than mist.

TABLE IV

COMPARISON OF WATERING METHODS WITH VERMICULITE AS THE MEDIUM

Plant	Cuttings under each method	Percent Rooting		
		Mist	Copper tubing	Manual
Ilex aquifolium	20	30	35	30
" cassine	60	63	67	62
" cornuta	40	58	80	65
" cornuta clon Burford	80	93	83	80
" crenata clon Spreading	20	80	90	90
" crenata clon Convexleaf	40	80	80	75
" crenata clon Roundleaf	40	93	77	75
" decidua	20	10	40	40
" opaca	40	35	60[a]	40
" vomitoria	40	15	30	28

[a]Better than mist.

TABLE V

COMPARISON OF WATERING METHODS WITH SAND AS THE MEDIUM

Plant	Cuttings under each method	Percent Rooting		
		Mist	Copper tubing	Manual
Ilex aquifolium	20	20	30	30
" cassine	60	60	55	42
" cornuta	40	68	68	68
" cornuta clon Burford	80	84	85	90
" crenata clon Spreading	20	90	90	80
" crenata clon Convexleaf	40	75	80	85
" crenata clon Roundleaf	40	73	80	73
" decidua	20	30	40	10
" opaca	40	45	65[a]	35
" vomitoria	40	20	35	20

[a]Better than manual.

The original data is to be found in the appendix. The tables under the discussion are designed to demonstrate the effect of each of the factors studied.

There are certain factors that should be kept in mind when using any type of watering method. The cuttings must be kept in a fresh, turgid condition for proper results. The watering method must, with the propagator's help, be able to apply water when needed. Too much water is as detrimental as too little, since it excludes air which is necessary for proper rooting. With sufficient water being applied by the watering methods tried, it was found that the method of watering did not significantly affect the rooting of the majority of the species. Table I shows that when all species were averaged, there were no significant differences in the watering methods. There seemed to be no outstanding differences in the type of root system under the different watering systems in corresponding mediums. The species and clon affected most were Ilex cornuta clon Burford, Ilex opaca and Ilex vomitoria. Burford rooted better under mist than under manual in peat-sand and peat-vermiculite. Copper tubing was better than mist with Ilex vomitoria in peat-sand or peat-vermiculite. The copper tubing also proved to be better than manual with Ilex opaca in sand.

A rooting medium should have the ability to hold a constant moisture supply and yet be well aerated. It should be sterile and of such structure that cuttings will not be injured when inserted or removed from the medium.

TABLE VI

SUMMARY OF MEDIUMS

Watering Methods	Percent Rooting			
	Peat-vermiculite	Peat-sand	Vermiculite	Sand
Mist	80[a]	79[a]	56	56
Copper tubing	88[a]	83[a]	64	63
Manual	81[a]	76[a]	60[b]	52
Average	83[a]	79[a]	60	57

[a]Better than vermiculite and sand.

[b]Better than sand.

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TABLE VII

COMPARISON OF MEDIUMS UNDER TEST

Plant	Cuttings in each medium	Percent Rooting			
		Peat-vermiculite	Peat-sand	Vermiculite	Sand
Ilex aquifolium	20	75[b]	80[b]	30	20
" cassine	60	77	83[b]	63	60
" cornuta	40	93[b]	90[c]	58	68
" cornuta clon Burford	80	95	96	93	84
" crenata clon Spreading	20	95	90	80	90
" crenata clon Convexleaf	40	98[a]	95[a]	80	75
" crenata clon Roundleaf	40	95[a]	93[a]	93[a]	73
" decidua	20	60[c]	50[c]	10	30
" opaca	40	85[b]	83[b]	35	45
" vomitoria	40	25	28	15	20

[a]Better than sand.

[b]Better than vermiculite and sand.

[c]Better than vermiculite.

TABLE VIII

COMPARISON OF MEDIUMS UNDER COPPER TUBING

Plant	Cuttings in each medium	Percent Rooting			
		Peat-vermiculite	Peat-sand	Vermiculite	Sand
Ilex aquifolium	20	80[b]	85[b]	35	30
" cassine	60	80[a]	77[a]	67	55
" cornuta	40	90[a]	83	80	68
" cornuta clon Burford	80	95	90	83	85
" crenata clon Spreading	20	100	85	90	90
" crenata clon Convexleaf	40	95	90	80	80
" crenata clon Roundleaf	40	85	85	77	80
" decidua	20	90[b]	80[b]	40	40
" opaca	40	95[b]	88[b]	60	65
" vomitoria	40	65[b]	63[b]	30	35

[a]Better than sand.

[b]Better than vermiculite and sand.

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TABLE IX

COMPARISON OF MEDIUMS UNDER MANUAL

Plant	Cuttings in each medium	Percent Rooting			
		Peat-vermiculite	Peat-sand	Vermiculite	Sand
Ilex aquifolium	20	70[b]	75[b]	30	20
" cassine	60	80[b]	77[b]	62[a]	42
" cornuta	40	83[b]	83[b]	65	68
" cornuta clon Burford	80	83	78	80	90
" crenata clon Spreading	20	90	85	90	80
" crenata clon Convexleaf	40	93	83	85	85
" crenata clon Roundleaf	40	98[c]	75	75	73
" decidua	20	90[b]	75[b]	40[a]	10
" opaca	40	75[b]	78[b]	40	35
" vomitoria	40	45[b]	53[b]	28	20

[a]Better than sand.

[b]Better than vermiculite and sand.

[c]Better than peat-sand, vermiculite and sand.

For the harder to root Ilex species, mixtures such as peat-sand and peat-vermiculite proved to be better than single mediums such as vermiculite or sand. The harder to root species, aquifolium, cassine, decidua, opaca, and vomitoria, require greater care in maintaining proper condition in the mediums. This explains, to some extent, why peat-sand and peat-vermiculite were the best mediums, since the air and water relationship in these mediums is fairly easy to control. Table VI shows that when the averages of all species tested are considered, peat-vermiculite and peat-sand were significantly better than vermiculite and sand. There was no significant difference between peat-vermiculite and peat-sand or between vermiculite and sand as rooting mediums for Hollies. The type of rooting medium did not greatly affect the rooting of Ilex cornuta and its clon Burford, or Ilex crenata and its clons Convexleaf, Roundleaf, and Spreading. Peat-sand and peat-vermiculite were better than sand for Convexleaf and Roundleaf under the mist watering system. Vermiculite proved to be more effective than sand for Ilex cassine and Ilex decidua under manual watering.

Table X contains data on the effect of peat-vermiculite and peat-sand, under the three watering methods, on several varieties or selections of Ilex opaca. There were no significant differences in either mediums or watering methods for each of the varieties or selections tested. There were, however, differences in the number rooting from different times of taking the cuttings. The fall months proved to be the best time for taking cuttings of the selections tested with the exception of Reynolds. The time of taking the cuttings does not

greatly affect this variety. The only time when Ilex opaca cuttings were extremely low in rooting percentage was the month of April with selection No. 2. This selection dropped its leaves on the majority of the cuttings in 30 days. It should be remembered that the time the cuttings of No. 2 were made is about the normal season for leaf drop on the American Holly for this section. East Palatka rooted much better than Howard's taken at the same time.

The following observations seem noteworthy:

1. Under a relative humidity ranging from 88-92 percent, the cuttings with the larger leaf area rooted first and developed larger root systems.

2. The season at which the cuttings were taken influenced the rooting of Ilex cassine, decidua, opaca, and vomitoria.

3. The plants from which the cuttings were taken influenced the rooting of Ilex opaca, and vomitoria.

TABLE X

SUMMARY OF PERCENTAGES GIVEN IN TABLE XI

Plant	Time in bench	Average percent rooting
Ilex opaca, East Palatka	Oct. 18 to Dec. 29, 1951	96
Ilex opaca, Howard's	Oct. 18 to Dec. 29, 1951	71
Ilex opaca, No. 1	Feb. 29 to May 10, 1952	56
Ilex opaca, Reynolds	March 10 to May 10, 1952	87
Ilex opaca, Reynolds	Aug. 21 to Oct. 18, 1952	90
Ilex opaca, No. 2	Apr. 4 to July 21, 1952	3

TABLE XI

EFFECT OF ROOTING MEDIUMS AND WATERING METHODS ON
ILEX OPACA VARIETIES AND SELECTIONS

Plant	Medium	Method of watering	Time in bench	No. set	Rooting Response				Total percent rooting
					Good	Med.	Poor	No roots	
Ilex opaca, East Palatka	P.-V.	Mist	Oct. 18 to	20	18	2	0	0	100
	"	C.T.	Dec. 29	20	19	0	1	0	100
	"	Man.	1951	20	16	1	2	1	95
"	P.-S.	Mist	"	20	14	2	3	1	95
	"	C.T.	"	20	15	1	3	1	95
	"	Man.	"	20	12	2	4	2	90
Ilex opaca, Howard's	P.-V.	Mist	Oct. 18, to	20	10	3	2	5	75
	"	C.T.	Dec. 29,	20	12	1	2	5	75
	"	Man.	1951	20	10	2	2	6	70
"	P.-S.	Mist	"	20	10	0	5	5	75
	"	C.T.	"	20	11	3	0	6	70
	"	Man.	"	20	9	2	1	8	60
Ilex opaca, No. 1[a]	P.-V.	Mist	Feb. 29, to	20	6	4	2	8	60
	"	C.T.	May 10,	20	7	1	3	9	55
	"	Man.	1952	20	6	2	3	9	55
"	P.-S.	Mist	"	20	5	2	4	9	55
	"	C.T.	"	20	8	3	1	8	60
	"	Man.	"	20	6	2	2	10	50

TABLE XI CONTINUED

EFFECT OF ROOTING MEDIUMS AND WATERING METHODS ON ILEX OPACA VARIETIES AND SELECTIONS

Plant	Medium	Method of watering	Time in bench	No. set	Rooting Response				Total percent rooting
					Good	Med.	Poor	No roots	
Ilex opaca, Reynolds	P.-V.	Mist	Mar. 10, to	25	23	0	0	2	92
	"	C.T.	May 10,	25	20	1	1	3	88
	"	Man.	1952	25	18	2	2	3	88
"	P.-S.	Mist	"	25	20	0	3	2	92
	"	C.T.	"	25	18	2	1	4	84
	"	Man.	"	25	16	2	2	5	80
Ilex opaca, Reynolds	P.-V.	Mist	Aug. 21, to	25	14	6	4	1	96
	"	C.T.	Oct. 18,	25	13	7	3	2	92
	"	Man.	1951	25	13	5	4	3	88
"	P.-S.	Mist	"	25	20	0	2	3	88
	"	C.T.	"	25	14	3	4	4	84
	"	Man.	"	25	12	5	4	4	84
Ilex opaca, No. 2	P.-V.	Mist	Apr. 4, to	20	0	1	0	19	5
	"	C.T.	July 21,	20	0	0	0	20	0
	"	Man.	1952	20	0	0	0	20	0
"	P.-S.	Mist	"	20	1	0	1	18	10
	"	C.T.	"	20	0	0	0	20	0
	"	Man.	"	20	0	0	0	20	0

[a]Numbered Ilex opaca signifies only selected trees, not varieties.

CHAPTER V

SUMMARY

When all species were averaged, there were no significant differences in watering methods. The method of watering did not greatly affect the easier to root species such as Ilex cornuta and Ilex crenata. The copper tubing method of watering was better than mist or hand watering for Ilex vomitoria and Ilex opaca.

When the average of all species tested were considered, peat-vermiculite or peat-sand were significantly better than vermiculite or sand. There was not a significant difference between peat-vermiculite and peat-sand or between vermiculite and sand as rooting mediums for Hollies. The type of medium did not greatly affect the rooting of Ilex cornuta, crenata or their clons. Peat-vermiculite and peat-sand were better mediums for Ilex aquifolium, cassine, decidua, opaca, and vomitoria.

There were significant differences in the rooting of Ilex opaca cuttings taken from different plants.

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APPENDIX

TABLE XII

THE EFFECT OF MEDIUMS AND WATERING METHODS ON THE ROOTING OF ILEX

Plant	Medium	Method of watering	Time in bench	No. set	Rooting Response				Total percent rooting
					Heavy	Med.	Light	No roots	
Ilex aquifolium	P.V.[1]	Mist	Dec. 18, to	20	10	3	2	5	75
"	"	C.T.[5]	July 21,	20	14	0	2	4	80
"	"	Man.[6]	1952	20	6	2	6	6	70
"	P.S.[2]	Mist	"	20	12	1	3	4	80
"	"	C.T.	"	20	12	4	1	3	85
"	"	Man.	"	20	10	1	4	5	75
"	V.[3]	Mist	"	20	0	4	2	14	30
"	"	C.T.	"	20	2	2	3	13	35
"	"	Man.	"	20	2	2	2	14	30
"	S.[4]	Mist	"	20	0	2	2	16	20
"	"	C.T.	"	20	1	1	4	14	30
"	"	Man.	"	20	0	2	2	16	20

[1]P.V. - Peat-vermiculite, 50-50 by volume.

[2]P.S. - Peat-sand, 50-50 by volume.

[3]V. - Coarse vermiculite (Terralite).

[4]S. - Medium coarse sand.

[5]C.T. - Copper tubing.

[6]Man.- Manual, hose with sprinkler head.

TABLE XII CONTINUED

THE EFFECT OF MEDIUMS AND WATERING METHODS ON THE ROOTING OF ILEX

Plant	Medium	Method of watering	Time in bench	No. set	Rooting Response				Total percent rooting
					Heavy	Med.	Light	No roots	
Ilex cassine	P.V.	Mist	July 17, to	20	2	10	0	8	60
"	"	C.T.	Oct. 24,	20	10	0	0	10	50
"	"	Man.	1952	20	10	0	2	8	60
"	P.S.	Mist	"	20	6	8	0	6	70
"	"	C.T.	"	20	10	0	2	8	60
"	"	Man.	"	20	10	4	2	4	80
"	V.	Mist	"	20	2	6	4	8	60
"	"	C.T.	"	20	1	5	2	12	40
"	"	Man.	"	20	2	4	8	6	70
"	S.	Mist	"	20	2	4	4	10	50
"	"	C.T.	"	20	2	2	0	16	20
"	"	Man.	"	20	2	0	2	16	20
"	P.V.	Mist	Oct. 7, to	20	4	4	7	5	75
"	"	C.T.	Dec. 30,	20	10	4	4	2	90
"	"	Man.	1951	20	6	6	5	3	85
"	P.S.	Mist	"	20	3	2	11	4	80
"	"	C.T.	"	20	4	3	9	4	80
"	"	Man.	"	20	4	4	4	8	60
"	V.	Mist	"	20	2	2	6	10	50
"	"	C.T.	"	20	12	4	2	2	90
"	"	Man.	"	20	6	4	6	4	60
"	S.	Mist	"	20	2	1	10	7	65
"	"	C.T.	"	20	6	4	4	6	70
"	"	Man.	"	20	4	4	2	10	50

TABLE XII CONTINUED

THE EFFECT OF MEDIUMS AND WATERING METHODS ON THE ROOTING OF ILEX

Plant	Medium	Method of watering	Time in bench	No. set	Rooting Response				Total percent rooting
					Heavy	Med.	Light	No roots	
Ilex cassine	P.V.	Mist	Jan. 17, to	20	10	6	3	1	95
"	"	C.T.	Apr. 8,	20	15	3	2	0	100
"	"	Man.	1952	20	12	5	2	1	95
"	P.S.	Mist	"	20	11	4	5	0	100
"	"	C.T.	"	20	12	2	4	2	90
"	"	Man.	"	20	8	6	4	2	90
"	V.	Mist	"	20	4	6	6	4	80
"	"	C.T.	"	20	1	9	4	6	70
"	"	Man.	"	20	6	2	1	9	55
"	S.	Mist	"	20	2	2	9	7	65
"	"	C.T.	"	20	8	4	3	5	75
"	"	Man.	"	20	3	3	5	9	55
Ilex cornuta	P.V.	Mist	July 11, to	20	17	2	1	1	95
"	"	C.T.	Oct. 1,	20	17		1	2	90
"	"	Man.	1952	20	16	2		2	90
"	P.S.	Mist	"	20	15	3		2	90
"	"	C.T.	"	20	14	1	1	4	80
"	"	Man.	"	20	12	3	2	3	85
"	V.	Mist	"	20	3	1	3	13	35
"	"	C.T.	"	20	14	1	1	4	80
"	"	Man.	"	20	4	4	6	6	80
"	S.	Mist	"	20	2	8	4	6	70
"	"	C.T.	"	20		4	8	8	60
"	"	Man.	"	20	1	6	6	7	65

TABLE XII CONTINUED

THE EFFECT OF MEDIUMS AND WATERING METHODS ON THE ROOTING OF ILEX

Plant	Medium	Method of watering	Time in bench	No. set	Rooting Response				Total percent rooting
					Heavy	Med.	Light	No roots	
Ilex cornuta	P.V.	Mist	Dec. 18, to	20	18			2	90
"	"	C.T.	March 10,	20	17		1	2	90
"	"	Man.	1952	20	15			5	75
"	P.S.	Mist	"	20	16		2	2	90
"	"	C.T.	"	20	15	1	1	3	85
"	"	Man.	"	20	14		2	4	80
"	V.	Mist	"	20	4	8	4	4	80
"	"	C.T.	"	20	14	2		4	80
"	"	Man.	"	20	6	2	2	10	50
"	S.	Mist	"	20	1	9	3	7	65
"	"	C.T.	"	20	1	5	9	5	75
"	"	Man.	"	20		8	6	6	70
Ilex cornuta, clon Burford	P.V.	Mist	July 11, to	20	8	4	6	2	90
"	"	C.T.	Aug. 27,	20	8	2	6	4	80
"	"	Man.	1951	20	12	4		4	80
"	P.S.	Mist	"	20	2	2	14	2	90
"	"	C.T.	"	20	2	1	12	5	75
"	"	Man.	"	20	6	8		6	70
"	V.	Mist	"	20		8	10	2	90
"	"	C.T.	"	20	4	4	6	6	70
"	"	Man.	"	20		10	6	4	80
"	S.	Mist	"	20	2	8		10	50
"	"	C.T.	"	20		4	8	8	60
"	"	Man.	"	20		4	12	4	80

TABLE XII CONTINUED

THE EFFECT OF MEDIUMS AND WATERING METHODS ON THE ROOTING OF ILEX

Plant	Medium	Method of watering	Time in bench	No. set	Rooting Response				Total percent rooting
					Heavy	Med.	Light	No roots	
Ilex cornuta, clon Burford	P.V.	Mist	Oct. 1, to	20	15	1	2	2	90
"	C.T.	"	Dec. 19,	20	18	2			100
"	Man.	"	1951	20	12	1	1	6	70
"	P.S.	Mist	"	20	18		1	1	95
"	C.T.	"	"	20	9	5	5	1	95
"	Man.	"	"	20	8	5	2	5	75
"	V.	Mist	"	20	18		2		100
"	C.T.	"	"	20	6	2	4	8	60
"	Man.	"	"	20	6	1	7	6	70
"	S.	Mist	"	20	1	9	8	2	90
"	C.T.	"	"	20	7	11	1	1	95
"	Man.	"	"	20	7	6	5	2	90
"	P.V.	Mist	Dec. 1, 1951	20	20				100
"	C.T.	"	to Feb. 2,	20	19		1		100
"	Man.	"	1952	20	14	2	2	2	90
"	P.S.	Mist	"	20	18		2		100
"	C.T.	"	"	20	12	4	3	1	95
"	Man.	"	"	20	10	6		4	80
"	V.	Mist	"	20	16	1		3	85
"	C.T.	"	"	20	15	5			100
"	Man.	"	"	20	12	4	2	2	90
"	S.	Mist	"	20	10	5	5		100
"	C.T.	"	"	20	18	2			100
"	Man.	"	"	20	16	4			100

TABLE XII CONTINUED

THE EFFECT OF MEDIUMS AND WATERING METHODS ON THE ROOTING OF ILEX

Plant	Medium	Method of watering	Time in bench	No. set	Rooting Response				Total percent rooting
					Heavy	Med.	Light	No roots	
Ilex cornuta, clon Burford	P.V.	Mist	Apr. 21, to	20	20				100
	"	C.T.	June 30,	20	18	2			100
	"	Man.	1952	20	16	2		2	90
	P.S.	Mist	"	20	18	1	1		100
	"	C.T.	"	20	14	3	2	1	95
	"	Man.	"	20	10	4	3	3	85
	V.	Mist	"	20	15	4		1	95
	"	C.T.	"	20	18		2		100
	"	Man.	"	20	14		2	4	80
	S.	Mist	"	20	9	4	4	3	85
	"	C.T.	"	20	12	4	1	3	85
	"	Man.	"	20	15	2	1	2	90
Ilex crenata, clon Spreading	P.V.	Mist	Feb. 2, to	20	14	3	2	1	95
	"	C.T.	Apr. 21,	20	14	3	3	0	100
	"	Man.	1952	20	12	4	2	2	90
	P.S.	Mist	"	20	10	4	4	2	90
	"	C.T.	"	20	10	7		3	85
	"	Man.	"	20	8	7	2	3	85
	V.	Mist	"	20	4	10	2	4	80
	"	C.T.	"	20	2	12	4	2	90
	"	Man.	"	20	6	6	6	2	90
	S.	Mist	"	20		6	12	2	90
	"	C.T.	"	20		10	8	2	90
	"	Man.	"	20		9	7	4	80

TABLE XII CONTINUED

THE EFFECT OF MEDIUMS AND WATERING METHODS ON THE ROOTING OF ILEX

Plant	Medium	Method of watering	Time in bench	No. set	Rooting Response				Total percent rooting
					Heavy	Med.	Light	No roots	
Ilex crenata, clon Convexleaf	P.V.	Mist	Jan. 17, to	20	10	9	1	0	100
"	"	C.T.	Apr. 11,	20	12	8	0	0	100
"	"	Man.	1952	20	15	3	2	0	100
"	P.S.	Mist	"	20	9	9	2	0	100
"	"	C.T.	"	20	8	7	3	2	90
"	"	Man.	"	20	10	7	0	3	85
"	V.	Mist	"	20	5	10	2	3	85
"	"	C.T.	"	20	7	4	4	5	75
"	"	Man.	"	20	9	7	1	3	85
"	S.	Mist	"	20	8	6	2	4	80
"	"	C.T.	"	20	5	6	4	5	75
"	"	Man.	"	20	6	10	0	4	80
"	P.V.	Mist	June 25, to	20	15	4	0	1	95
"	"	C.T.	Aug. 27,	20	10	7	1	2	90
"	"	Man.	1951	20	14	2	1	3	85
"	P.S.	Mist	"	20	10	6	2	2	90
"	"	C.T.	"	20	10	4	4	2	90
"	"	Man.	"	20	8	6	2	4	80
"	V.	Mist	"	20	8	6	1	5	75
"	"	C.T.	"	20	12	5	0	3	85
"	"	Man.	"	20	11	3	3	3	85
"	S.	Mist	"	20	8	4	2	6	70
"	"	C.T.	"	20	6	10	1	3	85
"	"	Man.	"	20	10	8	0	2	90

TABLE XII CONTINUED

THE EFFECT OF MEDIUMS AND WATERING METHODS ON THE ROOTING OF ILEX

Plant	Medium	Method of watering	Time in bench	No. set	Rooting Response				Total percent rooting
					Heavy	Med.	Light	No roots	
Ilex crenata,	P.V.	Mist	Jan. 17, to	20	11	9	0	0	100
clon Roundleaf	"	C.T.	April 11,	20	13	3	2	2	90
"	"	Man.	1952	20	17	2	1		100
"	P.S.	Mist	"	20	8	9	2	1	95
"	"	C.T.	"	20	10	6	0	4	80
"	"	Man.	"	20	4	8	2	6	70
"	V.	Mist	"	20	13	6	1	0	100
"	"	C.T.	"	20	7	5	1	7	65
"	"	Man.	"	20	13	0	1	6	70
"	S.	Mist	"	20	6	8	0	6	70
"	"	C.T.	"	20	4	10	2	4	80
"	"	Man.	"	20	4	8	3	5	75
"	P.V.	Mist	June 25, to	20	15	2	1	2	90
"	"	C.T.	Aug. 27,	20	13	2	1	4	80
"	"	Man.	1951	20	16	1	2	1	95
"	P.S.	Mist	"	20	12	3	3	2	90
"	"	C.T.	"	20	10	4	4	2	90
"	"	Man.	"	20	11	4	1	4	80
"	V.	Mist	"	20	13	4	0	3	85
"	"	C.T.	"	20	14	4	0	2	90
"	"	Man.	"	20	8	8	0	4	80
"	S.	Mist	"	20	4	8	3	5	75
"	"	C.T.	"	20	2	8	6	4	80
"	"	Man.	"	20	2	6	6	6	70

TABLE XII CONTINUED

THE EFFECT OF MEDIUMS AND WATERING METHODS ON THE ROOTING OF ILEX

Plant	Medium	Method of watering	Time in bench	No. set	Rooting Response				Total percent rooting
					Heavy	Med.	Light	No roots	
Ilex decidua	P.V.	Mist	July 16, to	20	2	6	4	8	60
"	"	C.T.	Oct. 24,	20	12		6	2	90
"	"	Man.	1951	20	8	4	6	2	90
"	P.S.	Mist	"	20	1	6	3	10	50
"	"	C.T.	"	20	4	4	8	4	80
"	"	Man.	"	20	8	2	5	5	75
"	V.	Mist	"	20			2	18	10
"	"	C.T.	"	20		4	4	12	40
"	"	Man.	"	20		4	4	12	40
"	S.	Mist	"	20		4	2	14	30
"	"	C.T.	"	20	2		6	12	40
"	"	Man.	"	20		2		18	10
Ilex opaca	P.V.	Mist	"	20	4		12	4	80
"	"	C.T.	"	20	18		2		100
"	"	Man.	"	20	14			6	70
"	P.S.	Mist	"	20	12	3		5	75
"	"	C.T.	"	20	14		2	4	80
"	"	Man.	"	20	12	2		6	70
"	V.	Mist	"	20		2		18	10
"	"	C.T.	"	20	4		4	12	40
"	"	Man.	"	20	2	4		14	30
"	S.	Mist	"	20		4	4	12	40
"	"	C.T.	"	20	6	4	2	6	70
"	"	Man.	"	20		2		18	10

TABLE XII CONTINUED

THE EFFECT OF MEDIUMS AND WATERING METHODS ON THE ROOTING OF ILEX

Plant	Medium	Method of watering	Time in bench	No. set	Rooting Response				Total percent rooting
					Heavy	Med.	Light	No roots	
Ilex opaca	P.V.	Mist	Dec. 19, to	20	16	0	2	2	90
"	"	C.T.	Feb. 24,	20	13	3	2	2	90
"	"	Man.	1951	20	11	3	2	4	80
"	P.S.	Mist	"	20	13	1	4	2	90
"	"	C.T.	"	20	10	6	3	1	95
"	"	Man.	"	20	9	6	0	5	75
"	V.	Mist	"	20	4	6	2	8	60
"	"	C.T.	"	20	10	5	1	4	80
"	"	Man.	"	20	6	2	2	10	50
"	S.	Mist	"	20	2	4	4	10	50
"	"	C.T.	"	20		10	2	8	60
"	"	Man.	"	20	1	8	3	8	60
Ilex vomitoria	P.V.	Mist	July 16, to	20	0	0	0	20	0
"	"	C.T.	Oct. 26,	20	6	2	2	10	50
"	"	Man.	1951	20	6	0	0	14	30
"	P.S.	Mist	"	20	0	0	0	20	0
"	"	C.T.	"	20	0	6	2	12	40
"	"	Man.	"	20	0	6	4	10	50
"	V.	Mist	"	20	0	0	0	20	0
"	"	C.T.	"	20	0	0	2	18	10
"	"	Man.	"	20	0	0	1	19	5
"	S.	Mist	"	20	0	0	0	20	0
"	"	C.T.	"	20	0	0	2	18	10
"	"	Man.	"	20	0	0	0	20	0

TABLE XII CONTINUED

THE EFFECT OF MEDIUMS AND WATERING METHODS ON THE ROOTING OF ILEX

Plant	Medium	Method of watering	Time in bench	No. set	Rooting Response				Total percent rooting
					Heavy	Med.	Light	No roots	
Ilex vomitoria	P.V.	Mist	Dec. 1, to	20	6	4		10	50
"	"	C.T.	Feb. 24,	20	12	2	2	4	80
"	"	Man.	1951	20	12	0	0	8	60
"	P.S.	Mist	"	20	5	2	4	9	55
"	"	C.T.	"	20	10	4	3	3	85
"	"	Man.	"	20	5	3	3	9	55
"	V.	Mist	"	20	0	5	1	14	30
"	"	C.T.	"	20	3	6	1	10	50
"	"	Man.	"	20	2	5	1	12	40
"	S.	Mist	"	20	6	2		12	40
"	"	C.T.	"	20	5	2	5	8	60
"	"	Man.	"	20	3	3	2	12	40