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Preliminary Yields of Southern Highbush Blueberry in Waimea, Hawai'i

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This blueberry project is a joint effort by the USDA–ARS Pacific Basin Agricultural Research Center's Tropical Plant Genetic Resource Management Unit, the USDA–ARS National Clonal Germplasm Repository at Corvallis, and the University of Hawai'i at Mānoa's College of Tropical Agriculture and Human Resources.

The purpose of this publication is to provide a preliminary report on a trial planting of blueberry cultivars that is still in progress. The methods, results, and observations will be discussed. It should be noted that this is a research trial and the methods used may not necessarily reflect recommended practices. A resource site for all aspects of blueberry culture is http://berrygrape.oregonstate.edu/fruitgrowing/berrycrops/blueberry.htm.

Background

Blueberry is a potential high-value niche-market crop for Hawai'i. Blueberry is not commonly grown in Hawai'i, and little is known about the adaptability of this crop to our conditions. In this publication, we are reporting what we did to establish a small plot of southern highbush blueberry at the UH–CTAHR Mealani Research Station in Waimea on the island of Hawai'i. Information is provided on plot establishment, fertilizer practices, and yield of six cultivars in a planting grown and observed from October 2004 to September 2005.

The Mealani Research Station is 2800 ft above sea level. The soil is a well drained silt loam belonging to the Maile soil series. The average annual maximum temperature is 75°F and the average minimum is 50°F (range 84–42°F). The average annual rainfall is 65 inches.

Fruits of Sapphire blueberry in various stages of development.

Blueberry cultivars grown

The six southern highbush blueberry cultivars tested were Biloxi, Emerald, Jewel, Misty, Sapphire, and Sharpblue; these are complex hybrids between northern highbush blueberry, *Vaccinium corymbosum* L, and southern *Vaccinium* species, such as *V. darrowii* Camp. These cultivars were selected based on their high quality and low chill requirements (USDA/ARS GRIN 2005). In general, the southern highbush blueberries were developed to be

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more tolerant of heat during the growing season, and to mineral soils rather than highly organic soils. The southern highbush cultivars require a lesser degree of cool weather (chilling) for flowering. Ten plants of each variety were provided by Fall Creek Nursery, Oregon, through the USDA/ARS National Clonal Germplasm Repository in Corvallis, Oregon. The plants arrived on April 7, 2004.

Biloxi
Released in 1986 by the USDA in Poplarville, Mississippi by James M. Spiers, Craighton L. Gupton, and Arlen D. Draper; Plant Introduction (PI) 1560112. Biloxi plants have an upright stature and are vigorous and productive. The fruits ripen early in temperate zones, are medium in size and firm, and have good flavor and skin color and a small picking scar. Biloxi should be planted with other southern highbush cultivars to facilitate fruit set and maximum yield (USDA/ARS GRIN 2005).

*Emerald**
Released in 2001 by the University of Florida, Gainesville, by Paul Lyrene; U.S. Plant Patent 12165. Emerald is an excellent southern highbush blueberry, vigorous and highly productive, and leafing out well. The berries are firm and well textured with a medium blue color. Emerald tends to produce the largest berries among southern highbush cultivars. Its chilling requirement is about 250 hours.

*Jewel**
Released in 2001 by the University of Florida, Gainesville, by Paul Lyrene; U.S. Plant Patent 11807. Jewel has a very low chill requirement and ripens its high-quality fruit early. In Florida, it ripens before Sharpblue. The plant is vigorous, strong-leafing, and productive, and it yields large, firm fruit with small picking scars. The flavor is tart. Its chilling requirement is about 200 hours at temperatures less than 40°F.

Misty
Released in 1990 by the University of Florida, Gainesville, by Paul Lyrene; PI 555317. Misty is upright and vigorous and should be interplanted with other southern highbush types for pollination. The fruits are medium to large, light blue in skin color, with good firmness and flavor and a small picking scar. It tends to produce excessive flower buds and requires winter pruning to manage flowering. Partially to completely evergreen in central Florida, if it defoliates in winter it may flower long before it produces new leaves, in which case it is highly susceptible to stem blight. The chilling requirement is about 150 hours (USDA/ARS GRIN 2005).

*Sapphire**
Released in 2001 by the University of Florida, Gainesville, by Paul Lyrene; U.S. Plant Patent 11829. Sapphire is not as vigorous as Sharpblue, with which it could be planted as a companion crop. Sapphire produces a firm berry with good flavor, and fruit thinning is recommended. Chilling requirement is estimated at 200 hours.

Sharpblue
Released in 1975 by the University of Florida, Gainesville, by R.H. Sharpe; PI 554948. Sharpblue is spreading, vigorous, productive, and resistant to canker disease. It produces tight clusters of medium size, round-oblate, dark blue berries that ripen early with a medium picking scar. The berry flesh is firm with excellent flavor (ASHS 1996). Sharpblue is the leading early variety in low-chill areas throughout the world and is considered a standard cultivar to which others are compared. Care must be taken to harvest it frequently during hot weather to maintain quality. In very mild climates, Sharpblue will flower and fruit throughout the year, with a commercial crop favored in spring and a smaller crop in fall. Sharpblue is recommended in areas with winter chilling of less than 500 hours, but it will grow in climates where there are practically no chilling hours (USDA/ARS GRIN 2005).

Field preparation and planting
An area 30 x 120 ft was tilled a month before planting. To lower soil pH from pH 6.3 to a more desirable level (target pH 4.5–5.0) and to improve soil fertility, we applied the following materials, spread over each 3 x 40 ft planting bed and tilled to a depth of 4–6 inches: peat

*Propagation of patented blueberry varieties requires a license from the agency holding the patent. Planting a patented variety does not require a license if the plant was purchased from a licensed propagator. Propagation of patented varieties without a license is a violation of the law, even if you own the plants from which the cuttings are taken. For more information, see: http://edis.ifas.ufl.edu/HS215.

Plastic ground cover (weed mat) and bird netting barrier at the blueberry trial planting, Waimea.

(7.6 cu ft, or 2 bales), steer manure (3 cu ft), treble superphosphate (0-41-0, 17 lb), gypsum (12 lb), ammonium sulfate (20.5-0-0-24S, 12 lb), and potassium magnesium sulfate (K-Mag, 0-0-22-22S, 12 lb).

The planting area was then covered with a weed-blocking plastic ground cover fabric (photo, above). The cover provided excellent weed control and reduced soil splashing in the planting area. The soil pH from six random spots in the planting rows sampled 18 months later averaged 5.7 (range 5.3–6.1). Additional general site preparation information is available at http://berrygrape.oregonstate.edu/fruitgrowing/berrycrops/blueberry/siteprep.htm.

A total of 60 plants were planted on April 28, 2004, one week after application of the soil amendments. Plants were spaced 5 ft apart in rows 10 ft apart, resulting in a density of 871 plants/acre.

Holes 2 ft in diameter were cut into the weed mat for each plant, and an additional ⅛ cu ft of peat was mixed into each hole at planting, after which the plants were thoroughly watered. For *Phytophthora* mitigation, metalaxyl-M (Ridomil Gold EC) was applied as a soil drench at an equivalent of 3.6 pints/acre (0.123 ml of Ridomil in 2 liters of water for each planting hole).

Care and maintenance

The plants were irrigated with a drip irrigation system having two emitters per plant and supplying ½ gallon of water per emitter per hour. The plants were watered three times a week for 45 minutes each time during the dry season. The irrigation was reduced to twice weekly for 45 minutes during the wet season.

The plants were fertigated monthly through the same drip irrigation system. A 50-gallon stock solution of fertilizer was prepared and injected into the drip system with a small gasoline-engine powered pump. The stock solution was prepared by mixing 2 cups (15 ounces by weight) of 4-41-27 soluble fertilizer in 50 gal water.

Every third month, 1 cup of a 4.5% iron chelate liquid was added to the stock solution in addition to the 4-41-27. The solution was injected into the irrigation water that supplied the 60 plants. The nitrogen in this formulation was derived from ammonium sulfate, which was intended to help acidify the soil over time. Also, when soil pH is higher than 5.5, a nitrate form of nitrogen is not as readily available to the plants, and the ammonium form is preferred. When soil pH is less than 5.5, either the ammonium or nitrate forms of nitrogen can be used. For more information on nutrient management for blueberry, visit http://berrygrape.oregonstate.edu/fruitgrowing/berrycrops/blueberry/nutri.htm.

Results, observations, comments, suggestions

Plant growth

The plants grew fairly well until about the fifth month, at which time all of the cultivars except Jewel flowered and fruited profusely on short branches. We believe that this heavy flowering and fruiting on the young plants contributed greatly to reduced vegetative growth of these varieties (with the exception of Jewel). Periods of insufficient moisture and less than optimal soil conditions may also have contributed to the reduced vegetative growth. Jewel, which produced very little fruit during this reporting period, ended up with the most vigorous growth and largest plants. It is as yet unknown whether Jewel will become productive when the plants become more mature.

Fruit production and quality

Fruits were harvested weekly beginning on October 26, 2004 (Figure 1). Ripeness was determined by color, and harvest was by hand. The combined yield of all 60 plants reached 1000 g in two consecutive weeks in May 2005 (1176 g and 1029 g) and one week in June (1592 g), and thereafter weekly yield increased from 1800 g to 5394 g over the period from late July to early September (Figure 2).

Total fruit production per cultivar (10 plants each) between October 2004 and September 2005 was led by Sapphire (9788 g), Biloxi (9744 g), Emerald (9446 g), and Sharpblue (8654 g); yields of Misty (4512 g) and Jewel (4225 g) were about half as much (Figure 3). Further observations will be needed to confirm if Misty and Jewel have a bearing pattern different from the other varieties; if so, this could be exploited to achieve a longer fruit-production period by combining cultivars in a planting.

Typical fruits of the Waimea blueberry planting with a quarter (diameter about 1 inch) to indicate their size.

Fruit quality observations were made in May 2005. Fruit weight, thickness, diameter, and total soluble solids (TSS) were measured on random samples of fruit (Table 1).

TSS was measured with a refractometer. Sharpblue had the highest brix reading of 14.92, followed by Emerald and Misty. Misty had the largest fruit size, followed by Jewel and Emerald. The small fruit size of Sharpblue (Table 1) may be due to the abundant fruit load on a young plant. An area of further research is fruit acidity testing to determine sugar:acid ratios.

Crop nutrient management

Most literature mentions that for blueberry growth and production the soil pH should be within the range 4.0–5.2 (with an optimum of 4.5–4.8). When the soil pH is higher than this range, growers often use an acidifying amendment such as finely ground sulfur to lower the pH. Although the soil at the Mealani Research Station averaged pH 5.7 and ranged from pH 5.3 to 6.1, sulfur was not used to amend the pH, except to the extent that it was supplied in the fertilizers used.

Micronutrient deficiency, such as iron deficiency, can occur when the soil pH is too high. For this preliminary trial, chelated iron was applied through the irrigation system. The crop was also fertilized through the irrigation system using a 4-41-27 formulation. Further

Figure 1. Weekly yield of southern highbush blueberry cultivars in Waimea, October 2004 to September 2005.

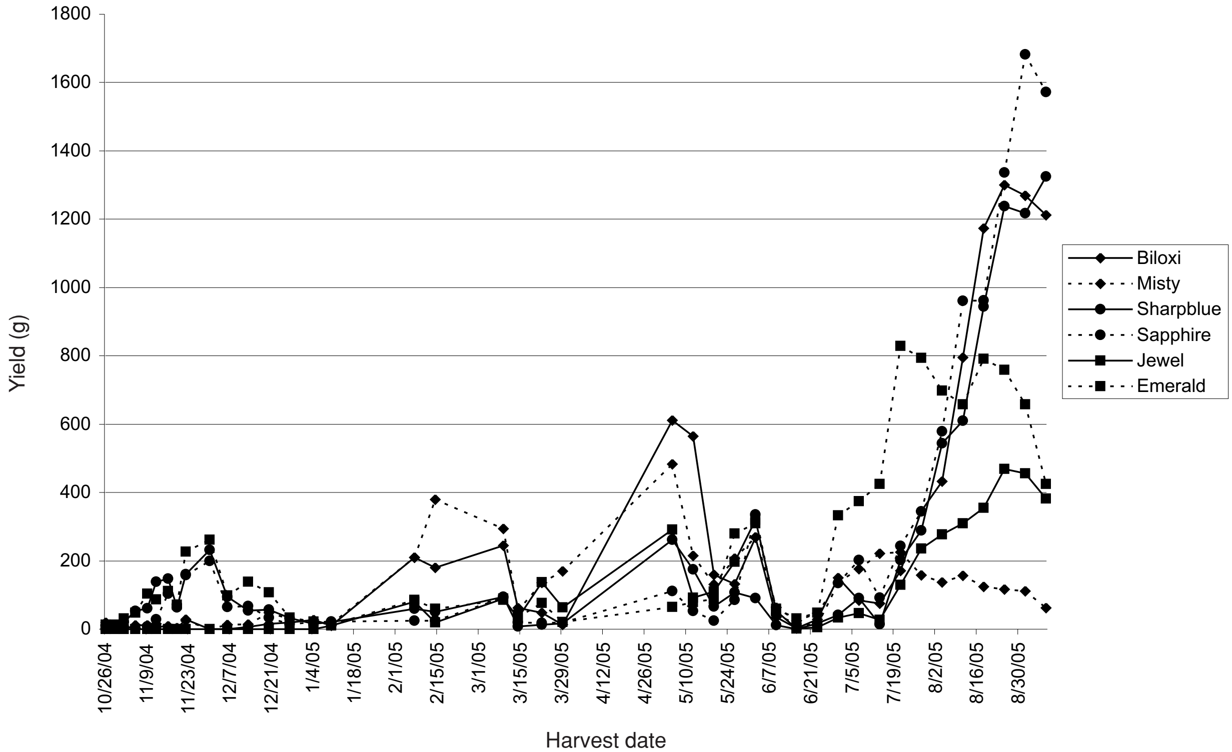
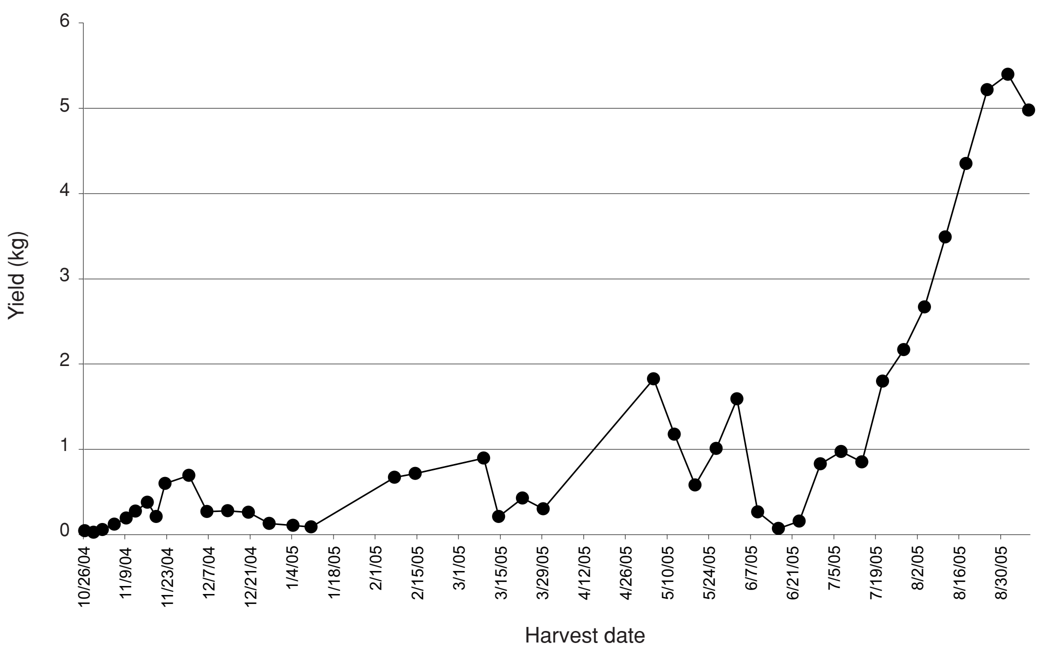


Figure 2. Combined weekly yield of southern highbush blueberry cultivars in Waimea, October 2004 to September 2005.



A bearing Sapphire blueberry bush.

research is needed into the area of soil acidification and fertility management under Hawai‘i soil conditions.

Pest management

The most serious problem encountered during the first year of growing blueberries at the Mealani Research Station was bird damage. Turkeys and pheasants damaged the young plants. Cardinals and white-eyes damaged and fed on the fruit. Mylar ribbons and plastic owls initially reduced the small birds' visits, but ultimately the problem was overcome by installing bird netting on a metal pipe frame (Figure 1). Chinese rose beetles sometimes caused significant chewing damage to the foliage, and control measures were necessary on occasion. Although blueberries are listed as a host for the Mediterranean fruit fly, no obvious fruit fly damage was noted on ripe fruit. Leaf spots and melon aphid colonies occasionally occurred on new shoots but were not serious problems.

Conclusion

Based on this preliminary trial, Biloxi, Emerald, Sharpblue, and Sapphire grew well and produced good yields of quality berries at the Mealani Research Station. Plants of Jewel were the most vigorous and robust but the least productive during this early phase of crop development. Sharpblue produced the sweetest fruit (highest TSS), but when harvested at proper ripeness, all the cultivars' fruits were well received in informal taste tests. Fruits of Emerald, Misty, and Jewel were most impressive, with their large size.

Bird damage and feeding on fruit can cause serious losses. Enclosing blueberry plants within bird netting, although expensive, was the most effective method of preventing serious losses. Disease and insect problems were minimal during the first 18 months after planting. The Chinese rose beetle appeared to be the most important insect pest during the trial.

This study is preliminary, and further observations

Figure 3. Total yields of six southern highbush blueberry cultivars in Waimea, October 2004 to September 2005.

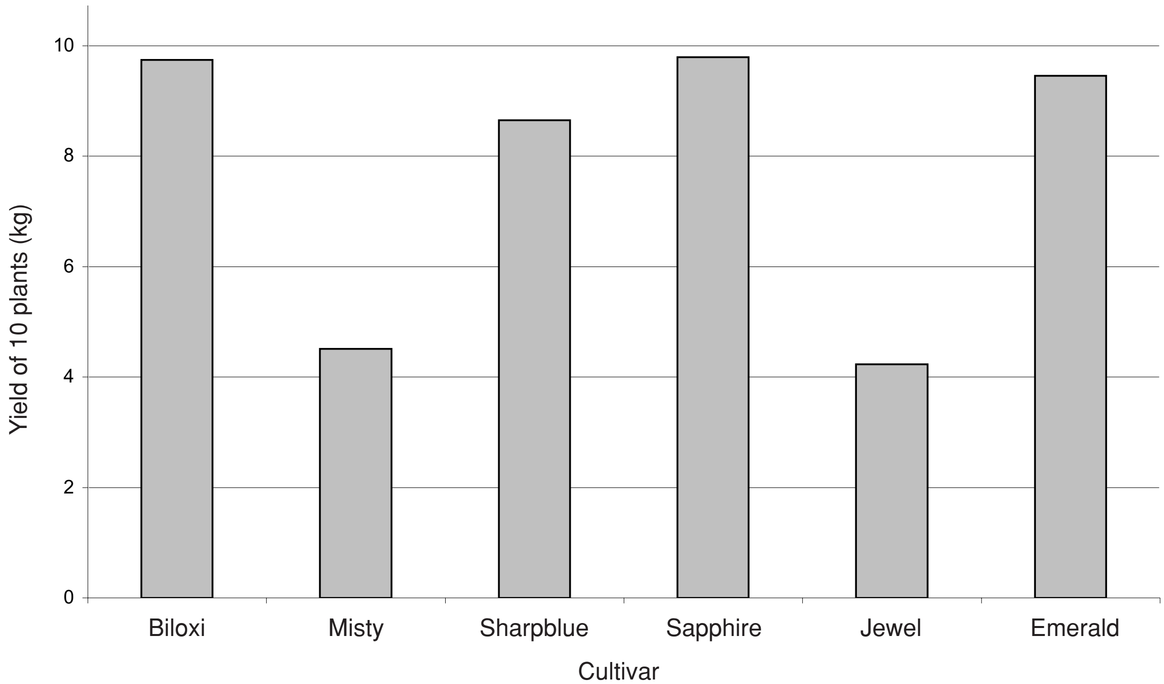


Table 1. Fruit characteristics of southern highbush blueberry cultivars grown in Waimea.

	Biloxi	Misty	Sharpblue	Sapphire	Jewel	Emerald
No. of fruits sampled	43	50	49	36	40	31
Average fruit weight (g)	1.51	2.42	1.28	1.65	2.13	1.99
Fruit weight range (g)	0.40–3.10	1.30–3.50	0.40–2.70	0.50–2.60	1.10–4.60	0.60– 4.50
Average fruit thickness (cm)	1.02	1.32	1.01	1.16	1.20	1.16
Fruit thickness range (cm)	0.68–1.28	1.01–1.53	0.71–1.23	0.77–1.77	0.95–1.36	0.83–1.48
Average fruit diameter (cm)	1.44	1.75	1.33	1.49	1.61	1.64
Fruit diameter range (cm)	0.97–1.92	1.40–2.06	0.97–1.84	1.02–1.82	1.24–2.31	1.14–2.22
Average TSS	12.27	13.40	14.92	12.82	12.09	13.71
TSS range	9.5–14.7	11.2–15.7	11.8–19.3	8.6–15.9	9.2–14.2	10.1–17.2

TSS = total soluble solids (^{o}brix)

on the growth of these six cultivars will be needed over several years to identify their production potential. This description of the trial's materials and practices is neither an endorsement of the cultivars nor a recommendation for their management. However, these preliminary observations provide optimism for blueberry as a new crop for Hawai'i. Interested farmers can start with small-plot testing at their locations to determine suitable combinations of plant cultivars and management practices.

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Disclaimer

Another view of the blueberry trial planting at Waimea.