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FERTILIZATION of CAMELLIAS

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FERTILIZATION *of* CAMELLIAS

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THE CAMELLIA (*Camellia japonica*) is one of the most popular garden plants in the lower South and along the Atlantic seaboard.

Its popularity is indicated by the number of flower shows devoted to displays of its blooms. The extent of interest in camellias is marked by the widespread membership in the American Camellia Society. In 1946, 442 Alabamians held membership in the Society, which listed members in 40 states, District of Columbia, and 13 foreign countries.[1]

Alabama has become the principal center of commercial camellia production in the United States. Each year more than a million plants are sold by nurserymen in Mobile and Baldwin counties. The rise in popularity of the camellia has resulted in many inquiries about care, both in the home garden and in the nursery.

Little information on camellia fertilization was available and widely divergent recommendations were being made to growers prior to 1948. That year experiments were begun to determine the best fertilizer practices for camellias in Alabama.

Studies of the problem were first based on conditions under which both good and poor specimens grew. Experiments were then begun to determine symptoms of fertilizer deficiencies. The next step was to determine the effects of fertilizer rates and grades on growth of the plants, both in pure sand and in soils of varying texture. Later, some effects of excess fertilization were determined.

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[1] From the American Camellia Yearbook, 1956.

SURVEY OF ESTABLISHED PLANTS

MATERIALS AND METHODS. In March, 1950, a study was made of 39 established camellias in Auburn, Opelika, and Montgomery, Alabama. Observations of soil appearance, type, organic content, and drainage were recorded. Soil samples were collected at each location and analyzed by the Spurway soil test.[2] The environmental condition and general appearance of each plant were observed and recorded.

RESULTS. Results of this survey of established camellia plants showed little correlation between soil fertility levels and appearance of the plants, except when deficient in one or more elements. As long as nutrients are present, even though low, the plants grow well.

Growth was definitely influenced by soil drainage and amount of sunlight the plant received. These results are summarized in Table 1. As soil drainage improved growth increased. Plants grew better in partial shade than in full sun when conditions of soil drainage and organic matter content were similar. In addition, results of this survey showed that soil texture has little influence on growth of plants.

Not only did the fertility levels make little difference in final appearance of the plants, but plants of excellent quality were found in soils varying in acidity from pH 4.2 to 7.5. However, newly planted camellias did poorly when the pH of the soil was

TABLE 1. INFLUENCE OF ORGANIC MATTER CONTENT, DRAINAGE, EXPOSURE AND SOIL TEXTURE, ON THE GROWTH OF *Camellia japonica*

Soil	Organic matter content	Soil drainage	Amount of sunlight	Condition[1] of plant
Sandy	Poor	Fair	Full sun	1.0
	Fair	Fair	Full sun	1.0
	Fair	Good	Part shade	3.0
	Good	Fair	Full sun	1.0
	Good	Good	Full sun	2.5
	Excellent	Good	Part shade	3.2
Clay	Poor	Poor	Part shade	1.0
	Poor	Good	Part shade	3.0
	Fair	Fair	Part shade	2.0
	Good	Good	Part shade	2.9
	Good	Excellent	Part shade	4.0
	Excellent	Good	Part shade	3.4

[1] Condition of plant rated on a scale from 1 to 4. Plants rated 1 were dying, plants rated 4 were excellent in all respects.

[2] Spurway, C. H., and Lawton, K. Soil testing. Tech. Bul. 132, Mich. State College. 1949.

above 6.5. The largest number of excellent plants was found in soils varying in pH from 4.5 to 6.0.

NUTRIENT ELEMENT DEFICIENCY SYMPTOMS

MATERIALS AND METHODS. Pure, 8-mesh, quartz sand was selected as the medium; 2-gallon glazed pots were used as containers. The ¾-inch side drainage holes at the base of the pots were covered with fiber glass.

The pots were filled to 1 inch from the top with quartz sand, mounted in raised wooden racks, and inclined to the drainage side. By means of rubber stoppers with holes and glass and rubber tubing, each glazed pot was connected to an amber nutrient solution bottle placed beneath the pot rack. The glass tube connection from pot to bottle extended to the bottom of the bottle. Each bottle head was fitted with a compressed air connection.

The nutrient solutions in the bottles were forced into the respective pots as needed by injecting compressed air into the bottles. When the air source was disconnected, the nutrient solutions drained back into the bottles. Two pumpings per day were used followed by frequent syringing with distilled water between pumpings.

Duplicate series of camellia plantings were prepared, with the following test solutions: Complete, minus nitrogen, minus phos-

TABLE 2. ELEMENTS STUDIED AND OBSERVED SYMPTOMS OF DEFICIENCY

Deficient element	Symptoms	
	Type of growth	Foliage color
Nitrogen	Weak, spindly, growth delayed, second cycle began as the complete-solution plants ended second cycle	Yellow, small
Phosphorus	Weak, spindly, short	Dark green
Calcium	Progressively smaller	Necrosis of young leaves
Magnesium		Yellow-orange, chlorosis of older leaves
Zinc	Rate slow	Clear necrotic spots, some chlorosis on young leaves
Sulfur	Very short internodes	All foliage light yellow
Manganese		Yellow-orange, chlorosis between veins of young leaves
Boron	Sheaths of terminal bud died	Yellow-orange, chlorosis of young leaves
Copper		Necrosis and white mottling of young leaves
Iron		White chlorosis of new leaves

phorus, minus potassium, minus calcium, minus magnesium, and minus iron. These solutions were prepared similarly to Hoagland's No. 2 solution.[3]

Each pot was planted with three rooted and weighed cuttings consisting of one each of Pink Perfection, Monarch, and Jarvis Red varieties.

RESULTS. Omission of the various elements from the nutrient solution resulted in symptoms described in Table 2. In general, the deficiency symptoms on camellias were similar to those reported for other plants.[4] In this experiment, symptoms of potassium deficiency were not expressed by the technique used.

EFFECTS OF GRADES AND RATES OF FERTILIZERS ON CAMELLIA GROWTH

SAND-PEAT MIXTURE

MATERIALS AND METHODS. The experiments were conducted in a greenhouse, using glazed, 2-gallon pots as containers. One inch of pea-size gravel was placed in the bottom of each pot for drainage. The pots were filled to 1½ inches of the top with a mixture of one-fourth shredded imported peat and three-fourths bank sand. Three varieties of camellias were used: Pink Perfection, Monarch, and Jarvis Red. One rooted cutting of each variety was placed in each pot. The treatments were triplicated.

Various fertilizer grades were mixed using commercial grade ammonium nitrate, superphosphate (18%), and muriate of potash. These grades were applied at the rates given in Table 3. Applications were based on the assumption that 1 gm. of fertilizer per kg. of soil was equivalent to an application of 2,000 pounds per acre. One-fourth of the fertilizer was applied in the potting soil with three-fourths applied in three subsequent applications. During the second year the fertilizer was divided equally into four applications.

Observations of all the plants were made periodically. One and 2 years after the beginning of the experiment, growth measurements were made. After 2 years, the plants were removed

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[3] Hoagland, D. R., and Arnon, D. I. The water culture method for growing plants without soil. Circ. 347, Calif. Agr. Expt. Sta. 1939.

[4] Beatie, James M., and Norman F. Childers. Chap. VIII. Small Fruits for the Home Garden: The care and feeding of garden plants. Amer. Soc. for Hort. Sci. 1954.

TABLE 3. INFLUENCE OF RATE AND GRADES OF FERTILIZERS ON GROWTH AND SURVIVAL OF THREE CAMELLIA VARIETIES

Treatments		Pink Perfection					Monarch					Jarvis Red				
Acre rates	Grade[1]	Dead	Fresh wt.	Dry wt.	Height 9/18/50	Height 5/6/51	Dead	Fresh wt.	Dry wt.	Height 9/18/50	Height 5/6/51	Dead	Fresh wt.	Dry wt.	Height 9/18/50	Height 5/6/51
Lb.		*No.*	*Gm*	*Gm*	*In.*	*In.*	*No.*	*Gm*	*Gm.*	*In.*	*In.*	*No.*	*Gm*	*Gm.*	*In.*	*In.*
0	0-0-0	0	3.68	2.27	4.43	7.00	0	3.67	1.80	3.58	6.00	0	1.18	0.90	3.08	4.50
2,000	0-10-8	0	4.06	2.20	8.00	9.50	0	4.13	2.10	3.08	5.58	0	2.32	1.03	4.17	7.08
1,000	3-10-8	0	10.60	4.63	9.50	12.50	0	7.17	3.40	6.08	8.58	0	10.10	4.76	8.17	11.92
2,000	3-10-8	0	11.80	5.30	8.90	11.40	0	16.17	6.70	7.00	11.17	0	14.57	6.30	9.33	12.25
6,000	3-10-8	1	12.80	5.40	13.25	17.00	0	45.20	17.90	9.83	15.33	0	11.37	6.50	7.83	11.83
1,000	6-10-8	0	25.50	11.80	12.50	15.30	0	15.63	6.50	7.67	11.08	0	23.51	6.10	10.83	16.00
2,000	6-10-8	0	30.97	14.27	14.50	18.33	0	38.28	13.10	10.17	15.50	0	25.37	10.77	11.25	15.33
6,000	6-10-8	2	22.90	8.50	10.25	10.50	1	64.34	23.10	9.33	14.75	3	0	0	0	0
2,000	6-0-8	2	2.30	1.90	5.00	7.50	1	2.60	1.60	4.17	6.00	2	4.40	2.20	4.25	6.50
1,000	6-5-8	0	13.62	7.00	9.25	11.92	0	18.53	8.40	7.83	12.83	0	16.30	8.57	8.08	10.17
2,000	6-5-8	0	22.05	10.00	11.92	15.50	0	46.20	19.10	11.08	17.25	0	33.00	14.23	12.83	17.33
6,000	6-5-8	2	39.00	14.70	11.50	15.00	0	41.78	15.90	9.33	16.75	0	27.50	11.60	15.50	19.33
1,000	6-15-8	0	22.70	11.10	14.00	17.25	0	22.80	10.00	13.25	16.75	0	25.65	7.57	9.42	14.92
2,000	6-15-8	0	20.67	8.60	11.83	16.75	0	45.28	18.00	8.92	15.83	1	26.35	10.70	9.17	14.38
6,000	6-15-8	3	0	0	0	0	2	45.80	18.20	11.25	20.25	3	0	0	0	0
2,000	6-10-0	0	17.07	7.47	16.50	15.00	0	33.33	15.00	9.42	15.00	1	13.30	6.00	10.58	14.75
1,000	6-10-0	0	17.88	7.70	11.00	12.85	0	32.03	13.90	11.92	17.92	0	17.47	9.10	10.50	15.50
2,000	6-10-4	0	20.30	8.87	13.25	17.66	0	33.67	25.00	7.83	15.50	0	33.48	10.97	14.58	19.58
6,000	6-10-4	2	21.70	9.50	11.00	15.50	0	56.80	21.90	13.67	17.42	2	11.70	5.50	17.50	19.50
1,000	6-10-12	0	17.27	7.70	11.00	15.58	0	26.03	11.00	8.25	14.67	0	18.13	7.73	7.92	13.42
2,000	6-10-12	0	23.73	9.50	13.67	17.00	0	38.95	14.60	10.25	16.58	0	27.23	10.80	8.33	12.33
6,000	6-10-12	3	0	0	0	0	3	0	0	0	0	2	36.20	14.00	13.00	17.00
8,000	6-10-8	3	0	0	0	0	2	47.90	15.80	10.50	16.50	2	17.80	6.50	8.00	12.50
10,000	6-10-8	3	0	0	0	0	3	0	0	0	0	3	0	0	0	0
12,000	6-10-8	3	0	0	0	0	3	0	0	0	0	3	0	0	0	0

[1] N-P_2O_5-K_2O.

from the pots, and the fresh and dry weights of the plants' tops were determined.

RESULTS. Nitrogen had the greatest influence on growth. Its omission resulted in stunted plants with light greenish-yellow foliage; however, all plants survived. Increased growth resulted from increased nitrogen application.

Omission of phosphorus resulted in death of the test plants. In addition, high levels of this element decreased growth. The total amount of phosphorus that can be applied without decreasing growth depended on the amount of nitrogen and potassium present. In all cases, whenever a 3-5-4 (N-P_2O_5-K_2O) ratio was exceeded, growth decreased, Table 3.

Omission of potassium did not influence growth greatly, since all plants survived and grew well. Growth increased with more potassium, but it decreased when the 3-5-4 ratio was exceeded.

Some plants died when more than 2,000 pounds of 6-10-8 per acre was applied. The greatest increase in growth resulted from the first 1,000 pounds of fertilizer. Increase in dry weight of the plants from the second 1,000 pounds of fertilizer was less than one-half of that resulting from the first 1,000 pounds. In terms of plant height, the second 1,000 pounds of fertilizer resulted in only one-eighth of that from the first 1,000 pounds.

While many grades of fertilizers used in this experiment were good, the 6-10-8 seemed best. Rates of application could vary from 1,000 to 2,000 pounds per acre annually with 2,000 pounds giving the best results. This rate would amount to applications of 2½ to 5 pounds per 100 square feet of area.

DECATUR CLAY-PEAT AND NORFOLK-PEAT MIXTURES

MATERIALS AND METHODS. Experiments to determine the effects of grades and rates of fertilizers on camellia plants grown in Decatur clay and Norfolk sandy loam soils were conducted in a greenhouse. Two-gallon, glazed pots were used as containers. Pea-size gravel was placed to a depth of 1 inch in the bottom of each pot for drainage. The pots were filled with a peat-soil mixture to within 1½ inches of the top. The mixture (by volume) was one-half shredded, imported peat and one-half either Decatur clay or Norfolk sandy loam.

One-year liners of the Pink Perfection variety were used. These plants had been grown in 3-inch pots prior to this test. One plant was placed in each pot; the tests were replicated three times.

TABLE 4. INFLUENCE OF FERTILIZER RATE AND GRADE ON THE GROWTH OF PINK PERFECTION CAMELLIA IN TWO ALABAMA SOILS

Treatments, rate per acre		Decatur clay					Norfolk sandy loam				
		Total linear growth		Height	Branches	Flower buds per plant, av.	Total linear growth		Height	Branches	Flower buds per plant, av.
		12/3/52	6/29/53	6/29/53	6/29/53	6/29/53	12/3/52	6/29/53	6/29/53	6/29/53	6/29/53
Lb.	*Grade*	*In.*		*In.*	*No.*	*No.*	*In.*		*In.*	*No.*	*No.*
0	0-0-0	41.8	59.3	17.0	14.3	6.0	29.3	41.6	13.7	10.7	4.7
600	20-0-0	39.0	83.0	20.0	20.0	28.0	52.3	80.0	16.5	17.0	31.5
1,000	0-20-0	37.0	54.0	17.0	12.3	5.0	40.0	46.3	15.3	13.3	5.3
320	0-0-50	41.7	72.3	18.7	17.0	0.7	35.0	47.0	14.0	10.0	5.0
2,000	0-10-8	32.0	54.0	17.0	15.0	0	34.5	54.5	14.0	10.0	5.0
1,000	3-10-8	34.5	50.0	20.0	6.0	3.0	27.7	39.7	15.0	11.0	7.3
2,000	3-10-8	35.3	78.5	16.0	13.0	14.7	26.7	51.3	18.7	10.7	12.0
1,000	6-10-8	33.0	62.0	14.0	16.0	5.0	43.0	61.7	14.7	15.7	15.0
2,000	6-10-8	54.3	102.0	16.0	22.5	22.5	55.0	90.5	18.5	22.5	24.5
2,000	6-0-8	47.5	77.5	14.7	13.5	9.0	7.0	0	0	0	0
1,000	6-5-8	41.8	58.0	18.5	13.0	6.5	35.0	48.5	15.5	12.0	11.0
2,000	6-5-8	58.5	97.3	19.7	21.7	10.0	57.5	81.0	19.0	13.0	3.0
1,000	6-15-8	31.0	58.0	25.0	10.0	4.0	31.7	56.3	14.7	11.0	12.0
2,000	6-15-8	52.8	67.0	20.0	10.5	13.5	37.3	82.0	23.7	12.0	19.0
2,000	6-10-0	46.0	83.7	17.3	20.3	17.3	41.0	77.0	19.5	14.5	19.5
1,000	6-10-4	45.5	73.3	16.3	21.3	9.7	26.2	48.0	14.3	11.3	7.7
2,000	6-10-4	0[1]	0	0	0	0	41.5	64.0	13.7	15.7	17.3
1,000	6-10-12	52.8	76.0	15.5	23.0	5.5	37.0	56.0	19.0	15.5	14.0
2,000	6-10-12	34.0	68.5	21.5	15.0	10.0	36.0	63.0	12.0	16.0	30.0

[1] Plants died from root rot.

Results from the treatments are given in Table 4. The rates shown are total yearly amounts per acre. Each rate was divided into quarterly applications.

RESULTS. When plants were grown in either Decatur clay or Norfolk sandy loam soil, the 6-10-8 was superior to all the others tried in regard to flower bud formation, compactness, and height of the plants. Generally, fertilizer deficiencies were more pronounced, and the difference in growth between the various treatments more noticeable on the sandy soil than on the clay soil.

Excellent growth resulted when plants received only nitrogen, but growth was poor when only potassium or phosphorus was applied. Increasing the amount of nitrogen in the grades applied resulted in increased compactness of the plant and more flower buds. The highest number of flower buds per plant was formed when only nitrogen was applied. The next highest number formed was when 6-10-8 grade was applied at the rate of 2,000 pounds per acre. The increase in number of flower buds per plant was due to an increase in the number of stems per plant, and not to an increase in the number of buds per stem. Increased amounts of phosphorus or potassium resulted in increased growth and flower bud formation, but the differences were not as striking as those secured from increased applications of nitrogen, Table 4.

INFLUENCE OF MINOR ELEMENTS

MATERIALS AND METHODS. Rooted cuttings of three camellia varieties — Pink Perfection, Monarch, and Jarvis Red — were planted in a soil mixture made up of one-fourth shredded imported peat and three-fourths bank sand as previously described, page 6. Three replications were used.

The basic rate of fertilizer used consisted of 2,000 pounds of 6-10-8 per acre. Minor elements studied were iron, magnesium, boron, manganese, copper, and zinc. Eight treatments were used: Check (basic fertilizer only), all minor elements, minus iron, minus magnesium, minus boron, minus manganese, minus copper, and minus zinc. One-fourth of the basic fertilizer and all of the minor element application were incorporated in the potting soil. Minor elements were applied on the following per acre basis: boron, 5 pounds borax (household); copper, 10 pounds copper sulphate; manganese, 10 pounds manganous sulphate; magnesium, 20 pounds magnesium sulphate; zinc, 10 pounds zinc sulphate, and iron, 10 pounds ferrous sulphate. The remaining

TABLE 5. GROWTH OF THREE VARIETIES OF CAMELLIAS WHEN MINOR ELEMENTS WERE ADDED TO THE FERTILIZER MIXTURE

Treatment	Pink Perfection					Monarch					Jarvis Red				
	Dead plants	Fresh wt.	Dry wt.	Height 7/18/50	Height 5/6/51	Dead plants	Fresh wt.	Dry wt.	Height 7/18/50	Height 5/6/51	Dead plants	Fresh wt.	Dry wt.	Height 7/18/50	Height 5/6/51
	No.	*Gm.*	*Gm.*	*In.*	*In.*	*No.*	*Gm.*	*Gm.*	*In.*	*In.*	*No.*	*Gm.*	*Gm.*	*In.*	*In.*
Check	0	30.97	14.27	14.50	18.33	0	38.28	13.10	10.17	15.50	0	25.37	10.77	11.25	15.33
All minor elements	1	16.30	6.95	10.25	14.03	0	36.40	14.90	9.17	16.08	1	20.23	8.25	9.38	13.50
Minus iron	1	21.53	11.70	13.13	19.00	1	16.55	7.30	10.00	14.75	1	14.35	6.30	11.13	14.75
Minus magnesium	0	32.27	13.80	13.50	18.17	0	40.17	17.00	12.42	19.92	1	27.60	11.50	8.75	14.50
Minus boron	0	35.37	10.07	12.83	16.42	0	46.57	19.20	8.92	15.67	0	24.03	9.67	13.33	17.75
Minus manganese	0	29.93	12.87	12.75	16.92	0	39.53	16.40	11.17	17.75	0	15.65	6.53	7.33	12.00
Minus copper	0	25.43	11.20	17.50	20.67	0	31.17	12.90	9.50	14.67	0	29.57	12.50	13.83	18.33
Minus zinc	1	10.63	4.80	8.50	13.50	0	45.23	18.30	10.08	16.92	0	29.37	12.37	12.25	17.50

amount of the basic fertilizer was applied as quarterly sidedressings.

Heights of the plants were measured 1 and 2 years after treatment began. Fresh and dry weights of the tops were recorded after 2 years.

RESULTS. The use of minor elements resulted in less dry weight of the tops of Pink Perfection and Jarvis Red plants growing in the sand-peat mixture. With Monarch plants there was a slight increase in dry weight. The least growth of Monarch and Jarvis Red plants occurred when iron was omitted from the application. On a dry weight basis, the greatest amount of growth in the check treatment occurred with Pink Perfection plants, in the minus-boron treatment on Monarch plants, and in the minus-copper treatment on Jarvis Red plants. Data in Table 5 indicate a varietal difference of camellia plants to use of minor elements in a sand-peat mixture. Additions of minor elements do not seem warranted as a general practice.

INFLUENCE OF TYPE AND AMOUNT OF ORGANIC MATTER

MATERIALS AND METHODS. Glazed, 2-gallon pots were prepared for use as described previously. The potting mixtures listed in Table 6 were used to fill the pots to 1½ inches of the top. Pink Perfection, Monarch, and Jarvis Red varieties were used. One rooted cutting of each variety was placed in each pot. One-fourth of the fertilizer (rate of 2,000 pounds of 6-10-8 per acre) was applied in the potting mixture. The remaining three-fourths was used as sidedressings divided in quarterly applications. Each treatment was replicated three times.

RESULTS. Little difference in plant growth resulted from using domestic and imported peat moss. There seemed to be little advantage in incorporating more than one-fourth peat moss by volume to any soil mixture. Some increase in growth was noted up to one-half peat by volume, but the added growth did not warrant the additional cost.

Both peanut hulls and sawdust were excellent materials to use. However, the plants showed signs of nitrogen deficiency. Tests were not made to determine the additional amount of nitrogen needed to overcome this difficulty.

TABLE 6. GROWTH OF CAMELLIAS USING VARIOUS KINDS AND AMOUNTS OF ORGANIC MATTER

Type and amount of organic matter[1]	Pink Perfection				Monarch				Jarvis Red			
	Fresh wt.	Dry wt.	Height		Fresh wt.	Dry wt.	Height		Fresh wt.	Dry wt.	Height	
			7/18/50	5/6/51			7/18/50	5/6/51			7/18/50	5/6/51
	Gm.	*Gm.*	*In.*	*In.*	*Gm.*	*Gm.*	*In.*	*In.*	*Gm.*	*Gm.*	*In.*	*In.*
¼ foreign peat	25.57	11.57	14.33	18.33	40.70	18.20	10.25	15.25	40.97	15.00	13.42	17.92
¼ domestic peat	28.87	12.50	13.75	16.67	55.97	14.70	13.50	18.92	47.53	20.60	18.33	22.42
½ foreign peat	34.60	14.50	14.58	18.25	43.73	18.50	10.67	16.83	38.52	15.90	10.00	16.17
½ domestic peat	51.87	21.87	15.33	18.58	74.90	31.40	15.25	21.42	44.98	19.33	16.66	21.33
¾ foreign peat	21.23	9.10	12.08	15.17	51.83	20.70	10.33	17.17	23.55	9.65	12.50	16.50
¾ domestic peat	26.70	13.33	12.17	17.25	40.40	17.10	8.33	14.83	65.38	26.83	16.42	21.42
¼ peanut hulls	74.28	31.75	20.25	27.63	24.83	16.30	12.50	15.92	15.70	16.60	14.17	19.00
½ peanut hulls	43.95	14.80	17.88	23.50	84.67	38.10	12.33	20.67	15.60	6.70	14.00	17.88
¼ sawdust	27.50	11.80	11.25	18.50	52.53	21.50	9.42	15.83	51.40	22.20	10.00	20.50
½ sawdust	13.50	6.33	9.42	13.50	34.65	13.80	8.83	13.17	22.30	12.63	6.25	12.25

[1] The organic matter was mixed with sand. Fertilizer rate was 2,000 pounds of 6-10-8.

RESPONSE OF THE CAMELLIA TO EXCESS BORON

MATERIALS AND METHODS. Three years prior to this test, Pink Perfection plants were propagated by terminal stem cuttings and grown for 1 year in 4-inch pots in peat moss. The plants were then transferred to 2-gallon glazed crocks and were grown for 2 years. One-half was grown in a mixture of one-half peat moss and one-half Decatur clay loam; the other half was grown in a mixture of one-half peat moss and one-half Norfolk sandy loam. Six months before the start of this experiment, a 2-inch mulch of peat moss was applied to the soil in each crock.

From the time the plants were propagated until the experiment was begun, a 6-8-4 fertilizer was applied three to four times a year at the rate of 1 teaspoonful per crock. In addition, each plant was fertilized with 1 teaspoonful of a 6-8-4 fertilizer one week before treatment with boron.

Three plants in each soil type were treated with borax at rates of 0, 5, 10, 20, 40, and 80 pounds per acre, while three other plants in each soil type were treated with chicken manure at rates of 0, 1, 2, 3, 4, and 8 tons per acre. The chicken manure, obtained from the Station poultry farm, had been treated with Polybor-3 at the rate of 1 pound per 100 square feet of floor area per week to control flies. Borax treatments were applied July 6, 1953, and the chicken manure was applied July 29, 1953. The pH of the Norfolk soil at the beginning of treatment was 4.3 and that of the Decatur soil was 5.4.

Leaf samples, consisting of the third and fourth leaves from the tip of shoots, were collected 1 month after treatment from the plants in each soil type treated with borax. Similarly, leaf samples were taken 3 months after treatment from the plants growing in the Norfolk sandy loam. The boron content was determined by a colorimetric method developed by Naftel.[5]

RESULTS. Symptoms of boron toxicity appeared in plants growing in Norfolk sandy loam soil 3 months after application of borax at rates of 40 and 80 pounds and chicken manure containing boron at the rates of 4 and 8 tons. No visible toxic symptoms appeared on the plants growing in Decatur clay loam soil, except where 80-pound rate of borax was applied. This appeared 6 months after treatment.

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[5] Naftel, James A. Colorimetric microdetermination of boron. Ind. and Eng. Chem. 11:407-409. 1949.

Symptoms of boron toxicity were small, irregular dead areas, which appear on the older leaves in the upper surface near margins of the leaf blade. Some were surrounded by light yellowish-green areas. The dead areas enlarged and penetrated to the undersurface of the leaves. Individual spots grew until the entire margin of the leaf blade was dead. These areas had irregular margins. The leaf area along the midrib was green, and remained so until sometime after abscission.

At the end of this experiment, it was observed that plants showing toxicity symptoms began to grow well in the spring. Growth began at the same time as the other plants and new growth was as long as that of any other plant. No evidence of damage was present on the new growth.

SUMMARY

Experiments were conducted on the *Camellia japonica* to determine fertilizer requirements of the plant.

1. Survey of established plants showed that the best site for camellias is one in partial shade where the soil is well drained. If the organic matter content is high and drainage excellent, good plants can be grown in full sun. Excellent plants were found in soil varying in pH from 4.2 to 7.5.

2. Symptoms of mineral element deficiencies are similar to the general descriptions given for all plants. Potassium deficiency was not expressed in the experiment.

3. Nitrogen was the most important element in camellia fertilization. Minor element addition did not improve growth in this study, and its use does not seem warranted. Varietal differences were noted. The best rate and analysis was 2,000 pounds of 6-10-8 per acre per year (5 pounds per 100 sq. ft.).

4. Peat moss at one-fourth by volume in the soil was adequate for good growth. The source of peat did not influence growth. Peanut hulls and sawdust in the soil resulted in the appearance of nitrogen deficiency symptoms on the plants at the fertilization rate used (120 pounds N per acre per year).

5. The camellia is relatively tolerant to boron in the soil. Damage can ocur if a 40-pound per acre rate is used on a Norfolk sandy loam or an 80-pound rate on a Decatur clay loam.