COOPERATIVE EXTENSION
UNIVERSITY OF HAWAIʻI AT MĀNOA
COLLEGE OF TROPICAL AGRICULTURE AND HUMAN RESOURCES

# Farmer Driven Sweetpotato Weevil IPM using UNI-Traps

Roshan Manandhar[1*], Taiwan Gu[2] and Koon-Hui Wang[1]

[1]College of Tropical Agriculture and Human Resources, University of Hawaii at Manoa, [2]Hawaii Xing Long Farm, Kauai

[*]Corresponding Author: roshanm@hawaii.edu

## Introduction

Sweetpotato is a culturally significant staple crop and one of the top vegetable crops produced in Hawaii (NASS 2022). However, sweetpotato production is challenged by multiple pests and pathogens, and resulted in a continuous decline in production areas since 2012, with additional 54% reduction in acreages from 2019 to 2021 (NASS 2022). None-the-less, sweetpotato still have an increase of 21% of farm gate values from 2019 to 2021 with a farm gate value of $2.8 mil in 2021 (NASS 2022). Among the pests, sweetpotato weevil (*Cylas formicarius*), rough sweetpotato weevil (*Blosyrus asellus*), root-knot (*Meloidogyne* spp.) and reniform nematodes (*Rotylenchulus reniformis*) can cause more than 80% sweetpotato yield loss in Hawaii (Hue and Low, 2020).

On the island of Kauai, while nematode pests were problematic on sweetpotato for a long time, the population of sweetpotato weevils (SPW) have been found increasing in present over time. This is a serious pest that can cause up to 97% yield loss if left unattended. The adult weevils crawl on the soil surface and the females lay eggs in sweetpotato roots or the swollen roots exposed on soil surface. The weevil infested roots can be recognized by the presence of tiny holes made by the females for oviposition (Fig. 1a). Weevil infested roots are consisting of mines and galleries (Fig. 1b) with or without larvae and dark spongy appearance often producing fermenting smell, when cut open (Capinera and Castner, 2018).

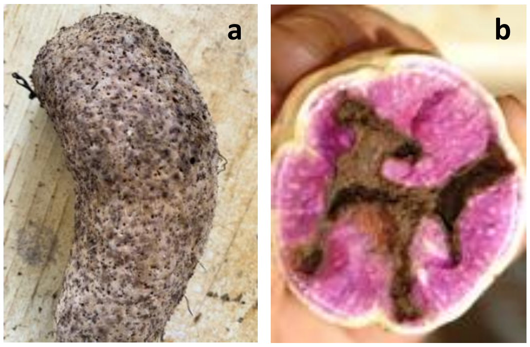

**Fig. 1.** Sweetpotato weevil a) oviposition holes and b) galleries inside a root of sweetpotato.

Application of insecticides either at pre- or post-plant have been commonly used to manage SPW (Pulakkatu-Thodi et al., 2016). Post-plant insecticide foliar sprays are meant to target on the adults, especially if the adjacent fields are infested by SPW. Systemic insecticides are available to control SPW larvae inside the vines and roots close to the soil surface (Capinera and Castner, 2018). The damage from SPW is not apparent until the swollen roots are harvested or examined. Therefore, it is difficult to determine when to spray insecticide when dealing with cryptic insect pests like SPW, as scouting of pest pressure would be difficult.

Sex pheromones could offer a more versatile integrated pest management strategy (Yasuda, 1995). Sweetpotato weevils respond greatly to the low dosage of male pheromones and have been effectively used for mass trapping (Reddy et al., 2014). The use of sex pheromone (Z3-dodecen-1-ol (E)-2-butenoate) traps at 100 µg in sweetpotato fields not only reduced the density of the weevils but also reduce the damage they caused in Hawaii (McQuate and Sylva, 2014). Commercial SPW pheromone traps, UNI-traps (Alpha Scents Inc., West Linn, OR) (Fig. 2a and 2b) had been determined to have an effective trapping range of 60 m (about 200 ft) radius in a sweetpotato field (Reddy et al. 2014). An added benefit of this pheromone trap is that farmers can visually count the number of weevils (Fig. 2b and 2c) as a scouting indicator to decide when to spray.

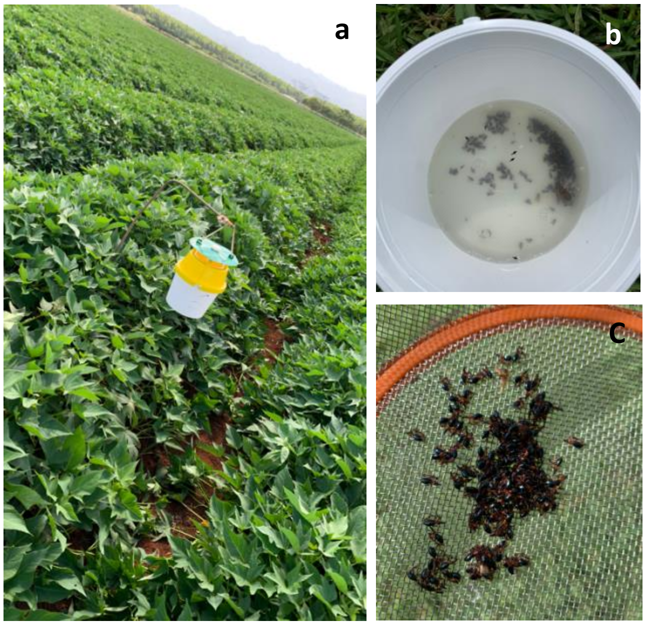

**Fig. 2.** a) UNI-trap to lure male sweetpotato weevils, b) weevils in the trap, c) counting weevils by pouring trapped weevils on a wire mesh screen.

This project aims to integrate the use of pheromone traps with insecticide spray to develop a more effective SPW management strategy for sweetpotato farmers to use.

## Materials and Methods

*Pheromone traps:* A farmer's driven study was conducted at Hawaii Xing Long Farm at Kapaia, Kauai. The farmer planted approximately 10 acres of 'Purple Okinawan' sweetpotato almost every month. Three fields 1, 2 and 3 were planted on Nov 15, Dec 5, 2021 and Feb 25, 2022, respectively (Table 1) and were monitored for SPW pressure using UNI-traps (Alpha Scents Inc.) baited with 100 µg of Z3-dodecen-1-ol (E)-2-butenoate pheromone per trap.  Each UNI-trap had a lure septum in a basket loaded in the top center opening of a white/yellow/green plastic container (Fig. 2a). The container was partially filled with soapy water to suffocate trapped SPW (Fig. 2b). The traps were deployed in each field approximately 3-4 months after sweetpotato planting when the roots were beginning to swell as shown in Table 1. The first trap was placed at 200 ft in from the borders of the field, then subsequent traps were placed 400 ft apart, arranging in 2 rows of 4 traps in each field. The traps were hanged in a metal post above the sweetpotato foliage. The trapped adult weevils were monitored weekly by pouring out the soapy water on a kitchen sieve (Fig. 2c).

**Table 1**. UNI-trap placement, planting and harvesting date in Fields 1, 2 and 3.

| Field | Acre | Planting date | No. traps | Traps installed | Harvesting date |
|---|---|---|---|---|---|
| **1** | 7 | Nov 15, 2021 | 8+4[*] | Feb 28 – April 18, 2022 | Jun 7, 2022 |
| **2** | 10 | Dec 5, 2021 | 8+4[!] | April 19 – May 26, 2022 | Jul 5, 2022 |
| **3** | 13 | Feb 25, 2022 | 8 | May 27 – July 12, 2022 | Aug 30, 2022 |

4[*] and 4[!] indicated number of additional traps after April 18 and May 26, 2022 in the Field 1 and 2, respectively.

*Insecticide rotation:* To avoid insecticide resistance selection pressure, the farmer rotated 3 insecticides with different mechanism of action classes (Table 2): Mustang Maxx (FMC, Philadelphia, PA), Warrior II (Syngenta, Greensboro, NC) and Sevin XLR plus (Tessenderlo Kerley, Phoenix, AZ) all three insecticides are systemic (chemicals are absorbed by the plants), Mustang and Warrior are Restricted Use Pesticides whereas Sevin is not. The higher recommended dosages in the labels are used to ensure success rate (Table 2). All insecticides were applied at 50 gal/acre of spray coverage.

**Table 2.** Insecticides used against sweetpotato weevils in Field 1, 2 and 3.

| Trade name | Active Ingredient | Class | Dosage per Acre |
|---|---|---|---|
| Warrior II | Lambda-cyhalothrin | 3A | 1.92 fl oz |
| Sevin XLR plus | Carbaryl | 1A | 16 fl oz |
| Mustang Maxx | Zeta cypermethrin | 3 | 4.0 fl oz. |

*Integrating Pheromone traps with Insecticide rotation program for IPM:* In the past, these insecticides were used either alone or in rotation periodically at intervals of 2-3 weeks once the sweetpotato reached root swollening stage (approximately 3 months after planting). By integrating with UNI-Traps, it is feasible for the farmer to monitor SPW counts in each UNI-Trap weekly and to determine if insecticide spray is not necessary. The adult weevils were monitored by deploying 8 traps for a variable time periods - 49, 37 and 46 days in Fields 1, 2 and 3 respectively (Fig.3). The traps were transported after monitoring each field, when four additional traps were overlapped between Fields 1 and 2, and Fields 2 and 3 (Table 1). The mean number of SPW trapped was calculated from all traps used at a time irrespective of the Fields where they were deployed (Fig. 3).

Initially, the farmer practice preventative spray at 2-week intervals in Field 1 and 2. Over time, the farmer slowly gained experience by observing damage pressure on some roots, he then arbitrarily selected 50 SPW/trap/week as the threshold level to spray insecticide, i.e., if SPW count was < 50/trap, he would stop spraying. An inventory of his spray applications was recorded in Table 2. Thus, due to low count of SPW up to March 28, 2022, he stopped spraying in Field 1. Similarly, due to low count of SPW after April 28, he stopped spraying in Field 2. However, in Field 3, despite of greater trap catches, he failed to spray insecticides as regularly as before, this field served as a poorly managed IPM site as a comparison.

**Table 2.** An insecticide spraying record on sweetpotato foliage in Field 1, 2, and 3 in 2022.

| Field | Jan6 | Jan20 | Feb 7 | Feb 19 | Mar 2 | Mar 28 | Apr 14 | Apr 28 | May 29 | Jun 19 |
|---|---|---|---|---|---|---|---|---|---|---|
| **1** | Warrior | Warrior | Warrior | Sevin | Mustang | Warrior | | | | |
| **2** | | | Warrior | Sevin | Mustang | Warrior | Mustang | Sevin | | |
| **3** | | | | | Mustang | Warrior | Mustang | Sevin | Warrior | Sevin |

*Impact of IPM on yield:* To determine the yield impact of this IPM practice, sweetpotato roots were harvested from each field at around 6 months after planting (Table 1). Marketable swollen roots from each field were harvested, cleaned, cured, and weighted. Total marketable yield from each field was converted to lbs/acre. The rejected sweetpotato roots due to weevil or nematode damage and off shaped roots were lumped together and weight were estimated. This was later calculated as percent yield loss from each field.

## Results and Discussion

Results from this farmer-driven field research showed that integrating SPW pheromone trap with insecticide spray could be a promising strategy to manage SPW while reducing insecticide sprays. UNI-trap can help farmers to monitor as well as trap and reducing the population densities of SPW. Trap catches of SPW in Field 1 were low mostly remained < 10 SPW/trap, only had two sampling dates with 50 < SPW/trap <100 (Fig. 3) before the crop was harvested on Jun 7, 2022. For this reason, the insecticide application in Field 1 was paused after March 28 (Table 3). This had resulted in highest marketable yield in Field 1 (Fig. 4), approximately 4 folds higher than the poorest managed field (Field 3). This is particular due to high weevil densities that could not be controlled with the fewer sprays at the pea k; and drought during the summer might have affected the yield in the Field 3.

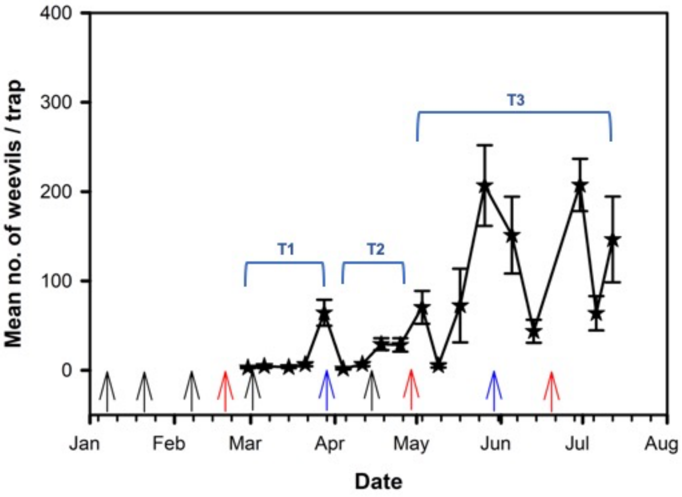

**Fig. 3.** Mean number of sweetpotato weevils per trap in the field plots from February to August 2022 at Hawaii Xing Long Farm, Kauai. ↑ indicated the date of insecticide spray (black = Warrior, Red = Sevin, and Blue = Mustang). T1, T2, and T3 indicated traps deployed in Field 1 only, Field 2 and 1, and Field 3 and 2, respectively.

The farmer started to learn that preventative spray at 2-week interval was not necessary and started to adopt no spraying unless SPW/trap > 50 on March 28. In Field 2, two SPW peaks were observed on May 3 and May 26 (Fig. 3). Insecticide application soon after those two peaks effectively reduced trap catches thereafter and resulted in intermediate sweetpotato yield in Field 2 but still produced 2.5-fold higher yield than Field 3 (Fig. 4).

In Field 3, all sampling occasion had > 50 SPW/trap and at least 3 of these sampling dates had SPW/trap > 150 approaching 200. At this high level, Sevin applied on June 19 failed to suppress SPW count on June 30. It was unclear why the trap catch was low on July 6 in the Field 3. Only 8 traps were deployed in the Field 3, while there were up to (8+4) traps in the Field 1 and 2 overlapped between fields for extended period of time. Besides less of SPW monitoring effort in Field 3, higher count of SPW/trap in this field could also be due to the migration of weevils from the culls of adjacent two fields (Field 1 and 2).

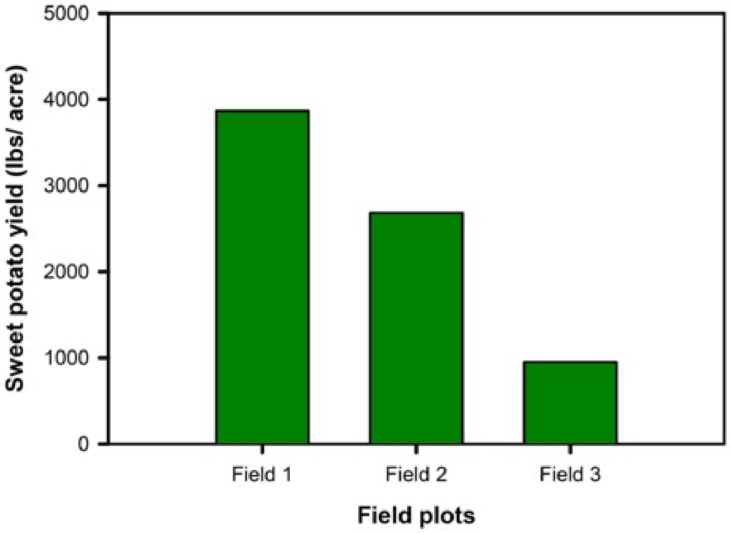

**Fig. 4.** Marketable sweetpotato yield (lbs/acre) in Fields 1, 2 and 3.

**Fig. 5.** a) Marketable sweetpotatoes harvested, and b) rejected sweetpotatoes in the field.

Sweetpotato marketable yield was the greatest in Field 1 (3872 lbs/acre) followed by Field 2 (2690 lbs/acre), and Field 3 (962 lbs/acre) (Fig. 4) with the estimated rejection of 10%, 10% and 30%, respectively (Fig. 5). Lower rejection in Fields 1 and 2 could be attributed to 1) proper and timely management of SPW to < 50 SPW/trap, and 2) longer duration of UNI-traps deployment. In Field 3, insecticide application was not executed soon after SPW/trap > 50, hence resulted in higher rejected roots, lowest marketable yield than Field 1 and 2.

None-the-less, the pheromone traps are very effective in trapping adult weevils in Fields 2 and 3. Our results also showed that insecticides tested here are very effective in controlling weevil population when applied soon after SPW/trap > 50 in Fields 1 and 2. This study suggested that the pheromone trap is also a good monitoring tool for SPW pressure in the field and could help farmers to make decision on when to spray insecticides. The arbitrary determination on SPW/trap > 50/week as the threshold level could further be refined, but this is a good start to develop an IPM program for SPW management in Hawaii. This management decision could reduce insecticide use, labor cost of pesticide spray. Thus, integrating pheromone trap with chemical control can be one effective management strategies in semi-large-scale sweetpotato production system like this. However, future research needed is to develop a pheromone-based IPM program against SPW using organic certified insecticides such as *Beauvaria bassiana*, neem products, or indigenous entomopathogenic nematodes (Myers et al., 2020).

## Acknowledgements

This project is in parts supported by CTAHR Plan of Works (POW 23-071 and 16-964), Multi-state project (HAW09034-R, Hatch project (HAW09048-H), NIFA OREI (HAW09705-G) and WSARE (SW22-936).

## Literature Cited

Capinera J. L. and Castner, J. L. (2018). Sweetpotato weevil. EENY-27, University of Florida

Hue, S.-M., and Low, M.-Y. 2015. An insight into sweet potato management. Psyche: A Journal of Entomology, Article ID 849560: 11 https://doi.org/10.1155/2015/849560

NASS (2022). Pacific Region – Hawaii Vegetable and Melon Crops Report. National Agricultural Statistics Service, United States Department of Agriculture https://hdoa.hawaii.gov/add/files/2022/02/202202vegrv.pdf

Pulakkatu-Thodi, I., Motomura, S. and Miyasaka, S. (2016). Evaluation of insecticides for the management of rough sweetpotato weevil, *Blosyrus asellus* (Coleoptera: Curculionidae) in Hawaii Island. College of Agriculture and Human Resources, University of Hawaii, IP-38, June 2016.

Myers, R.Y., C.D. Sylva, C.L. Mello, and K.A. Snook. 2020. Reduced emergence of Cylas formicarius elegantulus (Coleoptera: Curculionidae) from sweetpotato roots by Heterorhabditis indica. Journal of Economic Entomology, 113(3), 2020, 1129-1133 (doi: https://doi.org/10.1093/jee/toaa054)

Reddy, G. P., Wu, S., Mendi, R. C. and Miller, R. H. (2014). Efficacy of pheremone trapping of the sweetpotato weevil (Coleoptera: Brentidae): Based on dose, septum, attractive radius, and mass trapping. Environmental Entomology 43: 767-773.

Yasuda, K. (1995). Mass trapping of the sweet potato weevil, *Cyclas formicus* (Fabricus) (Coleoptera: Brentidae) with a synthetic pheromone. Applied Entomology and Zoology 30: 31-36.

**Disclaimer:** Mention of a trademark or proprietary name does not constitute an endorsement, guarantee, or warranty by the University of Hawaii Cooperative Extension Service or its employees and does not imply recommendation to the exclusion of other suitable products. Pesticide use is governed by state and federal regulations. **Read the pesticide label to be sure that the intended use is included on it, and follow all label directions**.