COOPERATIVE EXTENSION
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Three promising sweet potato varieties for Kauaʻi from a 2019 trial

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Introduction

Sweet potato is a popular local food and multimillion-dollar export crop for Hawaiʻi. Because of its export market, the acreage under sweet potato dramatically increased in the last two decades (NASS, 2020). However, sweet potato production has been recently challenged by multiple pests, namely sweet potato weevils and a nematode pest. Among the sweet potato weevils, the common sweet potato weevil (*Cyclas formicarius*) is the most serious one, causing crop losses of up to 97%. The adults crawl on the soil surface, and the females lay eggs in roots and exposed developing tubers. Eggs are deposited in the small cavities created by females on the roots and tubers. The infested tuber with weevils is normally identified by the presence of tiny holes made by the females for oviposition (Figure 1A and 1D). Such tubers contain mines and galleries with or without larvae and have a dark spongy appearance, often producing a fermenting smell when cut open (Capinera and Castner, 2018). Sweet potatoes infested with common weevils develop a bitter off-taste making them unsaleable; the pest is also a quarantine pest on the US mainland, requiring irradiation for export from Hawaiʻi. On the other hand, the juveniles of reniform nematodes (*Rotylenchus reniformis*) enter the developing tubers and their feeding on the tissue causes cracks and deformed tubers (often called slipper-shaped tubers) (Figure 1B and 1D). Because of the long growing season, even a low nematode population at planting can still develop into a large population and become a serious problem at the time of harvest. The life cycle of both these pests is underground (except the adult stage of beetles), and the damage is not apparent until the tuber is harvested or the tubers are sampled periodically for harvesting. So, it is difficult to decide when and to what extent one should implement available management methods.

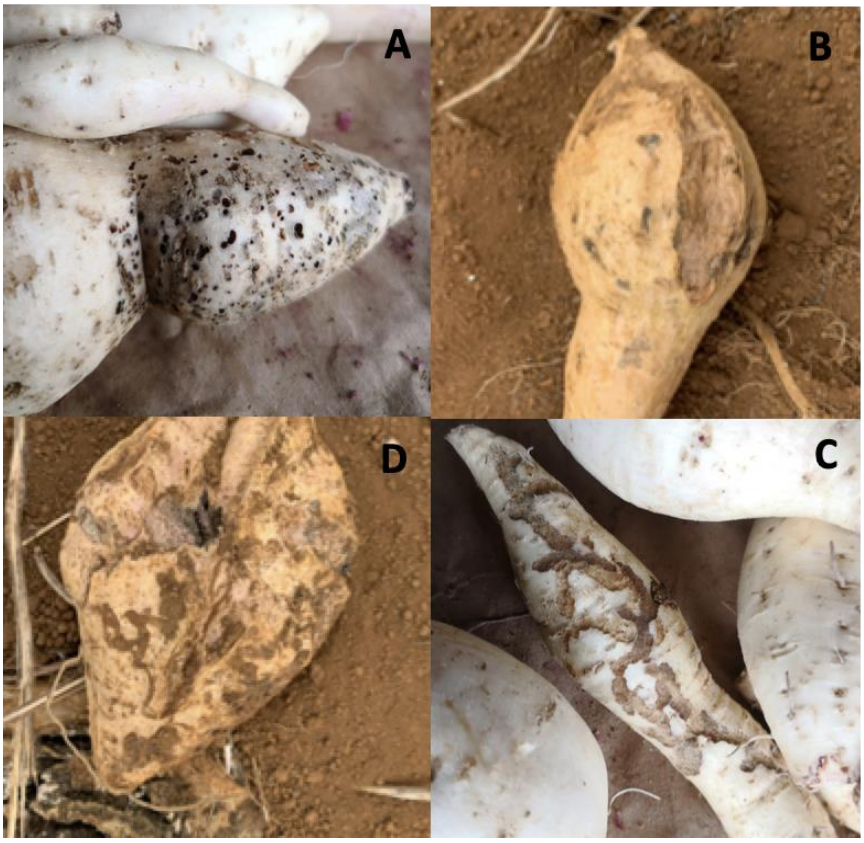

Figure 1: (A) A sweet potato tuber with numerous holes made by sweet potato weevils; (B) a typical infestation caused by reniform nematodes; (C) a tuber with damage most probably caused by rough sweet potato weevil feeding; (D) a tuber with the combined infestation of weevils and reniform nematodes

In these scenarios, a variety which is resistant/tolerant to one or both of these pests may support sustainable pest management. A wide range of sweet potato varieties are available in Hawai‘i and the purple fleshed ‘Okinawan’ is one widely grown variety in Hawai‘i. A preliminary study conducted on the Big Island showed that some varieties may be tolerant to reniform nematodes and sweet potato weevils (Miyasaka and Arakaki, 2010). Thus, this study intends to identify sweetpotato varieties that are resistant/tolerant to reniform nematodes and weevils while also producing an acceptable tuber yield in the Kaua‘i agroecosystem.

Methods

A total of six USDA sweet potato varieties (‘Jonathan’, ‘NZ 196’, ‘Ruddy’, ‘Regal’, ‘Sumor’, ‘W390’) along with the locally popular purple-fleshed ‘Okinawan’ were screened for sweet

potato weevils and reniform nematode resistance/ tolerance at the Kauaʻi Agricultural Research and Extension Station in Wailua on the windward side of the island, approximately 500 ft above sea level (Figure 2). These varieties were selected and sourced from previous trials from the sweet potato program on Hawaiʻi Island, whose original plants came from the USDA Plant Genetic Resources Conservation Unit in Griffin, Georgia. This trial consisted of 30 ft rows of each variety, in a randomized complete-block design with 3 replications. Due to planting challenges, ʻOkinawanʼ was not replicated. Cuttings 8-12 in long were planted in rows with 1 ft between plants and 5 ft between rows. The plants were fertilized three times after planting: at 3 weeks (NPK 7:30:20), at 10 weeks (NPK 16:16:16), and a final foliar application at 3 months (NPK 0:28:25). An insecticide pyrethrin (Pyganic, Crop Protection EC 1.4) was applied once to control a flea beetle infestation approximately 4 months after planting. This trial was planted in May 2019 and harvested 7 months after planting.

Figure 2: Sweet potato trial in the field approximately 4 months after planting, Kauaʻi Agricultural Research and Extension Station

The harvested tubers were cured for a week in harvest bins at ambient temperatures, then washed and subsequently graded according to the Hawaiʻi Department of Agriculture's (HDOA) Standards for Hawaiʻi-Grown Sweet Potatoes (Standards document; HDOA, 1986). The percentage of commercial yield (Grades AA and A) was calculated from the total yield. Then the tubers were evaluated for damage caused by sweet potato weevils or reniform nematodes, and the percentages of either weevil or nematode or both were calculated (Table 1). Although we

were not able to visually confirm the presence of rough sweet potato weevil (*Blosyrus asellus*), we have observed damage that is similar to the rough sweet potato weevil feeding (Figure 1C). The grubs of this insect also live under the soil and gouge grooves or channels along the surface of the tubers (Heu et al., 2011); these marks do not affect taste quality like the common weevil, but they are aesthetically unpleasing and may affect sale ability. Because only a small proportion of harvested tubers had such damage, we included these numbers in the overall weevil damaged tubers.

Table 1: Commercial-grade yield and observed pest damage of sweet potato tubers from different varieties at Kauaʻi Agriculture Research and Extension Station, 2019; sorted descending by commercial-grade yield; bolding indicates the most desirable outcome for each column

Variety	Total Yield (lb/ac)	Commercial-Grade Yield (lb/ac), % of total in Parentheses	Nematode Damaged Tubers (%)	Weevil Damaged Tubers (%)	Tubers with Both Nematode and Weevil Damage (%)
Ruddy	13878	**6734 (48.5)**	11.7	16.8	1.9
W-390	**16524**	6120 (37.0)	23.8	7.1	1.5
Regal	14406	3961 (27.2)	13.1	**4.3**	3.3
Sumor	12457	3507 (28.2)	17.2	20.6	2.9
Jonathan	8419	3200 (38.0)	25.2	14.7	**0.0**
NZ 196	3861	1312 (34.0)	44.4	37.4	2.3
Okinawan	5634	1203 (21.3)	**0.0**	9.1	**0.0**

Results and Discussion

Results showed the variety ‘Ruddy’ had the highest commercial yield, with the second lowest percentage of nematode damaged tubers. The second highest yielding variety was ‘W-390’, however the percent of nematode damage was substantially higher than other varieties. The third best variety was ‘Regal’ in terms of commercial yield, with the lowest percentage of weevil

damage and the third lowest percentage of nematode-damaged tubers. ‘Okinawan’ was the only variety which was not replicated, and thus results may have been biased; however, ‘Okinawan’ had both the lowest yield but also the lowest nematode damage. Notably, the percent marketable tubers of the total yield was also lowest in ‘Okinawan’. The main aim of this study was to determine sweet potato varieties that are tolerant to weevils and nematode pests, beyond ‘Okinawan’ to provide more diverse recommendations for growers. Nematode pressure was exceptionally high in these fields, providing strong selective pressure data for this trial. Based on these results, the varieties ‘Ruddy’, ‘W-390’ and ‘Regal’ can be recommended for further trialing in Kaua‘i’s agroecosystems and other locations across the state. Serendipitously, all three of these cultivars are also orange-fleshed and therefore satisfy the requirements of the National School Lunch Program as “red/orange vegetables.” This presents a substantial market opportunity for growers to provide for the ‘Aina Pono Hawai‘i State Farm to School program. Further trials were conducted in 2020 and 2021, and results will be forthcoming.

Figure 3. Top-performing sweet potatoes in this trial:
(A) ‘Ruddy’ - Released by the USDA in 2002. Orange-fleshed, red-skinned; bred for resistance to soil insects and diseases; also offered as an alternative to ‘Regal‘, especially for organic farmers. (Bohac et al., 2002);
(B) ‘W-390’ - Developed by the USDA in 1993 as a breeding line; orange-fleshed, red-skinned; bred for strong resistance to soil insects (Jackson and Bohac, 2006);
(C) ‘Regal’ - Released by the USDA in 1985; orange-fleshed, red-skinned; bred to exceed resistance available at the time to soil diseases and insects (Jones et al., 1985); highest commercial-grade yields in several variety trials on Hawai‘i Island;

All photos are of field-harvested roots and courtesy of Michael Jackson at the USDA Plant Genetic Resources Conservation Unit in Griffin, Georgia

Acknowledgements

This project was funded by CTAHR Extension with funds allocated from the 2018 State Legislature for variety trials. We thank all volunteers and crew members at the Kaua‘i Agriculture Research and Extension Station (KARES) for trial planting, maintenance of the plots, and harvesting and grading of tubers. Also, many thanks to Dr. Susan Miyasaka’s sweet potato program on Hawai‘i Island, who provided the original planting material.

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