Cultivar trial of olives (*Olea europa*) in Hawai`i

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ABSTRACT

Hawaii has the advantage of diverse ecological zones with 11 of the world's 13 climate zones. Many crop species can be grown in Hawaii, including olives (*Olea europa*) that are adapted to Mediterranean growing conditions with mild, rainy winters and long, warm, dry summers. Ten olive cultivars were selected for oil production; six cultivars were transplanted on 24 February 2011 and four cultivars were transplanted at 13 July 2011 at the Lalamilo Research Station in Kamuela, Hawaii (760 m elevation; latitude and longitude, 20.0188ºN, 155.6765ºW). The soil series was the Waimea series (medial, amorphic, isothermic, humic Haplustands). Trees were planted in a randomized complete block design with 1-tree plots replicated seven times at a spacing of 3 m in single row windbreaks. Maximum/ minimum air temperatures were recorded at the Lalamilo station, and the lowest minimum temperature recorded was 8.3ºC, which is above that reported to be required for breaking the dormancy of buds. Yet, during March 2013, trees of three cultivars (Arbequina, Arbosana, and Koroneiki) were observed to flower. On 16 October 2013, five trees each of 'Arbequina' and 'Arbosana' were harvested, and six trees of 'Koroneiki' were harvested in a one-time harvest. Average yields per tree were 1.89, 4.89, and 2.04 kg (fresh weight) and total yields were 8.8, 14.2, and 11.0 kg fresh weight, respectively for 'Arbequina', 'Arbosana', and 'Koroneiki'. The average color of fruit was 3.5, 2.1, and 3.3, respectively. Oil was milled from these fruit (in two presses), resulting in 2.0, 3.0, and 2.6 kg of oil (assuming a specific gravity of 0.91) or a yield of 22, 21, and 24%, respectively. Oil was sent to the University of California Davis Analytical Lab and olive oil quality was determined to be extra virgin. Apparently, the agro-environment of Kamuela, Hawaii is suitable for the flowering and fruit set of these three olive cultivars. Further research is needed to determine whether olive oil production is economically profitable in Hawaii.

METHODS

Ten cultivars of olives (Table 1) were selected and planted (Fig. 1) at the Lalamilo Research Station in Kamuela Hawaii (760 m elevation; latitude and longitude, 20.0188ºN, 155.6765ºW).

Table 1. Ten cultivars of olives were selected and obtained from nurseries in Hawaii and California and planting at two dates in 2011.

Cultivar	Country of Origin	Nursery	Planting Date
Arbequina	Spain	McKanna	2/24/2011
Arbosana	Spain	Duarte	2/24/2011
Frantoio	Italy	Duarte	2/24/2011
Koroneiki	Greece	Duarte	2/24/2011
Leccino	Italy	Duarte	2/24/2011
Mission	California	Duarte	2/24/2011
Coratina	Italy	McEvoy	7/13/2011
Moraiolo	Italy	McEvoy	7/13/2011
Pendolino	Italy	McEvoy	7/13/2011
Taggiasca	Italy	McEvoy	7/13/2011

Figure 1. 'Koroneiki' at planting at Lalamilo Experiment Station, Waimea, Hawai`i.

REFERENCES

Orlandi, F., H. Garcia-Mozo, L. Vazquez Ezquerra, B. Romano, E. Dominguez, C. Galan, and M. Fornaciari. 2004. Phenological olive chilling requirements in Umbria (Italy) and Andalusia (Spain). Plant Biosystems. 138:111-116.

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RESULTS

Young olive plants were damaged probably due to Fuller Rose beetle (*Naupactus cervinus* Boheman; Coleptera) (Fig. 2A). Shade cloth cages were made to protect olive plants from beetle damage and wind.

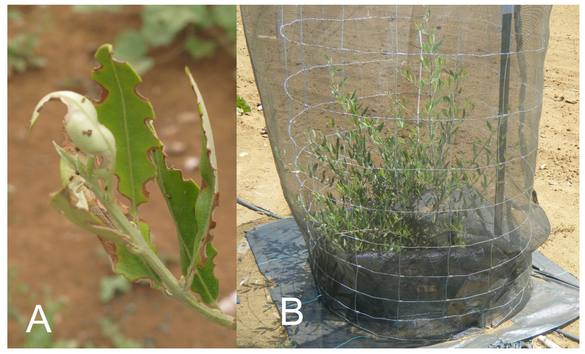

Figure 2A . Damage to young, olive plants probably due to Fuller Rose beetle. 2B. Shade cloth cages.

Trees grew well in the agro-environment of Kamuela, Hawaii (Fig. 3). Heights after 22 or 17 months of growth are shown in Table 2.

Fig. 3. Olive trees at Lalamilo station on 27 November 2012.

Table 2. Heights and basal diameters of olive trees measured on 27 November 2012.

Cultivar	Months after planting	Height, m	Basal Diameter, cm
Arbequina	21	1.99	4.03
Arbosana	21	2.02	4.43
Frantoio	21	2.37	6.36
Koroneiki	21	2.75	5.84
Leccino	21	2.91	6.80
Mission	21	2.05	3.86
Coratina	16	1.30	2.06
Moraiolo	16	1.77	3.06
Pendolino	16	1.48	3.81
Taggiasca	16	1.20	2.64

Cultivars Arbequina, Arbosana, and Koroneiki flowered in March 2013 and produced harvestable yields in October 2013, or 25 and 32 months after planting.

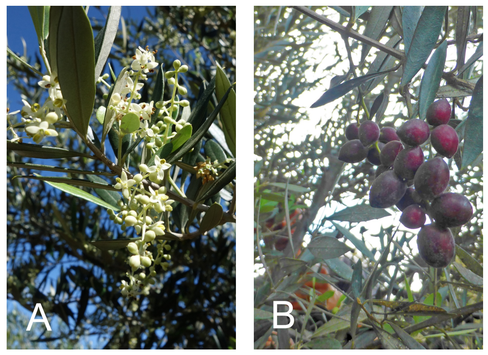

Figure 4A. Flowers were found in cultivars Arbequina, Arbosana' and Koroneiki'in March 2013. 4B. Fruit were ready to be picked in October 2013.

Chilling hours to break dormancy have been calculated as number of days from when mean daily temperature dropped below 7.2ºC until the first reproductive budburst (Orlandi et al., 2004). During December 2012 to January 2013 (Fig. 5), the lowest minimum temperature recorded was 8.3ºC.

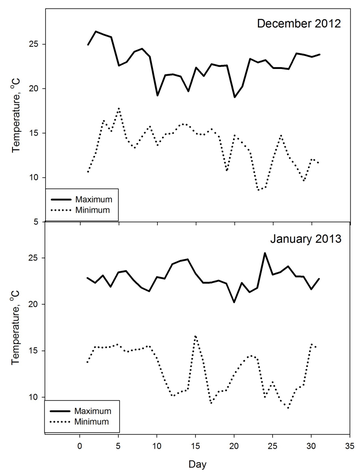

Figure 5. Maximum/ minimum air temperatures during December 2012 and January 2013.

Mr. Doug McKanna hand-harvesting olives using a similar method to harvesting coffee cherries, although all olive fruits were harvested at one time.

Average color of olive fruits from 'Arbequina' , 'Arbosana', and 'Koroneiki' (Fig. 6) were 3.5, 2.1, and 3.3, respectively. Average fruit color of 'Arbosana' was reduced by one tree that had green fruit. According to Sibbett and Ferguson (2004), an average of 2.5 to 4.5 is the usual range of olive fruit maturity for olive oil production.

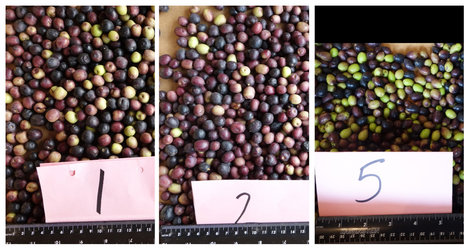

Figure 6. Olive fruits from 'Arbequina' (#1), 'Arbosana' (#2), and 'Koroneiki' (#5)

Fresh weight yields are shown in Table 3. Analysis of olive oil is shown in Table 4. Yield of oil was estimated at 22, 21, and 24% for the above cultivars, respectively, assuming a specific gravity of 0.91. Based on analysis, it appears that all three cultivars produced oil that met all analytical criteria for acceptable "extra-virgin" olive oil.

Table 3. Harvest data from first harvest in October 2013.

Cultivar	Total Fresh Wt., kg/ tree	Summed Good[1] Fresh Wt., kg	Olive oil, 1st press, mL	Olive oil, 2nd press, mL
Arbequina	1.89	8.81	350[2]	1800
Arbosana	4.89	14.2	905	2400
Koroneiki	2.04	11.0	1835	1010

[1]Off-grade fruit were removed from fruit to be milled. A sample was sent for diagnosis of disease, but no disease was found. Off-grades were due primarily to dessication caused by inadequate irrigation and to bruising.
[2]The low yield of olive oil for the 1st press of 'Arbequina' was due to an error during processing.

Table 4. Analysis of olive oil quality from three cultivars for free fatty acids (FFA), peroxide value (PV), UV absorption for conjugated double bonds UV-K232, UV-K268, UV-delta K, 1,2-diacylglycerol (DAG), and pyropheophytins (PPP). Analysis conducted at the Olive Center at the University of California, Davis.

Test	Arbequina	Arbosana	Koroneiki
FFA	0.24	0.18	0.22
PV	8.2	3.7	10.5
UV-K232	1.73	1.71	1.47
UV-K268	0.08	0.09	0.14
UV-delta K	0.001	0.001	0.002
DAG	96.6	98.3	94.9
PPP	0.0	0.0	0.56

CONCLUSIONS

Olive cultivars Arbequina, Arbosana, and Koroneiki appear to grow well in the agro-environment of Lalamilo station in Waimea, Hawai`i. After only 2.5 years of growth, they flowered, fruited, and produced a harvestable yield and high-quality "extra-virgin" olive oil. We are in the process of working with cooperators to determine other agro-environments suitable for olive production in Hawai`i Island, and to determine the minimum chilling hours required to break bud dormancy.

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