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Root-knot Nematode Management in Dryland Taro with Tropical Cover Crops

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Abstract: Twenty-two cover crops were evaluated for their ability to reduce damage by root-knot nematode, *Meloidogyne javanica,* to taro, *Colocastia esculenta,* in a tropical cropping system. Cover crops were grown and incorporated into the soil before taro was planted. Barley, greenpanic, glycine, marigold, sesame, sunn hemp, and sorghum × sudangrass DeKalb ST6E were poor or nonhosts to the nematode as measured by low population changes of nematodes in soil between cover crop planting and taro planting. Alfalfa, buckwheat, cowpea, lablab, Lana vetch, mustard, oat, okra, rhodes grass, ryegrain, ryegrass, siratro, sweet corn, and wheat allowed nematode populations to increase dramatically. Taro yields were greatest in the marigold plots and lowest in the ryegrain plots. Taro corm weight decreased with increasing initial nematode population (Pi) ($r = 0.22$, $P = 0.056$). Siratro, ryegrass, and Blizzard wheat plots had higher taro yield than plots with similar Pi's but planted to other cover crops. These cover crops may have antagonism to other soil microorganisms or their decomposition products may be toxic or adversely affect the nematodes. Cover crops can be an effective and valuable nematode management tactic for use in minor tropical cropping systems such as taro.

Key words: barley, *Colocasia esculenta,* control, cover crop, *Crotalaria juncea,* glycine, greenpanic, *Hordeum vulgare,* management, marigold, cover crop, *Crotalaria juncea,* glycine, greenpanic, *Hordeum vulgare,* management, marigold, *Meloidogyne javanica,* nematode, *Neonotonia wightii, Panicum maximum,* root-knot nematode, sesame, *Sesamum indicum,* sorghum × sudangrass DeKalb ST6E, sunn hemp, sustainable agriculture, *Tagetes erecta,* taro, tropical cover crops.

Taro, *Colocasia esculenta,* is cultivated on farms of less than 2 ha in paddies or under dryland conditions in Hawaii (Hawaii Agricultural Statistics Service, 1996). Root-knot nematode, *Meloidogyne javanica,* can be devastating in dryland taro, reducing corn weights by 90% (Sipes et al., 1995). Host plant resistance is not readily available in existing cultivars (Sipes et al., 1995), and few registered chemical treatments are available for this minor crop. Root-knot nematode management must therefore be achieved with alternative tactics, such as cultural methods. The planting material, locally referred to as huli (the top few centimeters of the corm containing the growing point), can be trimmed to remove root-knot nematode-infected tissue, although some nematodes may remain in the huli. Planting material can be subjected to hot-water treatment, but the huli is injured if the temperature is higher than 45°C (A. S. Arakaki, unpubl.). These cultural practices, however, are often insufficient, and additional tactics are needed for root-knot nematode management.

The average farm size and its status as a minor crop make taro suitable to sustainable agricultural practices such as use of cover crops and soil amendments to manage nematodes. Cover crops can be selected and grown to reduce the nematode soil populations below damaging thresholds or to enhance beneficial microorganisms (Cook and Baker, 1983). Many plants adapted to tropical environments are nonhosts of *M. javanica* and could be useful as cover crops between taro planting cycles. Our objective was to determine the effect of selected cover crops on *M. javanica* soil population densities and subsequent taro yield.

MATERIALS AND METHODS

An experiment was initiated in a Holumua silt loam field infested with *M. javanica* on Molokai, Hawaii. Twenty-two potential cover crops were selected based upon utility in a sustainable tropical agricultural system (Evans et al., 1988). Bun Long taro, okra, and a fallow also were included in the test

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for comparison. Plots, 3.7 m × 4.6 m, were established, sampled to determine nematode Pi (initial populations), and planted with one of 24 crops or fallowed (Table 1) in a randomized complete block design with three replications in August 1994. Legumes were inoculated with appropriate rhizobial symbionts, and the plots were fertilized with 112 kg 10-20-20/ha. A single-drip irrigation line was installed in the center of each plot. The cover crops were sampled for nematodes with a soil probe to a depth of 12 cm. Three samples were collected and combined for each plot. A 250-cm^3 soil subsample was processed by a combination of elutriation and centrifugation (Byrd et al., 1976; Jenkins, 1964). At cover crop plant senescence, a second soil and root sample was collected. Soil was processed as before, and eggs were extracted from the root sample with an NaOCl solution (Hussey and Barker, 1973). Roots were dried and weighed. The cover crops were then incorporated into the soil. A single-drip irrigation line was reinstalled in each plot to hasten cover crop decomposition.

Bun Long taro was subsequently planted into the plots 8 weeks later. The taro was grown for 9 months and harvested. Taro corm weight and root-knot nematode population densities in soil and roots were determined as described above.

Data were analyzed for variance and, where appropriate, means were separated with the Waller-Duncan *k*-ratio *t*-test. Nematode numbers in soil and roots at cover crop senescence were combined for a taro preplant Pi and $\log_{10}$-transformed. Correlation coefficients were calculated for preplant nematode population densities and taro corm weight. Contrasts were made between cover crop and taro Pi's.

TABLE 1. Population changes of *Meloidogyne javanica* under various cover crops and subsequent Bun Long taro yield on Molokai, Hawaii. Nematode populations were assayed before cover crop planting (Pc) and following cover crop soil incorporation before taro planting (Pt).

Cover crop	Scientific name	*M. javanica* per 250 cm^3 soil		Average corm weight (kg)^b
		Pc	Pt^{a,b}	
Alfalfa	*Medicago sativa* cv. Spreader 2	10	91,920 abc	0.49 bcde
Awnless barley	*Hordeum vulgare*	0	47 klm	0.39 cde
Buckwheat	*Fagopyrum esculenta*	0	15,667 bcde	0.28 de
Corn	*Zea mays* cv. Waimanalo Super Sweet	0	1,727 fghi	0.44 bcde
Cowpea	*Vigna unguiculata*	7	168,060 a	0.27 de
Fallow		0	23 mn	0.52 abcde
Glycine	*Neonotonia wightii*	7	45 lmn	0.38 cde
Greenpanic	*Panicum maximum*	3	118 ijklm	0.77 ab
Lablab	*Lablab purpureus*	23	44,453 abcde	0.31 cde
Lana vetch	*Vicia villosa*	7	636,799 abcd	0.31 de
Marigold	*Tagetes erecta*	10	2 n	0.86 a
Mustard	*Brassica napus*	80	3,600 defg	0.37 cde
Oat	*Avena sativa* cv. Coker	0	5,873 cdefg	0.38 cde
Okra	*Hibiscus esculentus*	13	280,000 a	0.35 cde
Rhodes grass	*Chloris gayana*	53	887 ghij	0.56 abcde
Ryegrain	*Secale cereale* cv. Danko	7	130,163 ab	0.20 e
Ryegrass	*Lolium multiflorum* cv. Alamo	0	9,690 defg	0.60 abcd
Sesame	*Sesamum indicum*	0	158 ijkl	0.60 abcd
Siratro	*Macroptilium atropurpureum* cv. Siratro	0	451 hijk	0.68 abc
Sudex	Sorghum × sudangrass 'DeKalb ST6E'	10	97 jklm	0.57 abcd
Sunn hemp	*Crotalaria juncea*	57	63 klm	0.51 abcde
Taro	*Colocasia esculenta* cv. Bun long	0	24,067 bcde	0.30 de
Wheat	*Triticum aestivum* cv. Blizzard	20	19,657 bcdef	0.78 ab
Wheat	*Triticum aestivum* cv. Norstar	0	6,217 efgh	0.45 bcde
Wheat	*Triticum aestivum* cv. Weston	10	13,646 cdefg	0.35 cde

[a] Numbers are untransformed means of second-stage juveniles and eggs from the soil and roots. $\log_{10}$ (Pt + 1) transformations were used for statistical analysis. Data are the means of three replications.

[b] Numbers in a column followed by the same letter are not different according to the Waller-Duncan *k*-ratio *t*-test (*k* ratio = 100).

Results and Discussion

Taro had a low damage threshold for *M. javanica* (Fig. 1). Corm weight was reduced by 40% with a nematode Pi increase from 2 to 23 second-stage juveniles/250 cm^3 soil (Table 1). Consequently, management tactics must reduce the Pi to very low levels. The cover crops tested differed in their ability to reduce root-knot nematode damage to the taro plants.

Population densities of *M. javanica* were low when the cover crops were planted (mean of 13 nematodes/250 cm^3 soil) and did not differ among the cover crop treatments ($P > 0.1$). Taro yield was generally greater with lower preplant Pi (Fig. 1). Some of the cover crops, i.e. barley, greenpanic, glycine, marigold, sesame, sunn hemp, and sorghum × sudangrass DeKalb ST6E, which were poor or nonhosts to the root-knot nematode, maintained or further reduced nematode soil population densities (Table 1). Marigold was the only cover crop that reduced nematode population densities between cover crop planting and subsequent taro planting ($P > 0.03$). Taro yield was lower following cover crops that were good hosts (Pi[cover]/Pi[taro] > 40) for the root-knot nematode, i.e. alfalfa, buckwheat, cowpea, lablab, Lana vetch, mustard, oat, rhodes grass, ryegrain, ryegrass, siratro, sweet corn, and the wheats. The dramatic nematode population increase under these cover crops reduced taro yield (Fig. 1).

Several cover crop treatments produced high taro yield even though nematode Pi was high, suggesting a method of control other than suppression of nematode reproduction on the cover crop. The plots in which siratro, ryegrass, and Blizzard wheat were grown had greater taro yield compared to plots with similar Pi's where another cover crop was grown (Table 1). The correlation between nematode Pi at taro planting and taro yield (Fig. 1) was variable because of these cover crops ($P > 0.1$).

Siratro, ryegrass, and Blizzard wheat, as organic amendments to the soil, may have affected the microbial dynamics of the soil

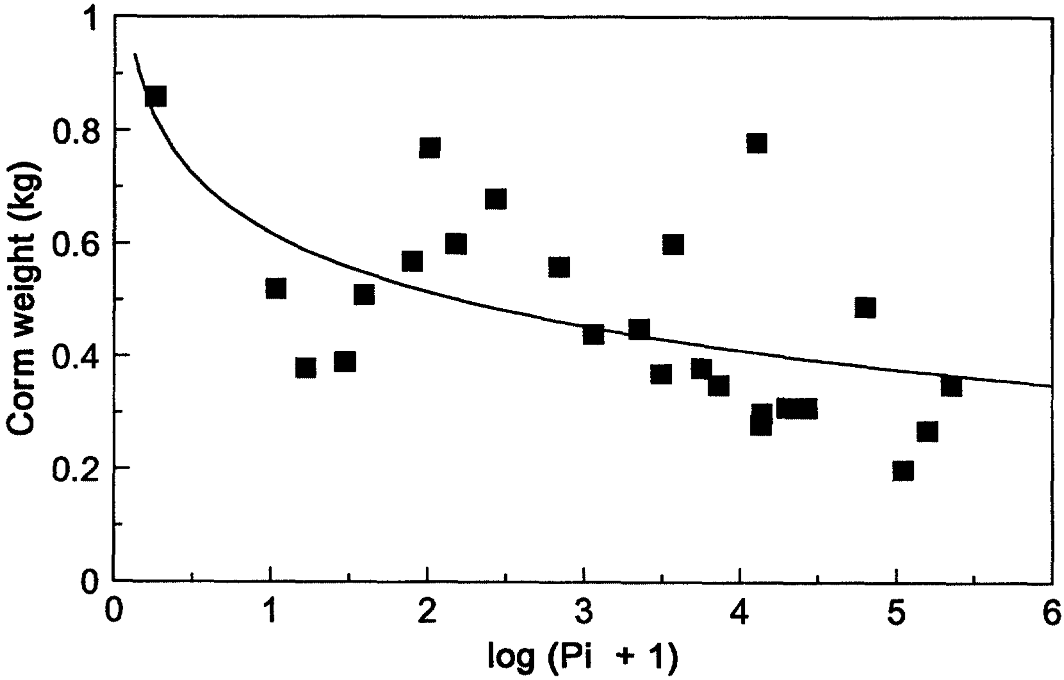

Fig. 1. Taro yield under different initial population densities of *Meloidogyne javanica* (Pi) following a 5-month cover crop. A negative relationship between $\log_{10}$ (Pi + 1) and taro yield is given by the equation: Yield = 0.66 − 0.06[$\log_{10}$ (Pi + 1)], $P = 0.0004$, $r^2 = 0.16$. Each ■ represents the Pi of a different cover crop.

or been antagonistic to fungal pathogens that seem to exacerbate root-knot nematode damage in taro (Sipes et al., 1995). The breakdown products of Blizzard wheat, siratro, and ryegrass may be toxic, reducing nematode Pi or adversely affecting nematode activity by the time of taro planting. Consequently, the cover crop was more beneficial than expected. We did not assay nematode population densities between cover crop incorporation and taro planting. A decrease in nematode Pi could have occurred during these 8 weeks.

Several tropical cover crops have been reported as potential controls for *M. incognita* or *M. arenaria*. Sesame and sorghum × sudangrass were effective cover crops for controlling *M. arenaria* in Alabama and Florida (McSorley et al., 1994b; Rodríguez-Kábana et al., 1988). A marigold cover crop was effective against *M. incognita* in a Florida cropping system (McSorley and Dickson, 1995). *Meloidogyne javanica* potentially could be managed with sorghum × sudangrass hybrids and crotalaria in Florida (McSorley et al., 1994a). We found similarities among certain cover crops used to manage *M. javanica* in Hawaii. Marigold, sesame, sorghum × sudangrass, and sunn hemp were beneficial for controlling root-knot nematode in dryland taro. We also found Blizzard wheat to be an effective cover crop for improving taro yield, whereas other wheats were not effective, and none reduced *M. javanica* Pi. *Brassica* spp. cultivars differ in their glucosinolate content (Johnson et al., 1992) and may therefore differ in their ability to manage nematodes. Wheat cultivars also may differ in their decomposition products, with the decomposition of Blizzard wheat releasing compounds affecting nematode activity more than Weston or Norstar wheat. The evaluation of additional wheat cultivars is warranted.

Cover crops can manage root-knot nematode damage in a tropical dryland taro production system. Some cover crops are effective in reducing nematode populations while the plants are growing, such as occurs with marigold. Other cover crops may act as they decompose, producing toxic products that reduce nematode Pi or enhance antagonistic fungi. Because taro has a low damage threshold to *M. javanica*, an ideal cover crop should not allow nematode reproduction and should produce decomposition products toxic to soil microorganisms.

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