Quick Tree Decline: A New Problem of Macadamia in Hawaii

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Mauna Loa Macadamia Nut Coloration, H. C. 01 Box 3, Hilo, HI 96720

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Abstract. A new problem of macadamia trees (*Macadamia integrifolia* Maiden and Betche) in Hawaii is characterized by slight leaf chlorosis, followed by rapid leaf browning, and tree death. Ambrosia beetle [*Xyleborus affinis* Eichhoff and *X. perforans* Wollaston (Coleoptera: Scolytidae)] infestations and fungal fruiting bodies were present on trees that subsequently exhibited the decline pattern. 'Ikaika' was the most susceptible cultivar, and tree death occurred 8.3 ± 2.6 SD months after beetle infestations were detected.

Macadamia nut production in Hawaii is a \$45.5 million industry and ranks only behind sugarcane and pineapple in value (Rowley, 1988). Although disease and arthropod pests are associated with macadamia culture in Hawaii, the industry has not encountered problems that pose a serious economic threat (Mau and Tsuda, 1982; Nishijima, 1983). However in 1986, many dead and rapidly declining 14- to 36-year-old macadamia trees were observed in an orchard in Keaau, Ha-

waii, and this may represent an emerging threat to the industry. Subsequently, similar observations have been reported from other orchards located on the east side of Hawaii Island (Hirae, 1989). This report describes this new problem of *M. integrifolia* in Hawaii. We report the rate of tree decline, cultivars affected, and the association of ambrosia beetle infestations with declining trees.

Tree foliage of declining trees initially becomes slightly chlorotic, followed by rapid leaf browning and tree death. Although some defoliation precedes tree death, trees typically retain most of their dead leaves. This decline pattern, which has been designated as "macadamia quick decline" (Hirae, 1989),

is new to macadamia in Hawaii and has not been reported in other countries or regions growing macadamia.

Ambrosia beetles appear to be associated with the declining and dead trees. These beetles typically bore into the trunks at 0.5 to 1.5 m above ground, resulting in entry holes evidenced by cylindrical dust posts (≤ 1 mm in diameter) or mounds of wood dust (2 to 5 mm in diameter). Before this decline problem, ambrosia beetle trunk infestations were not normally seen on healthy macadamia trees. Other wood-boring insects have also been recovered; however, their presence is not as consistent, nor are they as abundant as *X. affinis* or *X. perforans*. Cross sections of trunks of declining trees revealed the presence of dead phloem and discolored xylem tissue in the area of ambrosia beetle infestations.

Intensive field surveys were conducted monthly from Nov. 1988 to Jan. 1990 in four discontinuous, 0.6-ha blocks in a 4.8-ha section of a 17-year-old orchard of compound trees in Keaau, Hawaii. Blocks contained the cultivars Ikaika, Kau, Kakea, and Keaau. All trees in the surveys were visually rated from 1 (dead) to 5 (vigorous-healthy) on the basis of chlorosis and defoliation. Trees were inspected for beetle infestations by examining trunks for dust posts or mounds, and beetle entry holes. In addition, the trunks were examined for the presence of fungal fruiting bodies.

During the 15-month study, 41% of the 'Ikaika' trees in the surveyed plots became infested with ambrosia beetles, and 95% of the 138 infested trees were 'Ikaika' (Table 1). All trees, except one, were rated as healthy when infestations were detected. New infestations fluctuated throughout the study and resulted in an average increase of $9.0 \pm$

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Table 1. Ambrosia beetle infestation of macadamia trees of various cultivars.^{xy}

Cultivar	Surveyed		Infested		Dead
	Total trees	Percent $\pm$ SD	Total trees	Percent $\pm$ SD	Total trees
Ikaika	319	74.9 ± 2.8	131	41.0 ± 4.6	31
Kau	25	5.9 ± 1.1	2	8.3 ± 9.6	0
Kakea	63	14.8 ± 4.3	1	1.3 ± 2.6	0
Keaau	19	4.5 ± 5.0	4	16.7 ± 14.4	0

^xTotal trees are from four, discontinuous 0.6-ha blocks within the same orchard.

^yPercentages are means of four, discontinuous 0.6-ha blocks within the same orchard.

Fig. 1. Frequency of new infestations of ambrosia beetles on macadamia trees in a mixed cultivar orchard. Infestations are total trees in four 0.6-ha blocks of a single orchard.

6.0SD new trees infested per month (Fig. 1). Peak periods of new infestations were not correlated with rainfall, temperature, or other possible stress factors, such as other pests, herbicides, and fertilization. Fruiting bodies of *Nectria rugulosa* Pat. and *Shizopora paradoxa* (Schröd. :Fr.) Donk or *Kretzschmania clavus* (Fr.) Sacc. were evident on 75% and 7% of the newly infested trees, respectively. All 31 trees that died during the study were 'Ikaika'. All trees were infested with ambrosia beetles before death and had *N. rugulosa* fruiting bodies in the area of beetle infestations. Tree death occurred 8.3 ± 2.6 SD months after initial beetle infestation was observed. Trees that were not infested with

beetles or did not have *N. rugulosa* fruiting bodies did not exhibit the quick decline pattern.

These observations suggest that 'Ikaika' macadamia trees are more susceptible to quick decline than other cultivars. Also, the occurrence of ambrosia beetle infestations on the trunks of healthy-appearing macadamia trees provides a means for detecting trees that may be susceptible to quick decline. Since ambrosia beetles usually attack unhealthy or recently fallen trees (Beaver, 1976; Kovach and Gorsuch, 1985; Norris, 1979), their presence in the trees does not necessarily implicate them as the primary cause of the decline, but suggests that the trees were

predisposed to infestation. An association of ambrosia beetles with trees weakened by pathogens or nutritional stress has been reported in peach (Kovach and Gorsuch, 1985) and coconut (Ferreira and Morin, 1985). Other possible predisposing factors, such as a particular susceptible rootstock or graft incompatibility, does not seem likely because infested trees from other orchards had several rootstock and were of different ages. Nematode levels were also low and no parasitic species were recovered.

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