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Fertilization, Incorporated Organic Matter, and Early Growth of Rabbiteye Blueberries[1]

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Additional index words. plant nutrition, *Vaccinium ashei*

Abstract. **The effect of incorporated sphagnum peatmoss and minimal fertilization on the establishment and subsequent growth of rabbiteye blueberries (*Vaccinium ashei* Reade) was determined in 4 field studies conducted on typical fine sandy loam, upland mineral soils in south Mississippi. Incorporated peatmoss increased plant vigor, plant height, shoot weight, leaf chlorophyll level, and fruit yield and reduced chlorosis symptoms. First- and second-year plant growth and second-year fruit yields were reduced by either slow-release or fast-release granulated fertilizer. Soluble fertilizers produced less plant damage than granulated fertilizers but no more plant growth than no fertilization. There was a close association between over-fertilization and cholorosis symptoms.**

Commercial rabbiteye blueberry plantings are normally established using 2-year-old, bare-rooted plants. Early and continued optimum fruit production depends upon the successful establishment and first-year growth of these plants. General planting instructions include the incorporation of peatmoss into soil in the planting hole and irrigation (1, 5, 8, 9); soil pH should range from 4.5 to 5.5.

Young rabbiteye blueberry plants are very sensitive to fertilizer (5, 7, 8, 9, 10) and inorganic fertilizer placed directly under first-year plants can cause severe damage (3). Fertilization recommendations (N–P–K) for the first year range from none (8, 9) to 5 monthly applications 8–5–7 fertilizer at the rate of 115–150 g/plant (6). A first-year fertilization program in Florida consists of applying 28 g of ammonium sulfate per plant in June and August (1). The recommendation in Georgia is to apply 42 g per plant of 12–2–7 or 16–2–7 slow-release fertilizer when growth begins and again in late July or early August (7). In Arkansas, good first-year growth resulted from the application of 225 g/plant of a complete fertilizer such as 10–9–8 in early spring, followed by 2 applications of 112 kg/ha of ammonium sulfate at 6-week intervals (7).

These studies were conducted to determine the effects of first-

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year fertilization and preplant-incorporated organic matter on the establishment and early growth of rabbiteye blueberry plants on mineral soils typical of the lower coastal plains of Louisiana, Mississippi, and Alabama.

Materials and Methods

In all studies, 2-year-old, bare-rooted rabbiteye blueberry plants were established on Ruston fine sandy loam soils (fine-loamy, siliceous, thermic Typic paleudults). Very low in organic matter and natural fertility, these soils have cation exchange capacity values which range from 5.0 to 6.2 meg/100 g and soil pH values (1:2 H_2O) between 4.5 and 5.3. Available soil (0–15-cm-depth) macronutrient ranges were (in kg/ha): N, 22–67; P, 49–98; K, 46–70; Mg, 53–112; Ca, 224–400; and S, 102–165, as determined by the Soil Testing Laboratory, Mississippi State University.

Study 1. In February 1972, 'Tifblue' plants were established in a randomized complete block design with 4 replicates and treatments assigned in a 2 × 3 × 4 factorial. The treatments were 2 types of incorporated organic matter (pine sawdust and sphagnum peatmoss), 3 levels of incorporated organic matter (0, 4, and 15 liters/plant), and 4 levels of nitrogen (0, 4.5, 14.2, and 42.3 kgN/ha) applied as $(NH_4)_2SO_4$ on plants grown without irrigation. Plants were fertilized uniformly with a 0–11–20 (N–P–K) fertilizer in April 1972 and March 1973. Nitrogen was applied in April and August 1972 and in March and June 1973. Visual vigor ratings were made May 15, 1972, and July 31, 1973, on a scale from 0 (dead plant) to 5 (most vigorous plant). The chlorophyll level of leaves was determined on June 2, 1972, by Association of Official Agriculture Chemists methods (2).

Study 2. 'Tifblue' plants were established under irrigation in February 1978. Treatments were assigned as a 3 × 2 × 3 × 3 factorial in a randomized complete block design with 4 replicates. Treatments included 3 rates/year (0, 4, and 16g) of equivalent 13–6–11 (N–P–K) fertilizer obtained from 2 types of fertilizer (fast-release from a 13.0–5.7–10.8 granular fertilizer and slow-release from 14.0–6.2–11.6 Osmocote—Sierra Chemical Co., Inc., Milpitas, Calif.), 3 types of incorporated organic matter (finely ground pine bark, sphagnum peatmoss, and 25-year-old pine sawdust), and 3 levels of incorporated organic matter (0, 4, and 15 liter/plant). Plants were irrigated uniformly and fertilizers were applied to appropriate plots on April 12, 1978, and April 6, 1979. Plants were visually rated for vigor on August 22, 1978, and July 16, 1979, using the 0–5 scale described in study 1. Visual chlorosis ratings were taken on June 5, 1979, (0 = dead, 1 = most chlorosis, 5 = least chlorosis). Plant height was measured on Nov. 22, 1978. Fruit yields (g/plant) were determined in 1979. On Sept. 14, 1979, plants were cut to ground level and fresh weight of shoots determined.

Study 3. 'Tifblue' plants were grown for 2 years to determine the influence of various fertilizer types and rates with and without incorporated peatmoss on establishment and subsequent development of rabbiteye blueberries. Plants were established with an overhead irrigation system in February 1978. The experimental design was a 2 × 2 × 5 factorial in a randomized block design with 4 replicates. This study consisted of 2 levels of incorporated peatmoss (0 and 8 liters/plant), 2 fertilizer types (fast- and slow-release 13–6–11, (N–P–K) and 5 fertilizer rates (0, 15, 30, 60, 120 g/plant), each rate applied twice per year. Plants were fertilized in March and June of 1978 and 1979. Plants were rated for vigor and chlorosis in August 1978 and July 1979 using previously described scales. Plant height was measured in November 1978 after the first year's growth. Fresh weight of shoots was determined after the second year's growth. Fruit yields were taken in 1979.

Study 4. Plants were uniformly established in February 1980 and grown under an overhead irrigation system. Fertilization treatments were initiated on April 15, two months after planting. Experimental design was a randomized complete block with 8 fertilization treatments and a control. These treatments were replicated 4 times using cultivars as replicates ('Tifblue', 'Delite', 'Climax', and 'Woodard'). Treatments consisted of applying fertilizer over a 4-month period at the following rates per plant (in grams per plant): 2.0 N, 0.8 P, and 1.6 K, as a fast-release fertilizer applied every 2, 4, or 8 weeks; 1.0 N, 0.4 P, and 0.8 K as a fast-release fertilizer applied every 2 or 4 weeks; and 1.0 N, 0.4 P, and 0.8 K as a soluble fertilizer applied every 1, 2, or 4 weeks.

The soluble fertilizer was mixed with 3.8 liters of water and allowed to drip slowly into the soil 10 cm from the plant to approximate fertilization through a trickle irrigation system. Fast-release fertilizers were applied as granules. All plants were irrigated by an overhead system before and after fertilization to minimize soil moisture differences due to liquid vs. granular fertilization. Irrigation was not excessive and leaching was minimized. Visual chlorosis and vigor ratings were taken in September 1980. Total amounts of NPK fertilization are shown in Table 4.

Results

Study 1. Nitrogen levels had no effect on plant vigor or chlorophyll content of the leaves during the first year (Table 1). In the second year after planting, nitrogen-fertilized plants were less vigorous than those receiving no nitrogen.

Incorporated organic matter levels and types interaction was significant for vigor and chlorophyll in 1972. As levels of sawdust increased, plant vigor ratings and chlorophyll content remained constant or decreased, while increasing levels of peat resulted in increased plant vigor ratings and chlorophyll content. Plants treated with higher levels of peat had better vigor and less chlorosis than plants receiving any level of sawdust. By 1973, no treatment differences were present between types of incorporated organic matter.

Table 1. Influence of nitrogen levels and incorporated organic matter types and levels on plant vigor and chlorophyll content of 'Tifblue' leaves, study 1.

Treatment		Vigor ratings[z] 1972	Vigor ratings[z] 1973	Chlorophyll level (mg/chlorophyll per g dry leaves) 1972
N levels (kg/ha)				
0		3.2a[y]	3.4a	0.91a
4.7		3.5a	2.9b	0.95a
14.2		3.4a	2.7b	0.96a
42.3		3.4a	3.0b	1.01a
O. M. type and level (liter/plant)				
Sawdust	0	3.4b		1.01b
	4	2.6b		0.89b
	15	2.3b		0.67c
Peatmoss	0	3.5b		1.00b
	4	4.2a		1.04ab
	15	4.4a		1.17a

[z]Scale of 0 (dead)–5 (most vigorous).
[y]Mean separation in columns within groups by Duncan's multiple range test, 5% level.

Study 2. Plant growth and fruit yields were reduced by increasing levels of fertilization and by omitting incorporated organic matter (Table 2). In all growth responses observed, the high rate of fertilization reduced growth. Plants that received 4 or 15 liters of incorporated organic matter grew larger and yielded more fruit than those that received no incorporated organic matter. Organic matter types had no influence on plant growth and yield. Fertilizer types had no effect on fruit yield but significant effects were seen on plant vigor for both 1978 and 1979, with fast-release fertilizer promoting the greatest vigor. However, the interaction between types and levels of organic matter was significant for fruit yields (Fig. 1). Plants with high levels of peatmoss yielded more fruit than those with high levels of bark and sawdust, but fruit yield from plants with bark at 4 liters/plant was not significantly different from plants with peatmoss at 15 liters/plant.

Study 3. With 1 possible exception, no differences were evident due to fertilizer types (Table 3). Plant vigor was less in 1978 for the slow-release fertilizer, but this difference was not present in 1979. As fertilizer rates increased, plant growth and fruit yields decreased. Unfertilized plants were equal or superior in vigor, growth, and production to plants receiving fertilizer. This agrees with studies showing a slow response of 'Tifblue' to fertilization (4). High rates of fertilizer reduced plant growth significantly. Plants with incorporated peatmoss grew and fruited better than plants with no incorporated peat.

Study 4. As the number of applications of 2.0 N, 0.8 P, 1.6 K (g/plant) of fast-release fertilizers decreased, plant vigor increased and chlorosis decreased (Table 4). When this fertilizer rate was applied at 8-week intervals, plant response was equal to unfertilized plants. More frequent applications were detrimental to plant growth.

With a 1.0 N, 0.4 P, 0.8 K fast-release fertilizer, increasing the number of weeks between applications resulted in increased plant vigor and decreased the intensity of chlorosis. Plants receiving equal total amounts of fast-release fertilizer grew better with less frequent applications.

Increasing application of a soluble 1.0 N, 0.4 P, 0.8 K fertilizer did not influence chlorosis symptoms. Plant vigor was decreased under the more frequent applications (every 1 or 2 weeks).

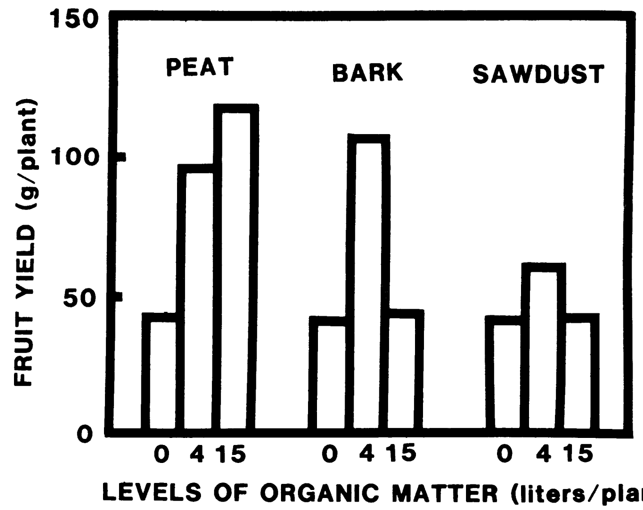

Fig. 1. Influence of incorporated organic matter types and levels on fruit yield of 'Tifblue' blueberry, study 2.

For equal fertilization rates and frequencies, plants receiving liquid fertilizer grew better and were less chlorotic than those fertilized with the granular form. This relationship was the same for plants that were fertilized either every 2 or 4 weeks.

Discussions

These studies indicate that young rabbiteye blueberry plants are extremely sensitive to fertilizer injury and/or have limited ability to regulate their intercellular ionic composition. Many plants were killed or severely damaged by fertilization, but some showed no apparent damage and were equal or superior in growth to nonfertilized plants. Nevertheless, fertilization generally produced detrimental effects on the plants.

Excessive concentrations of soluble salts in contact with plant roots may cause plasmolysis and/or restrict moisture availablity. Wadleigh and Ayers (11) found that plant growth decreased with

Table 2. Main effects of types and levels of fertilizers and incorporated organic matter (OM) on growth and fruit yields of 'Tifblue' blueberries, study 2.

Treatment	Vigor rating[z] 1978	Vigor rating[z] 1979	Plant height (cm) 1978	Chlorosis rating[y] 1979	Shoot fresh wt (g/plant)	Fruit yield (g/plant) 1979
Fertilizer (13N–6P–11K) rates (g/plant)						
0	2.6a[x]	3.1a	53a	3.9a	253a	100a
4	2.4ab	2.5b	51a	2.9b	202a	66ab
16	2.2b	1.6c	43b	1.8c	126b	35b
Fertilizer release						
Slow	2.2b	2.1b	46a	3.0a	184a	53a
Fast	2.6a	2.6a	51a	218a	210a	80a
OM types						
Bark	2.6a	2.4a	51a	3.0a	222a	66
Sawdust	2.1a	2.4a	46a	3.1a	182a	49
Peatmoss	2.5a	2.2a	51a	2.6a	189a	97
OM levels (liter/plant)						
0	2.2b	1.9b	43b	2.1b	142b	42
4	2.6a	2.6a	53a	3.1a	221a	90
15	2.4ab	2.6a	51a	3.5a	299a	69

[z]Visual rating: 0 = dead, 1 = least vigorous, 5 = most vigorous.
[y]Visual rating: 0 = dead, 1 = most chlorotic, 5 = least cholorotic.
[x]Mean separation within groups in columns by Ducan's multiple range test, 5% level.

Table 3. Main effects of fertilizer types and rates with and without incorporated peatmoss growth and fruit yield of 'Tifblue' blueberry, study 3.

Treatment	Plant vigor[z] Aug. 1978	Plant vigor[z] July 1979	Chlorosis[y] Aug. 1978	Chlorosis[y] July 1979	Plant ht (cm) Nov. 1978	Shoot fresh wt (g/plant) Sept. 1979	Fruit yield (g/plant) June 1979
Fertilizer (13N–6P–11K) types							
Fast-release	3.7a[x]	3.8a	2.7a	2.8a	74a	511a	253a
Slow-release	3.4b	4.1a	2.6a	3.3a	74a	581a	263a
Fertilizer rates (g/plant)							
0	4.3a	4.7a	3.8a	4.0a	94a	996a	404a
15	4.3a	4.5a	3.0b	3.8a	81b	679b	345a
30	3.5b	4.2ab	3.2b	3.3ab	76b	576b	282a
60	2.8c	3.5bc	2.3c	2.3bc	58c	268c	205ab
120	2.8c	2.8c	0.8d	1.8c	56c	216c	54b
Incorporated peatmoss (liters/plant)							
8	3.8a	4.2a	2.6a	3.4a	79a	652a	352a
0	3.3b	3.6b	2.4a	2.7a	69b	442b	175b

[z]Visual rating: 0 = dead plant, 1 = least vigorous plant, 5 = most vigorous plant.
[y]Visual rating: 0 = dead plant, 1 = most chlorotic plant, 5 = least chlorotic plant.
[x]Mean separation in columns within groups by Duncan's multiple range test, 5% level.

Table 4. Main effects of types and rates of fertilizers applied at differing intervals on chlorosis and vigor of rabbiteye blueberry plants, study 4.

Fertilizer type	g element per application N	P	K	Time between applications (wk)	Total g element applied over 16-week period N	P	K	Chlorosis rating[z]	Vigor rating[y]
Granular (fast-release)	2.0	0.8	1.6	2	16	7.0	13.0	1.3c[x]	0.9d
	2.0	0.8	2.6	4	8	3.5	6.6	2.8b	1.8c
	2.0	0.8	1.6	8	4	1.8	3.3	4.0a	3.3ab
	1.0	0.4	0.8	2	8	3.5	6.6	1.5c	1.4c
	1.0	0.4	0.8	4	4	1.8	3.3	2.5b	3.6a
Soluble	1.0	0.4	0.8	1	16	7.0	13.0	4.0a	2.9b
	1.0	0.4	0.8	2	8	3.5	6.6	3.8a	3.0b
	1.0	0.4	0.8	4	4	1.8	3.3	4.5a	3.5a
Check	0	0	0	---	0	0	0	4.0a	3.6a

[z]Visual rating: 0 = dead plant, 1 = most chlorotic, 5 = least chlorotic.
[y]Visual rating: 0 = dead plant, 1 = least vigorous, 5 = most vigorous.
[x]Mean separation in columns by Duncan's multiple range test, 5% level.

increasing water tension and increasing salt content of the soil solution. The sandy soils utilized in these studies have relatively low water-holding capacities, resulting in a high concentration of soluble salts in the soil solution. These soils also have low cation exchange and buffering capacities, which contribute to increased salt concentration of the soil solution when fertilizer is added.

Incorporated organic matter resulted in increased growth and fruit yields of young rabbiteye blueberry plants. Peatmoss has high cation exchange and water-holding capacities that decrease the soluble salt concentration and increase the availability of moisture in the rhizosphere. This probably accounts for some of the positive responses of young rabbiteye blueberries to incorporated organic matter.

Results from these studies suggest that preplant incorporation of organic matter and irrigation of young rabbiteye blueberry plants produces positive growth response, but fertilization is usually detrimental to plant growth in sandy soils and should be omitted during the first growing season.

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A Dwarfing Gene that Reduces Seed Weight and Pod Length in Common Bean[1]

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Abstract. **Common bean (*Phaseolus vulgaris* L.) genotype, MITA 10597, has small seeds ($\bar{x}$ = 122 mg, s = 31) and short, narrow pods ($\bar{x}$ = 44 mm, s = 13.2) with tight constrictions between seeds. A bean breeding line, 7-1404, has longer pods ($\bar{x}$ = 99 mm, s = 18.4) and larger seeds ($\bar{x}$ = 269 mg, s = 32). The inheritance of the dwarf seed and pod type of MITA 10597 was studied in the F_2 and backcross populations from the cross MITA 10597 x 7-1404 and also from F_2 populations from backcrosses of 7-1404 to an F_3 plant (from 7-1404 x MITA 10597) selected for the dwarf seed (DS) character. The DS character was found to be controlled by a single, recessive gene that restricts development in seeds with the *ds//ds* genotype. The apparent phenotypic segregation for seed size in the pods of heterozygous (+//*ds*) F_1 plants was found to be under genetic control.**

In 1979, Freytag (1) reported that a *Phaseolus vulgaris* genotype, MITA 10597, exhibited "metaxenia" effects on pod size development. When MITA 10597 was pollinated with foreign pollen, the resulting pods were nearly twice as long as the pods produced by self-pollination. A similar report was made by Tschermak (5) using 'Zucker Reisperl Tausend fur Eine' as a "xenia" source in crosses with 'Anker'. He indicated that seeds in the pods from F_1 plants appear to segregate for definite size classes. The small seeds produced "xenia" pod phenotypes in the F_2, i.e., short pods with small seeds and deep pod constrictions between the seeds. Medium-sized seeds produced F_2 plants that segregated for different seed size phenotypes in the pods (the same as F_1). Large seeds bred true for normal pods and seeds that were similar to 'Anker'. These cultivars are no longer extant (Christian Lehman, East Germany, personal communication).

In 1952, Lamprecht reported a recessive character he called *tenuis* that reduced normal pod lengths of 10–15 cm to only 5–8 cm (2). He did not report the source of the *tenuis* character and did not cite Tschermak's earlier report. This character may be the same as that reported by Freytag (1). S. Blixt at the Weibullsholm Institute in Sweden has kept Lamprecht's bean collection extant for many years, but informed me that there is no stock with the *te//te* genotype clearly indicated.

When Freytag's line, MITA 10597 (M 10597), is crossed as maternal parent with various breeding lines, there is an enlargement of the resulting F_1 seed as well as the reported (1) increase in pod length. In this report, I choose to avoid the term "metaxenia" to describe this phenomenon. Instead I postulate that the short pods of M 10597 are a secondary effect of the genetic restriction of seed size development in self-pollinated pods of M 10597. The purpose of this report is to investigate the inheritance of the dwarf seed character.

Materials and Methods

Line M 10597 carries the dwarf seed character and line 7-1404 is a breeding line with normal seeds and pods. Pod length measurements were made on 6 greenhouse-grown plants of both parental genotypes; all pods on each plant were included to compute the mean pod length. From 1 plant of each parental genotype all the seeds produced were harvested and individually weighed to compute the average seed weight.

Because M 10597 is poorly adapted to Florida field conditions, it was not included in the field plots, and 7-1404 was not included because it would serve no purpose without M 10597 being present for comparison. The F_1 generation was not planted in the field either, because segregation for seed size in F_1 pods could be studied in advanced generation lines (described below) that were better adapted and had lower environmental variability.

M 10597 was crossed with 7-1404 to produce an F_2 population. The backcrosses were produced as follows: M 10597 x (M 10597 x 7-1404), which was designated BC_a, and 7-1404 x (M 10597 x 7-1404), which was designated BC_b. The seeds of the F_2 and backcross generations were individually weighed and the weights recorded on a field plot label for each seed.

Seeds of the F_2 and backcross generations were planted in the field in March 1981 using a randomized complete block design with 10 replications. Each replicate of BC_a had 9 seeds except

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