Influence of Plant Spacing on Yield of Muscadine Grape¹

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Abstract. Plants set 6.1, 6.4 and 6.7 m apart in each of 3.0-, 3.7- and 4.3-m rows of the muscadine grape, Vitis rotundifolia, Michx., cv. Hunt, were compared for 25 years. The highest plant density, 477 plants/ha, gave the greatest yield per m² almost consistently for 25 years. The highest yields per plant were obtained from the wider in-the-row spacings. Alternate bearing was rather consistent from 1949 through 1963, but irregular thereafter.

Muscadine grape production is increasing and gaining in popularity in the Southeast. The life of the muscadine grape in GA ranges upward from 50 years (10). Plant spacing becomes an important factor if a vineyard is to be in production for this relatively long period of time. The optimum spacing will vary according to plant vigor, soil fertility, climatic, and cultural conditions (11).

It was reported that the highest yield per feddan (0.4167 ha) resulted from plants spaced 2×2 m in 5 out of 6 years from a study in Egypt that was first observed 8 years after planting (8). Working with 11 grape cultivars at 4 locations in Bulgaria, Stoev et al. (13) could not determine a single optimum spacing as the highest yields were produced by vines planted 1.2–1.5 m apart with row spacings of 1.7, 2.0, 2.5 or 3.0 m.

It has been suggested that muscadine plants be set 4.6 to 6.1 m apart in rows 3.0 to 3.4 m apart (5, 6). Armstrong et al. (2) and Savage (10) recommended that in GA muscadine plants be spaced 6.4 m apart in rows 4.4 m apart, but there was no experimental evidence presented to substantiate these recommendations.

Experimental plantings were made at Tifton, GA in Feb. 1945 to study the long-range effects of plant spacing on yield.

Materials and Methods

The pistillate 'Hunt' cultivar was used in this study with male plants set as a pollinator every 3rd plant in every 3rd row including guard rows. Guard plants were around each spacing block. Plants were set 6.1, 6.4, and 6.7 m apart in 3.0-, 3.7- and 4.3-m rows. All combinations of these spacings were used. Each block consisted of 8 'Hunt' plants and 1 male plant.

The plants were trained to a 2-wire trellis system. After the trellis was developed, short spur pruning (leaving 2 buds per shoot) was practiced each year with light spur thinning.

Plants received a split application of 113 g per plant of a 4-8-8 fertilizer in May and again in June, 1945. This amount was increased to 227 g per plant in each of 2 applications in 1946. In 1947 plants received 454 g per plant of a 4-8-8 fertilizer just after growth began. From 1948–1950, they received 680 g per plant. During 1951–1960, each plant received 907 g of a 4-8-8 fertilizer. The fertilizer was changed to 5-10-15 from 1961–1970. A cover crop of oats or rye was seeded in Oct. or Nov. each year and mowed in the spring when growth began. After mowing, the plots were harrowed lightly; thereafter, the middles were mowed to control weed growth until the soil was harrowed prior to seeding the cover crop the next fall. A 0.6 m area in the row was kept clean either by hoeing or more recently with herbicides, either Princep or Karmex.

The fruit was harvested when mature as indicated primarily by color and weighed to the nearest 113 g per plant.

Results and Discussion

As the average yield increased from 1946 to 1949, the maturity date became progressively later from July 12 to September 1. The latest

maturity date (September 11) occurred in 1952. The average maturity date for the next 18 years was August 18 ± 9 days (Fig. 1). The \overline{c} highest average yield (over 45 kg/plant) of all spacings was obtained \overline{c} in 1951, 1961, and 1963.

The increase in date of maturity the first 7 years could have been the result of young plants with a vigorous growth rate. The excessively early maturity in 1955 was associated with low yield.

Alternate bearing was consistent from 1949 through 1963, interrupted only by the 1955 freeze injury. As reported earlier (3), it became pronounced after the 14th crop year in 1959 (Fig. 1).

The high-low cycle was not regular for the years 1964-66 and 1967-69. The average yield increased over these 3-year periods. One cycle explanation for this trend is that during a season of low yield (1955, 1964, and 1967), plants did not utilize all the carbohydrates leaving a high reserve level for the following crops.

The alternate bearing habit was not consistent each year among geometry spacings as shown in years 1957, 1958, 1969 and 1970 (Table 1). In geach of these years yield trends differed from the norm in 2 to $3\frac{1}{2}$ spacings.

The highest average yield per hectare was obtained almost consistently at plant densities of 435 plants per hectare and greater (Table 1). The row spacings for these plant densities are the minimum to allow ample room for vineyard equipment now in use (12). Generally, similar yields per hectare were also obtained at wider spacings for 10-year averages for 1951-60 and 1961-70. Spacing differences were minimized in low-yield years.

The years when yields were high, a symptom of Mg deficiency was occurred on older leaves as fruit formation began. This observation was reported earlier (1, 3, and 9) and it is similar to that reported by Fudge (7) and Camp (4) in citrus. They reported that Mg is an deficiency symptoms become apparent in the leaves, especially if the graph of the soil Mg supply is insufficient for both fruit (seed) development and maintenance of leaf chlorophyll.

The highest average yield per plant varied with plant spacing over the years. In general, the highest yields per plant were obtained from the wider in-the-row spacings (Table 2). In 1946, '54, '55, '63 and '70¹, '50¹, '50², '63², '63²,

There was not a tremendous variation among the spacing treatments; therefore, climatic conditions could negate the effects of these treatments. The year, 1954, was the driest year during the 25-year period (59.1 vs. average of 118.5 cm of rain). Muscadine grapes bloom in late May and early June; and during these months in 1954, we had only 4.1 and 4.6 cm, respectively. Nevertheless, the average yield of 36.8 kg/plant for all spacing was good; therefore, the dryness could have negated the treatment effects. A late freeze (March 27, -5° C) in 1955 killed much of the fruiting wood, and therefore, destroyed the effects of treatments that year.

It is felt that the competition among treatments was destroyed, masked or negated in 1963 and 1970 by excessive moisture. In May and June 1963, 23.9 and 19.9 cm of rain, respectively, fell. In 1970, 18.8 cm of rain fell between May 25 and June 5.

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Fig. 1. Average yield (kg/plant) and maturity date of 'hunt' muscadine grape for 25 years.

Table 1.	Average yield	per hectare	of 'Hunt'	muscadine from	plant	spacing sy	ystems	for 25	years.
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- Martin - M	Square meters plants/ha									
	Year	18.3 477	19.2 455	20.1 435	22.6 400	23.7 381	24.8 363	26.2 343	27.5 326	28.8 309
						M.T./ha ^z				
	1946	1.4a	1.8a	1.8a	1.4a	1.3a	1.4a	1.0a	1.5a	1.2a
	1947	5.8a	6.1a	5.1a	5.4a	4.6a	5.8a	5.3a	5.2a	5.3a
	1948	11.5a	10.6a	9.1b	8.3b	8.0b	8.0b	9.1b	8.7b	7.4b
	1949	12.6a	10.7abc	10.2bc	11.3ab	9.4bc	10.4bc	10.7abc	9.5bc	8.9c
	1950	7.1ab	6.8ab	8.0a	7.1ab	5.8c	6.7ab	6.7bc	5.7c	6.6bc
	1951	18.8a	18.8a	19.6a	16.9b	16.9b	17.2b	16.6b	16.3c	15.5c
	1952	13.8a	14.1a	14.4a	14.0a	12.6a	12.9a	12.6a	15.2a	14.4a
	1953	18.7a	15.0hc	17.8ab	18.3a	14.0cd	13.9cd	16.9abc	14.4c	11.0d
	1954	16.6a	16.7a	16.8a	14.3ab	13.8bc	14.0abc	12.9bc	12.3bc	11.1c
	1955	3 8ah	4 5ab	11.7a	5.0ab	3.9ab	3.9ab	3.5ab	2.8b	2.0b
	1956	13.8a	15.6a	16.4a	15.1a	13.4a	13.9a	10.9b	10.2b	8.4b
	1957	17.2a	16.8a	16.1a	16.1a	13.0b	14.3b	11.8c	9.8c	11.2c
	1958	10.1c	13.0abc	14 8a	11.7abc	9.9c	14.0ab	9.6c	11.0bc	11.4abc
	1959	18.7a	18.8a	17.8a	19.1a	15.8ab	16.6a	16.9a	15.8ab	13.2b
	1960	7 9a	8.3a	9.6a	7.6a	6.6b	8.6a	5.1b	6.3b	5.5b
	1961	21.1h	24 8a	26.5a	19.0bc	16.2c	19.2bc	17.0c	16.2c	17.0c
	1962	9 7ab	8.6ab	10.8a	8.3ab	9.3ab	10.7a	7.6b	8.0ab	7.4b
	1963	22 0a	21 2ab	21.2ab	18.5abc	17.4bc	18.0bc	16.9c	16.0c	16.6c
	1964	3 7a	3 9a	3.2ab	3.3ab	3.8a	3.4ab	3.9a	2.3b	3.1ab
	1965	7 0a	5.9u	5.7a	4.8b	5.1b	7.2a	5.4a	3.3b	5.8a
	1966	18.9a	19.9a	20.1a	17.2a	15.1b	18.2a	14.3b	13.2b	14.5b
	1967	4 59	4 0a	4 4a	5.8a	4.1a	4.4a	5.6a	5.4a	4.3a
	1968	13.4h	16.1a	13.2h	11.7b	10.1c	10.4c	8.1c	7.0d	7.9c
	1969	12.40	13.9a	15.20	10.8c	10.5c	12.9b	10.4c	11.1c	12.1b
	1970	14 4a	13.1a	12.6a	13.7a	10.5b	9.9b	11.3ab	10.4b	8.5b
	Av	11.14	10.14	12100						
	46-70	12.2a	12.3a	12.9a	11.4ab	10.0bc	11.0b	10.0bc	9.5c	9.2c
	51-60	13.9a	14.2a	15.5a	13.8a	12.0b	12.9b	11.7bc	11.4c	10.3c
	61-70	12.8a	13.0a	13.3a	11.3b	10.2c	11.4b	10.0c	9.3c	9.7c

² Spacing means for each year separated by Duncan's multiple range test at the 1% level.

Table 2. Average yield per plant of 'Hunt' muscadine from plant spacing systems for 25 years.

	Square meters plants/ha									
Year	18.3 477	19.2 455	20.1 435	22.6 400	23.7 381	24.8 363	26.2 343	27.5 326	28.8 309	
					kg/plant ^z					
1946	2.9a	4 0a	4.0a	3.5a	3.3a	3.8a	3.0a	4.5a	3.9a	
1947	12.2h	13.4h	11.7b	13.4b	12.1b	16.0a	15.4a	15.9a	17.0a	
1048	24.2ab	23 3ah	20.9b	20.8b	21.1b	21.9b	26.5a	26.7a	23.8ab	
1940	24.240 26.4ab	23.6b	23.4b	28.2ab	24.7b	28.5ab	31.1a	29.0ab	28.8ab	
1950	14.90	14.8c	18.3bc	17.6bc	15.3c	18.5ab	19.5ab	17.5bc	21.3a	
1951	39.4c	41.2b	45.0b	45.0b	44.5b	47.4a	48.2a	49.8a	50.3a	
1952	28.9h	31.0b	33.2b	35.1b	33.0b	35.5b	36.8ab	46.6a	46.6a	
1953	39.1b	33.0b	41.0ab	45.7a	36.8b	38.2b	49.3a	44.1a	35.6b	
1954	34.7a	36.8a	38.6a	35.7a	36.1a	38.4a	37.4a	37.7a	35.9a	
1955	7.9a	10.0a	26.8a	12.6a	10.3a	10.7a	10.3a	8.5a	6.6a	
1956	28.8b	34.2ab	37.7a	37.7a	35.2ab	38.1a	31.6ab	31.3ab	27.1b	
1957	36.1ab	36.9ab	38.0a	40.2a	34.0ab	39.4a	34.3ab	30.1b	36.1ab	
1958	21.1b	28.5b	34.0a	29.2ab	26.1b	38.5a	27.9b	33.7a	36.9a	
1959	39.1b	41.3ab	40.9ab	47.6a	41.6ab	45.6ab	49.3a	48.4a	42.7ab	
1960	16.6bc	18.3abc	22.0ab	18.9abc	17.2abc	23.5a	14.7c	19.3abc	17.7ab	
1961	44.2b	54.5a	61.0a	47.3b	42.6b	52.7a	49.6b	49.7b	55.0a	
1962	20.3h	18.8b	24.9ab	20.6b	24.4ab	29.4a	22.1ab	24.6ab	24.0ab	
1963	46 0a	46.7a	48.8a	46.1a	45.5a	49.5a	49.2a	49.1a	53.7a	
1964	7.8ab	8.6ab	7.3b	8.2ab	9.9ab	9.4ab	11.3a	7.2b	10.0at	
1965	14.7b	11.1b	13.2b	12.1b	13.3b	19.8a	15.6a	10.2b	18.7a	
1966	39.6b	43.8ab	46.2ab	43.0ab	39.6b	50.2a	41.5b	44.6b	47.0ab	
1967	9.5bc	8.8c	10.1bc	14.5ab	10.8bc	12.2abc	16.2a	16.4a	14.0ab	
1968	28.1b	35.5a	30.4a	29.3b	26.5b	28.6b	23.5b	21.5c	25.6b	
1969	25.1d	30.6c	35.1b	26.9c	27.5c	35.5ab	30.1c	34.1b	39.2a	
1970	30.1a	28.8a	29.0a	34.2a	27.6a	27.3a	32.9a	31.9a	27.5a	
Avg.	25.5c	27.1b	29.6ab	28.5ab	26.4c	30.3a	29.1ab	29.1ab	29.8a	

 $^{z}\ Spacing means for each year separated by Duncan's multiple range test at the <math display="inline">1\%$ level.

The data and observations from this study indicate that when muscadine grapes (cv. Hunt) are grown in the home garden, a spacing of 6.1 to 6.7 m apart in rows 4.3 to 3.7 m apart, respectively, is desirable. When planted on a commercial scale, within broad limits the row spacings can be reduced by the development of new equipment. Small tractors and sprayers are now available. A minimum of 3.0 m between rows should be used. This study suggests that still closer spacings should be studied to obtain maximum commercial yields.

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