Influence of Trellis Type on Yield of Muscadine Grape[1]

W. T. Brightwell and M. E. Austin[2]
University of Georgia, Coastal Plain Experiment Station, Tifton

Abstract. One-wire, 2-wire, and overhead trellis systems of the muscadine grape, *Vitis rotundifolia*, Mich., cv. Hunt, were compared for 20 bearing years. Initially, plants trained to the 2-wire trellis had the highest yield; but for each of the next 18 years, the highest yield was obtained from the overhead trellis. All training systems exhibited alternate bearing after the 7th crop year. The alternate bearing pattern was the same as the state pecan production.

Muscadine grape production is gaining on popularity in the Southeast; however, little data is available on effects of trellis system on yield. The more common upright training systems used today are the 1-wire vertical trellis, 2-wire vertical trellis, which includes the Munson and the Geneva Double Curtain trellis systems, and the overhead system (2). Husmann and Dearing (4) reported that upright systems bore crops a year earlier than the overhead system and also bore larger crops of much better fruit which ripened more evenly. It also has been reported that it is more satisfactory to train vines on a 2-wire trellis than the overhead system (1).

Experimental plantings were made at Tifton, Georgia in March 1951 to study the long-range effects of trellis systems on yield.

Materials and Methods

We used the pistillate 'Hunt' muscadine grape with the perfect-flowered 'Tarheel' set every 3rd plant in every 3rd row as a pollinator including the guard rows; therefore, each recorded plant was adjacent to a pollinator. Plots consisted of 4 rows of 5 plants each with 18 'Hunt' plants for the 1-wire and 16 each for the 2-wire and overhead trellises. Guard plants were around each trellis type. Plants to be trained to the 1-wire and 2-wire trellis were set 37 x 61 dm (12 x 20 ft.). Plants to be trained to an overhead trellis were set 46 x 46 dm (15 x 15 ft.). The 1-wire and 2-wire trellises consisted of posts set 61 dm (20 ft.) apart between vines with the wires 12 dm and 15 dm (4 and 5 ft.), respectively, above the ground. Posts for the overhead trellis were 21 dm (7 ft.) high, and each plant was set about 3 dm (1 ft.) from a post.

Clean cultivation was practiced during the first 5 years. After that the vineyard was mowed during the summer, and a cover crop of oats or rye was seeded in the fall. Rows were kept clean by hoeing or with herbicides in later years. Plants received an annual application of 336 kg/ha (300 lb/acre) of 6-12-12 fertilizer the first 10 years and then a 10-10-10 fertilizer in the spring along the row and a fall application when the cover crop was planted. Plants were pruned during the dormant season to the short spur leaving 2 buds on the past season's growth. Light spur thinning was practiced. The total lengths of arms for the 1-wire, 2-wire and overhead were maintained at 61, 122, and 219 dm (20, 40, and 72 ft.), respectively. Pruning and training time were recorded after the 15th crop year. No spray program was followed.

Grapes hand picked each year at maturity were weighed to the nearest 113 g (¼ lb.).

Results

At the end of the third growing season, plants trained to the 1-wire and 2-wire trellises had well-developed arms. The overhead-trellised plants required more training and time to reach the 21 dm (7 ft.) trellis wires. Pruning and training time of the 1-wire, 2-wire and overhead trellises were 6.2, 9.9 and 12.2 man-minutes/plant, respectively, with 3 people pruning.

The average yield of the 3 systems increased to the 11th year then gradually decreased for the remaining 9 years. In the 3rd year (1955), a late freeze (March 27, −5°C) killed much of the fruiting wood on the 1-wire and 2-wire trellises (Fig. 1). The low yields in the 19th year were attributed to dry calyptra that prevented pollination. The total yields were significantly higher on the 9th, 11th, and 14th crop years.

Although alternate bearing was pronounced after the 7th crop year, plants trained to the 1-wire trellis had the lowest average yield each year for the 20-year period. Plants trained to the 2-wire trellis produced the highest average yield the first and second crop years and were intermediate the remaining 18 years. Plants trained to the overhead trellis were intermediate in yield the first and second years but produced the highest yield the remaining 18 years. Yield differences between "on" and "off" years in alternate bearing was double for each trellis system (Table 1). Alternate bearing was evident for the pollinator 'Tarheel', especially during the 7th through 13th crop year on each trellis system, and it was consistent each year after on the 1-wire trellis. These data are not presented.

In the years of high yields, a characteristic mottled chlorosis of the older leaves (Mg deficiency) was observed.

The effect of trellis system on the 20-year average yield was similar for both cultivars (Table 2). The 1-wire trellis produced the lowest yield compared with the highest yield of the overhead trellis. The highest yield of 66.7 kg (147 lb)/plant or 28.49 M.T./ha (12.7 tons/acre) was produced on plants trained to the overhead trellis in both 1961 and 1963.

The average yield per hectare (acre) for the 20-year period would have been 7.3 M.T. (3.2 tons) for the 1-wire trellis, 9.6 M.T. (4.3 tons) for the 2-wire, and 14.7 M.T. (6.6 tons) for plants trained to the overhead trellis. The average yield per kg/dm of arm for the 1-wire, 2-wire, and overhead systems was 0.30, 0.20, and 0.16 (2.0, 1.3, and 1.1 lb/ft), respectively.

Discussion

It has been reported that upright systems are more satisfactory (1) and produce larger yields than overhead systems (4), and our data substantiate this for the first 2 crop years. However, the reverse was true for the next 18 years. This demonstrates that studies on training systems of perennial crops, such as grapes, should be evaluated for several years.

The length of fruiting arms varied from 61 to 219 dm per plant according to trellis type. The greater the length of the arms, the greater the total yield though not in a direct proportion. However, the reverse was true when yields were put on a kilogram per decimeter basis. It would appear that plants trained to 1-wire were more efficient since the exposure of the arms and leaves on a 1-wire trellis are the same as on the overhead trellis. After plants became well established and arms on plants trained to the 3 systems had met, total leaf area exposed to the sun was much greater on the overhead trellis than on 1-wire or 2-wire ones.

Muscadine plants usually grow vigorously and require annual pruning. Loomis (6) observed that spur pruning of 'Scuppernong' gave significantly higher yields than cane pruning. However, in a later study he found that spur thinning was important. There was a greater

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[2] Professor (Retired) and Associate Professor, respectively, Department of Horticulture.

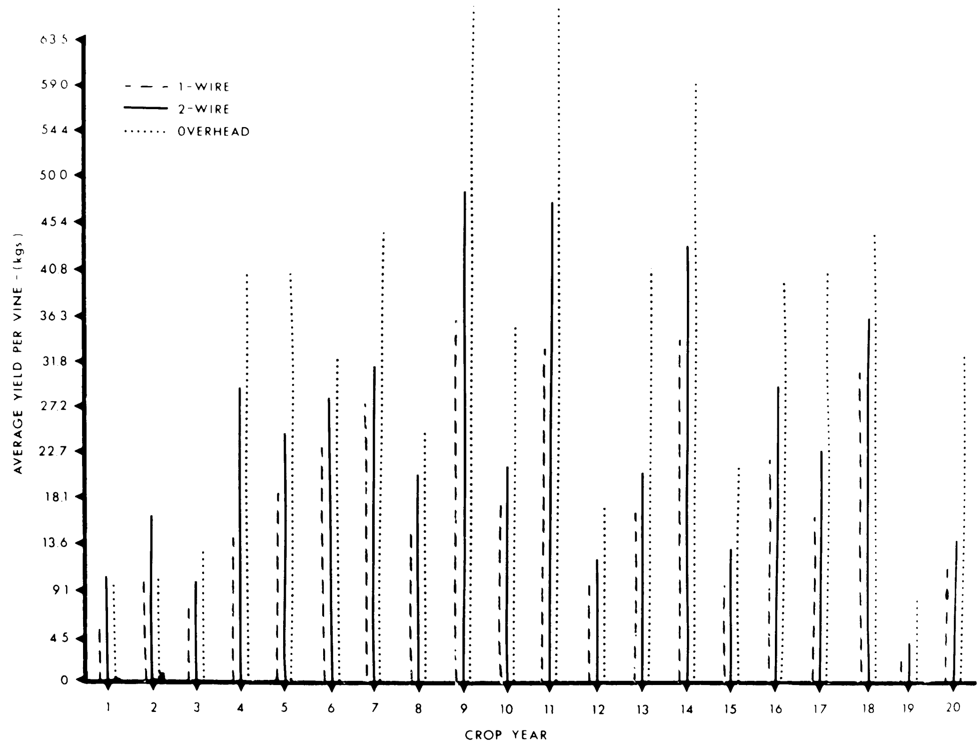

Fig. 1. Average yield of 'Hunt' muscadine from 3 training systems for 20 years (kg/plant).

Table 1. Yield comparison of the average "on" years with average "off" years of 'Hunt' cultivar.

Trellis type	"On" years[z]	"Off" years[y]	Difference
		(M.T./ha)[x]	
1-wire	11.3a	4.9a	6.4
2-wire	14.4b	6.3a	8.0
Overhead	21.7c	10.6b	11.1

[z] "On" years—1959, 61, 63, 66, 68, 70, and 72.
[y] "Off" years—1960, 62, 64, 67, 69, and 71.
[x] Mean separation by Duncan's multiple range test at the 1% level.

Table 2. Yield of 'Hunt' and 'Tarheel' muscadine grapes on 3 types of trellises[z].

Trellis type	Hunt	Tarheel
	(kg/plant)[y]	
1-wire	18a	15a
2-wire	24ab	22b
Overhead	34b	36c

[z] Means followed by same letter are not significant at the 5% level.
[y] Twenty-year average yield per plant.

tendency toward alternate bearing on vines pruned to spurs of 2 to 4 buds with practically no spur thinning than on vines pruned with extensive spur thinning (7). Our data support that of Loomis et al. (7) and Bryant et al. (3) that under usual pruning practices grapes tend to bear in alternate years.

Alternate bearing became very pronounced in 1960 with the eighth crop. Beginning in 1960 the pattern of alternate bearing of the muscadine grapes in Georgia coincided with pecan alternate bearing in a grove within one mile of the grapes (11) and with the entire state production in Georgia (9). Furthermore, the local grove did not always follow a high-low yielding cycle as the grapes in years 1964, 1965, and 1966. Yield of both pecans and grapes increased over this 3-year period. As with the influence of the late freeze in 1955 on yield, the bearing pattern of both pecans and grapes is closely related to climatic conditions.

Observations indicate that leaf drop is much earlier from plants which have produced a heavy crop. There were no apparent leaf diseases that defoliated the plants. However, it has been found that a natural abscission-accelerator is produced in rapidly growing fruits of lupins (8). Later Liu and Carns (5) announced the isolation of an abscission-accelerator (abscisin) from mature cotton fruit burs that promotes leaf drop in other plants as well as cotton, including beans, citrus, and coleus. If hormone-like chemicals are produced in other fruits that would promote leaf drop, it would seem that a large number of berries on a vine could do the same. Worley (10) found that pecan trees defoliated early produced no nutlets the next season. Nutlet set increased as defoliation date became later. Muscadine grapes, like pecan nutlets, are produced on current season growth. Therefore, muscadine grapes may need to retain foliage longer in the growing season to build up the reserve carbohydrates for the next season's growth and development.

Magnesium is an essential part of seeds; and it stands to reason that a large fruit yield would require more Mg, thus creating a deficiency in the leaves. It appears that under a set of conditions, such as the environment, type of training systems used with grapes and the size of yield (utilization of potential reserve carbohydrates and nutrients) will influence bearing habit the following year.

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Control of Endogenous Brown Spot of Fresh Pineapple in Postharvest Handling[1, 2]

Ernest K. Akamine[3], Theodore Goo[3], Thomas Steepy[4], Theodore Greidanus[4], and Noboru Iwaoka[4]
University of Hawaii, Honolulu

Abstract. In Hawaii, the physiological disease of pineapple [*Ananas comusus* (L.) Merr. cv. Smooth Cayenne] called endogenous brown spot (EBS), occurs throughout the year. During the development of EBS there is a significant positive correlation between the number of spots and degree of darkening of spots. Correlations between number and degree of darkening of spots with pulp translucence indicated that higher pulp translucency does not necessarily camouflage the spots and thereby reduce the number as well as the degree of darkening of the spots. A heat treatment at 32.3–37.8°C for 1 day controlled EBS in fresh fruits held under refrigeration (7.2°C). In simulated shipping experiments heat treatment was effective when applied in transit in shipping containers before, during, or after refrigeration, the last being most effective. The only detrimental effect of heat treatment was increased fruit-wt loss. This was more than offset by the beneficial effect of the reduction in EBS incidence, and improvement in appearance and flavor of the pulp.

Endogenous brown spot (EBS), an important physiological disease of pineapple, has been reported from many parts of the world. The characteristic symptom of the disease is the development of a dark spot at the base of a fruitlet close to the core. In its early stage of development, the spot appears watery; it then enlarges and turns brown as the severity of the disease increases. In severe cases, the dark spots coalesce and the affected areas become a mass of dark tissues giving rise to another name to the malady, Black Heart (2).

In Taiwan, EBS is reported to be prevalent mostly, if not only, during the coolest months of the year (private communication from C. C. Huang). In West Africa, one source (private communication from C. Pey) reported highest incidence of the malady during the hottest season, and another source (7) reported that, in the Ivory Coast, the disease is seasonal and appears with climatic changes in January to May. In Florida, EBS is more serious in winter than summer (6). The disease is also prevalent in Australia, Central America, and the Philippines (private communication from J. B. Smith). In Hawaii, the belief is common that EBS occurs only in winter.

EBS usually begins to appear in fresh fruit after about 4 days of storage at ambient temperature following refrigerated storage for at least 4 days. It occasionally appears in unrefrigerated fruit. It may also be found in fruit immediately after harvest, indicating the development of the disease prior to harvest when chilling field temperatures occur as in Australia (2).

While chilling is usually advanced as the initiating agent for the disease, reduced sunlight intensity has also been implicated. The latter condition usually results from dense planting or excessive cloudiness (1), conditions usually associated with winter months when field temperatures are also low. A significant reduction in ascorbic acid has been reported in pineapples with EBS induced by low temperature storage (4, 5).

During the past 10 years, the shipping of fresh pineapples from Hawaii to U.S. mainland, Japan, and elsewhere has steadily increased in spite of maritime labor disputes which disrupted shipments in some years[5]. The out-of-state shipment in 1972 and 1973 was 27,390.7 and 46,891.9 metric tons, respectively. As a result of recent reductions in air freight charges, increasing amounts of pineapples are being shipped by this method to inland markets of the U.S. mainland. However, the volume of air shipment is still small (only about 4% of the total shipped), compared with 96% shipped in refrigerated containers by maritime transportation to U.S. west coast markets. Air-shipped fruits are not refrigerated and do not develop EBS.

There are no visible symptoms of the disease in the intact fruit, and therefore roguing to eliminate affected fruits cannot be used. The Hawaii pineapple industry reported that losses due to the unsightly EBS in fruits shipped by surface transportation are significant, sometimes causing loss of entire shipments. Thus it appears imperative that measures be developed to control this malady in fruit for export. We report the results of an investigation conducted to control EBS in fresh Hawaiian pineapples held under refrigeration.

Materials and Methods

Fresh pineapples were obtained from Dole Company fields on the island of Oahu. They were harvested in the morning at the commercial harvest stage (2–20% yellowed fruit surface) for surface shipment. The basal end of each fruit was immediately dipped in a fungicidal preparation, Dowicide A (2.73 kg per 378.5 l water) to control storage decay (TV rot) caused by *Thielaviopsis paradoxa;* this is an approved commercial treatment for all fruit intended for the fresh market trade. The pineapples were installed in experiments by the afternoon of the day of harvest.

Fifteen to 62 fruits were used for each treatment. These were selected and matched for surface color development (percent of surface area yellowed) so that in all treatments in any experiment, the degree of initial surface color was similar. For fruit temperature determinations, a thermocouple was inserted about midway in the

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[2] Donation of pineapples by the Dole Company for this investigation is gratefully acknowledged.
[3] Botany Department, University of Hawaii.
[4] Dole Company, Honolulu, Hawaii.

[5] Hawaii State Department of Agriculture. Statistics of Hawaiian Agriculture 1973.