COOPERATIVE EXTENSION
UNIVERSITY OF HAWAI'I AT MĀNOA
COLLEGE OF TROPICAL AGRICULTURE AND HUMAN RESOURCES
Vol 63 (September 2026)

Velvet Bean for Nematode Suppression and Soil Health Management

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Velvet bean (*Macuna pruriens* var. *utilis*) is an ideal cover crop for warm climates (19-27°C). It produces abundant biomass, fixes nitrogen, tolerates drought once established, smothers weeds, and suppresses plant-parasitic nematodes. However, it is day length sensitive with more abundant growth in the summer and prefers well-drained soil with pH 5-8 to produce abundant biomass (ECHO Community, no date). Velvet bean used to be a familiar cover crop in Hawai'i during the sugarcane plantation era. It fell out of use over time, but it is catching interest of farmers in Hawaii recently. In 2022, we tested and confirmed it suppresses nematodes in sweetpotato production to a similar extent as other nematode suppressive cover crops like sunn hemp and energy sorghum in a field experiment at Poamoho CARES Center (Pitiki et al., 2023). After those results, we expanded the study of velvet bean to five on-farm collaborative trials with farmers to better understand its impact on soil health and nematode suppression in diverse conditions.





Figure 1: Velvet bean. Right: Bush-type velvet bean 'ECHO Bush Selection #1' growing in a single row. Below: beans growing under the leaf canopy.

This project examined if velvet bean could be a suitable cover crop for sweetpotatoes. Nematodes are one of the biggest limiting factors in sweetpotato production in Hawai'i, and reniform nematode (*Rotylenchulus reniformis*) is the top nematode concern for growers of 'Okinawa' sweetpotato. Reniform nematodes reduce sweetpotato yield by limiting sweetpotato initiation and slowing growth. Because sweetpotato is in the ground for four to six months, reniform populations can complete multiple life cycles and dramatically increase in abundance over a single sweetpotato crop.

One important note about velvet bean is that some wild velvet bean varieties are aggressive climbers with irritating bristles on the seed pods. For this trial we used the 'ECHO Bush Selection #1,' a bushy, non-vining, bristle-free cultivar bred specifically for cover crop use. If you are interested in growing velvet bean yourself, we recommend sourcing seed only from suppliers within the state who can verify it is the bristle-free type.

The study

Three objectives to be answered in this project were:

1. Nematode suppression: Does velvet bean reduce reniform nematode populations compared to a buckwheat cover crop?
2. Soil health: How does velvet bean affect the broader community of free-living, beneficial nematodes and other soil health indicators?
3. Sweetpotato yield: Does velvet bean increase yield, and is any yield boost tied to fewer nematodes?

Five field trials were conducted on three islands in Hawaii (Table 1). Each trial consisted of side-by-side comparisons of velvet bean vs buckwheat as pre-plant cover crops ahead of sweetpotato ('Okinawan' variety; except at WS where it was a mix of 'Ruddy' and 'Regal'). Each treatment was replicated 3 times in each trial. Soil was sampled at three time points: cover crop planting, cover crop termination/sweetpotato planting, and sweetpotato harvest. At each sampling point we measured the nematode community, microbial respiration, aggregate stability, and total soil nitrogen and carbon, and we graded the harvest at the end of the season.

Table 1. Farm histories of the five farms (referred to by pseudonym).

Farm	Location	Background
Pua Nani Farm (PN)	O'ahu	Previously fallow under weed mat
Island Produce (IP)	O'ahu	Previously fallow, weed-free open field
Wauke Shores (WS)	Kaua'i	Long-term, high-input organic operation
Kapiolani Farm (KF)	O'ahu	New organic farm, transitioning out of guinea grass
Hawai'i Sunrise Sweetpotato (HSS)	Hawai'i Island	Conventional, 3-year pasture rotation — did not complete the trial due to a Kona low storm disrupting harvest

Figure 2: Right: A mix of 'Ruddy' and 'Regal' sweetpotatoes following velvet bean and buckwheat cover crops. Below: reniform nematodes viewed at 100x magnification.





What we found

Yield: At the two farms following a fallow period (PN and IP), velvet bean plots out-yielded buckwheat plots by 50% or more. At Wauke Shores, the long-established high-input organic farm, yield was essentially the same between treatments. At Kapiolani Farm, the newest organic site, yield was slightly lower under velvet bean treated plots (Figure 3).

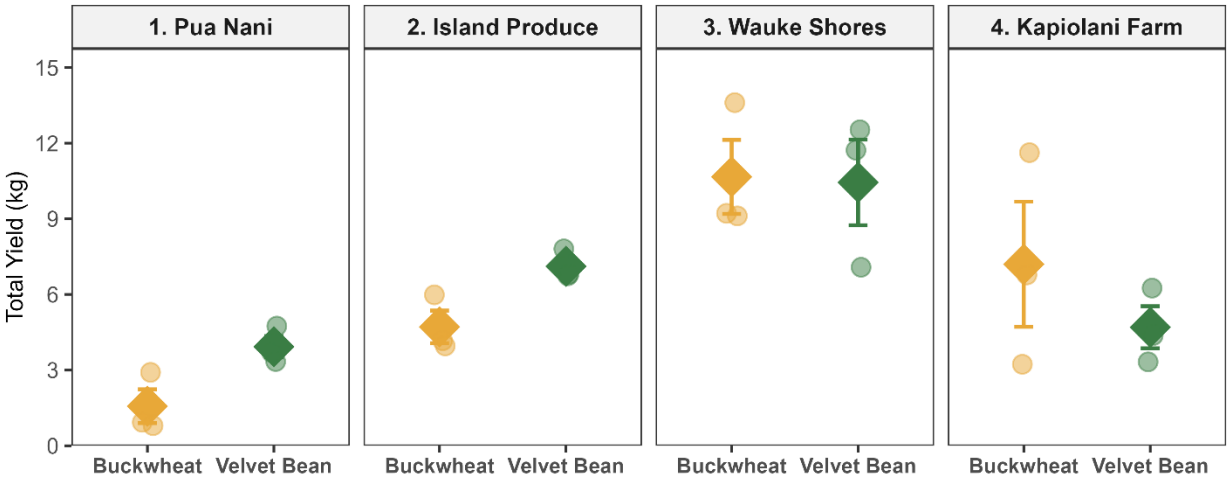

Figure 3: Total sweetpotato yield by farm. Yield shown is average yield per single row plot.

Nematodes: Similarly, at the two fallow-recovery farms, reniform nematode counts at harvest were lower under velvet bean (significantly at PN, and numerically at IP). At Wauke Shores, reniform counts were about the same between treatments by harvest. At Kapiolani

Farm, reniform counts were significantly higher at sweetpotato harvest where velvet bean had grown (Figure 4).

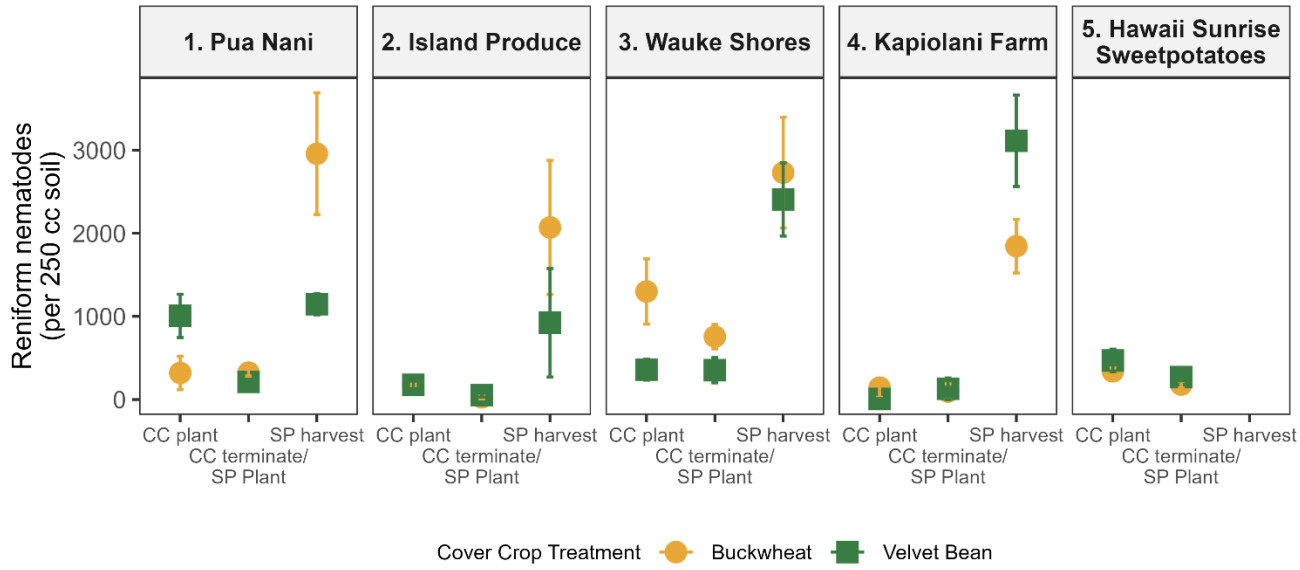

Figure 4: Reniform nematode abundance at three time points across five farms growing buckwheat or velvet bean cover crop (CC) followed by sweetpotatoes (SP).

There is an important caveat for the results from Kapiolani Farm. At Kapiolani Farm, sweetpotatoes in the velvet bean plots were grown under a row cover, while those in buckwheat plots were not. Row covers could improve vegetative growth and soil conditions on their own, so there is a possibility that the row cover could have led to more reniform nematode reproduction due to healthier sweetpotato plants. Vigorous vegetative growth and high infestation of reniform nematodes could be the reason why low sweetpotato tuberous roots were formed. Thus, results from Kapiolani Farm were treated cautiously as they might not show the true effect of the cover crop.

Soil food web activity:

The impact of velvet bean on soil health can be inferred from the broader soil nematode community, particularly beneficial, non-parasitic nematodes that feed on fungi, bacteria, and other microbes. At the farms following a long dormant or fallow period, velvet bean increased bacterial-feeding and fungal-feeding nematodes by the time of cover crop termination, indicating a burst of decomposer activity and microbial nutrients available in the soil. At these same farms, a significantly higher channel index (a metric indicating fungal-dominated decomposition) at sweetpotato harvest suggested that velvet bean promoted soil fungi. In contrast, Wauke Shores and Kapiolani Farm , the two farms that had not been fallowed, began the study with balanced counts of bacterial-feeding and fungal-

feeding nematodes, a sign of nutrient enriched soil food webs. By the end of the sweetpotato crop, the soil food web in Wauke Shores' velvet bean plots, but not buckwheat plots, shifted toward greater maturity, evidenced by an increased presence of omnivorous and predatory nematodes. At Kapiolani Farm, both buckwheat and velvet bean plots developed a more mature, structured food web with increased counts of omnivorous and predatory nematodes.

The big picture

Putting the yield, nematode, and soil food web results together, a pattern emerges: the benefits of velvet bean are dependent on the starting soil biology of the farm.

- On farms coming out of a fallow or otherwise dormant period, velvet bean suppressed reniform nematodes, jump-started the soil food web, and boosted yield.
- On the long-established, high-input organic farm, where the soil food web was already active, velvet bean increased the maturity of the soil food web but had no noticeable effect on reniform nematodes or yield.
- On the newest organic farm, freshly transitioned from guinea grass, velvet bean showed less benefit overall. However, the row cover confounded results making the nematode result hard to interpret cleanly.



Figure 5: 'Okinawa' sweetpotato at harvest with off market sweetpotatoes on the left and marketable sweetpotatoes on the right.

These results lined up with a two-year study in a previous field trial conducted by our team, where velvet bean suppressed nematodes more effectively when it followed a fallow period than when it immediately followed a sweetpotato crop. It's also consistent with prior research showing velvet bean can suppress nematodes through several possible pathways: by being a poor host for plant parasitic nematodes, releasing compounds that are directly toxic to nematodes, and by shifting the surrounding microbial community. Our results support the last mechanism where biological suppression through a more active soil food web, is a plausible piece of the story.

Take home message for farmers: Velvet bean is not a guaranteed plant-parasitic nematode-suppression tool for every situation. Its performance seems to vary by farm history and current soil conditions. However, even if you do not have plant-parasitic

nematodes, velvet bean is beneficial for adding organic matter, modifying soil food web structure, improving soil nitrogen availability and suppressing weeds between crops.

Challenges

The biggest ongoing challenge for farmers in Hawaii wanting to try velvet bean is seed procurement. Right now there is not a reliable local commercial source for the bristle-free bush cultivar, which limits how easily farmers can adopt it. In the meantime, interested individuals can contact our lab or CTAHR Cooperative Extension office for a sample of seeds to start their own cover crop and seed saving.

Acknowledgments

Thank you to the participating farmers who collaborated with us in this study and to the CTAHR faculty and students who provided support: Roshan Mandanhar, Lauren Braley, Roshan Paudel, Angelina Johnson, Kekoa Larger, and Renzo Hurtado.

This work was supported by a Western SARE graduate student grant (GW24-006), USDA-NIFA-OREI (HAW09705-G), and CTAHR (Plan of Work POW16-964; Multi-state award HAW09034-R; Hatch award HAW09048-H).

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