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Evaluation of pot size for greenhouse production of ‘Misty’ Southern highbush blueberry in Volcano, Hawai‘i

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In tropical climates such as in Hawai‘i, evergreen blueberry production could provide consistent year-round availability of blueberries for local premium markets rather than targeting the commodity market windows of the global blueberry market. Evergreen blueberry production in the field has been evaluated in South Florida to eliminate the dormancy period of blueberry plants, resulting in earlier fruit production (Reeder et al. 1994). Recently, three evergreen varieties of blueberry were released from the University of Florida, supporting the use of evergreen blueberry plants to optimize market windows in the U.S. (Buck 2015). However, existing information regarding evergreen blueberry production is limited to South Florida (Reeder et al. 1994).

The cost of land and labor in Hawai‘i dictates the reliance of the agricultural sector on niche markets to sustain the high costs of production (Suryanata 2000). High-value crops, such as locally grown blueberry (*Vaccinium corymbosum*), offer the potential for farmers to be profitable under the pressures of less-costly imported commodities and high costs of inputs. High-end markets, such as restaurants, resorts, and upscale farmer’s markets, provide a unique market opportunity for the agricultural sector in Hawai‘i to obtain a premium price for high-quality, fresh local produce from consumers willing to pay such a premium. Blueberries produced in Hawai‘i have been observed to command a retail price of up to $32/lb and have potential as a high-value crop for local markets in Hawai‘i (Hummer et al. 2007, Zee et al. 2006).

Low-chill or no-chill southern highbush blueberries can be grown in Hawai‘i (Hamasaki et al. 2015). Initial field evaluation of blueberry in Waimea on Hawai‘i Island indicated that several varieties, such as ‘Biloxi’, ‘Jewel’, ‘Sharpblue’, ‘Emerald’, ‘Misty’, and ‘Sapphire’, demonstrate evergreen growth and production under the local climatic conditions (Hummer et al. 2007). While varieties evaluated in the field in Waimea produced fruit, with several production periods throughout the year (Hummer et al. 2007), there were several limitations to field production of blueberry in Hawai‘i.

Bird damage in field-grown blueberry was extensive, and although it could be controlled by the use of bird netting, this was an expensive additional cost to a production system (Hummer et al. 2007). The rapid spread of rust caused by *Naohidemyces vacinii*, formerly *Pucciniastrum vaccinii* (Wint.) Joerst. (Keith et al. 2008, Nelson 2008, Retamales and Hancock 2012) also constituted a major constraint to field production of blueberry in Hawai'i. The evergreen nature of blueberry and Hawai'i's tropical environment provide ideal conditions for the year-round presence and rapid spread of blueberry rust fungal spores, which are easily dispersed by wind and air.

While field evaluation of blueberry in Hawai'i ended prematurely due to the arrival and spread of blueberry rust, there is still potential for Hawai'i-grown blueberry in the high-value local market (Hummer et al. 2007, Hamasaki et al. 2015). The difficulties of growing blueberry in the field suggest a need for the evaluation of protected blueberry production in Hawai'i (Hamasaki et al. 2015). In addition to protecting plants from rust, which is one of the primary challenges, greenhouse structures can also reduce crop loss from birds and mitigate unfavorable soil conditions, also a problem in field production of blueberry (Zee et al. 2006, Hamasaki et al. 2015).

However, greenhouse production will magnify the cost challenges faced by Hawai'i producers, so one consideration is using appropriate pot size to make the best use of limited greenhouse space. Therefore, the objective of this study was to evaluate different pot sizes for producing blueberries under greenhouse conditions in Hawai'i.

Materials and Methods

'Misty' was selected for use in this study based on the consistent year-round production and good berry quality found by Hummer et al. (2007), as well as availability of planting material. One-year liners of 'Misty' blueberry plants were purchased from Fall Creek Farm & Nursery (Lowell, Oregon) and transplanted into 1-gallon pots (February 2007) and grown out, then repotted into their treatment pots (August 2009) in the greenhouse at the Volcano Research Station (4000 ft elevation) in Volcano, Hawai'i. Data collection began in January 2011 when the plants were approximately 5 years old.

The experimental design was a randomized complete block, with four treatment pot sizes—3, 5, 7, and 10 gallons—and 7 replications. Each replicate was arranged on a 3 ft by 4 ft section of a raised bench (36 in), which aided harvesting. Potting media was 1:1 coarse peat + perlite mix. At the start of this experiment, pots had an average pH of 3.5, and all plants received the same amount of fertilizer and water throughout the trial. Each pot was irrigated with a spot spitter at the rate of 1 quart/minute for 2 minutes daily with rainwater collected from the roofs of greenhouses and held in a reservoir. Plants were fertilized every 100 days with 30 g of Nutricote Total 13-13-13 with minor nutrients (Florikan, Sarasota, FL) Type 100, and 29 g of prilled calcium sulfate (23.28% Ca, 18.62% sulfur) (Art Wilson Co., Carson City, NV).

Plants were pruned 1–3 times a year depending on fruiting cycle. Harvests were conducted every 4 to 5 weeks from 2011 to 2015, depending on fruit ripeness; however, in 2011, due to heavy pruning, only 9 harvests were conducted, whereas the remaining years had 12 harvests. Ripe blueberries were harvested by hand. Blueberries were harvested as individual plant units and weighed.

Results and Discussion

Over the five-year experimental period, the average yields per harvest were highest in the 10-gallon pot size at 161 g/harvest (Fig. 1). Average yields per harvest varied depending on year. The average yields per harvest were highest in 2012 (161 g), followed by 2011 (145 g) and 2014 (144 g) (Fig. 2).

Production dips occurred in 2013 and 2015 in yields per harvest (Fig. 2.), which might be attributable to growing conditions in the greenhouse. Low yields in 2013 were likely due to flower drop as a result of Botrytis blight. The presence of *Botrytis cinerea* (Pers.: Fr.) in this study was confirmed by Brian Bushe (University of Hawai'i at Manoa Agricultural Diagnostic Service Center, Hilo, Hawai'i) in March 2013. Botrytis blight begins with the blossoms browning and sometimes becoming moldy and can include infection of the fruits and canes. The spread of this disease is facilitated by cool and moist weather (Retamales and Hancock 2012), which is representative of the weather at the Volcano Research Station. Average annual rainfall at the Volcano Research Station is 120 inches with an average minimum temperature of 62°F and an average maximum temperature of 79°F. The onset of Botrytis blight in 2013 clearly affected the yields that year, with annual and yields per harvest dropping 41% and 37%, respectively, from 2012 (Fig. 2).

Despite the yield reduction observed in 2013, it seems that with the introduction of pruning and a management plan for Botrytis blight beginning in

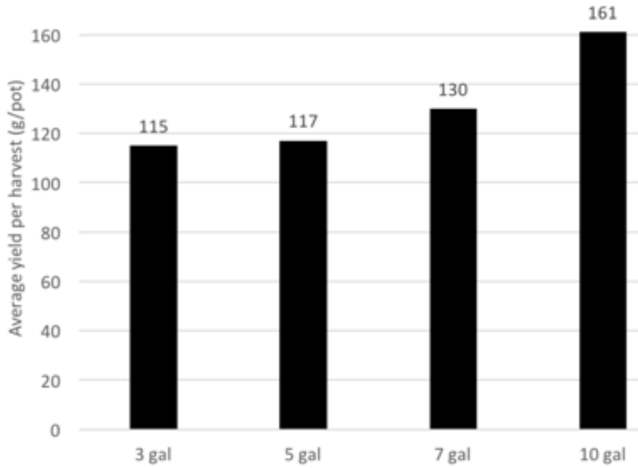

Figure 1. Average yield per harvest of ‘Misty’ blueberries grown in four different pot sizes under greenhouse production in Volcano, Hawai‘i, from 2011 to 2015.

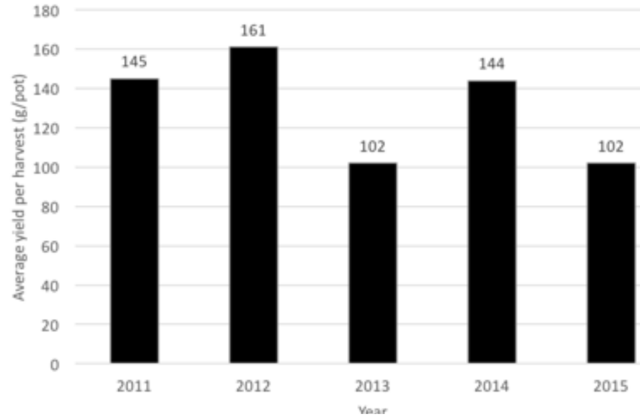

Figure 2. Average yield per harvest by year of ‘Misty’ blueberries grown under greenhouse production in Volcano, Hawai‘i.

November 2013, yields increased in 2014 (Fig. 2). An example of a management plan was the application of extract of *Reynoutria sachalinensis* (Regalia, Marrone Bio Innovations, Davis, CA) and *Bacillus subtilis* (Serenade ASO, Bayer CropScience Ltd, Milton Road, Cambridge) for prevention, combined with fenhexamid (Elevate, Arysta LifeScience, Cary, NC) and azoxystrobin (Abound, Syngenta Crop Protection LLC,Greensboro, NC) applied strategically as needed.

The low yields observed in 2015 are likely due to an irrigation failure that was discovered on July 8, 2015. The yields in 2015 clearly began to drop after this irrigation failure, emphasizing the importance of reliable irrigation systems and constant monitoring.

Average yields per harvest for all pot sizes (ranging from 115 to 161 g/pot) (Fig. 1) evaluated in this study regularly met or exceeded ‘Misty’ yields (113 g/pot) evaluated under similar greenhouse-grown conditions in North Carolina (Fernandez and Ballington 2002), suggesting that even under stressful growing conditions, ‘Misty’ grown in the greenhouse yields well in Volcano, Hawai‘i.

Summary

The results from this study suggest that ‘Misty’ can be grown under greenhouse conditions in Hawai‘i and that utilization of a 10-gallon pot will produce the highest blueberry yields under these conditions. The 10-gallon pot yielded an average of 161 g (0.35 lbs)/pot per harvest (Fig. 1). Based on this study, 10-gallon pots should be considered for greenhouse production of blueberry in Hawai‘i. However, it is important to consider yield on a per-area basis, in addition to all other inputs. The per-unit area yield is the most critical starting value for evaluating the economic potential of a high-value greenhouse-produced crop. Therefore, pot sizes should be evaluated under higher planting densities and various arrangements to fully evaluate yield potential on a per-area basis. This might include the evaluation of pot sizes larger than the 10-gallon pot sizes due to the significant increase in production observed with the largest pot size in this study. Elimination of the raised benches could also lead to more efficient arrangement of pots and increase efficiency of harvest. Similarly, the potential cost savings of using various pot sizes merits economic analysis at a commercial scale.

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Disclaimer

This study was conducted under a controlled greenhouse environment in Volcano, HI, and results from this study may vary under other environmental conditions.

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