Cover Your Asset: choosing appropriate cover crops for your production system

Ted Radovich

How do you know what the best cover crop for your system is? Unfortunately, there is no easy answer. The primary goal of using cover crops is to improve the ecological function of your production system, but specific objectives for a location and grower at any given time may vary widely. A first step is to decide what the most important function(s) you want your cover crop to serve are.

- Break the pest cycle?
- Improve nitrogen nutrition for the succeeding crop?
- Increase soil organic matter?
- Weed suppression?
- Erosion control?
- Habitat for beneficial insects?
- Nematode suppression?

"All of the above" is an obvious answer, but no single crop will serve to optimally address all those needs all the time, so priorities need to be set.

Also, several practical questions should be asked:

- How long can I keep the area out of a cash crop?
- What cash crop will be growing with/after the cover?
- Can I afford to irrigate the cover crop?
- What equipment do I have to mow and/or incorporate the cover?
- Is seed available? How much does it cost?
- What information is available on the species I am interested in?
- What are my neighbors and others doing?

It is important to be aware that cover crops must be managed properly to achieve their full potential. Management strategies to maximize the potential for legumes to contribute nitrogen and other benefits to the system include liming acid soils, improving phosphorous availability if soil is deficient, avoiding excess N, inoculating with the appropriate rhizobia, and timing killing and residue incorporation properly (Cassman, 1980; Habte, 2000; Hooks, 1997; NIFTAL, 2000; Yost et al, 1981; Yost and Evans, 1988). When used as a living mulch, all plants including legumes have the potential for competing with the concurrent cash crop. Strategies to minimize competition include planting the living mulch outside

Figure 1. Young papaya trees with living mulch of sweet white clover and hairy vetch 'Lana' and 'Naomi' (Top). Trees several months later with vetch grown up around the trees and mowed between rows (Bottom).

of crop rows, controlling growth of living mulch through mowing/ herbicides, avoiding genotypes with vining/climbing habit and ensuring nutrients are supplied directly to the cash crop (Evans et al., 1988; Glover, 1998; Leary et al., 2006; Radovich et al., 2009; Figure 1). Alternating strips of cover crops with cash crops in a simple rotation has been suggested as a strategy to reduce the economic production area lost to cover cropping (http://www.ctahr.hawaii.edu/sustainag/Downloads/Strip-till_row-switching.pdf). Grasses are often underrated as cover crops and are particularly well suited to retain excess nitrogen in the system, produce large amounts of biomass and suppress weeds (Evans et al.,1988; Leary et al., 2006; Smith, 2002;). However, grasses can vary in their cultural requirements, and a large biomass producers like sorghum x sudangrass may present challenges with regards to killing and incorporation in annual vegetable systems (Fig. 2).

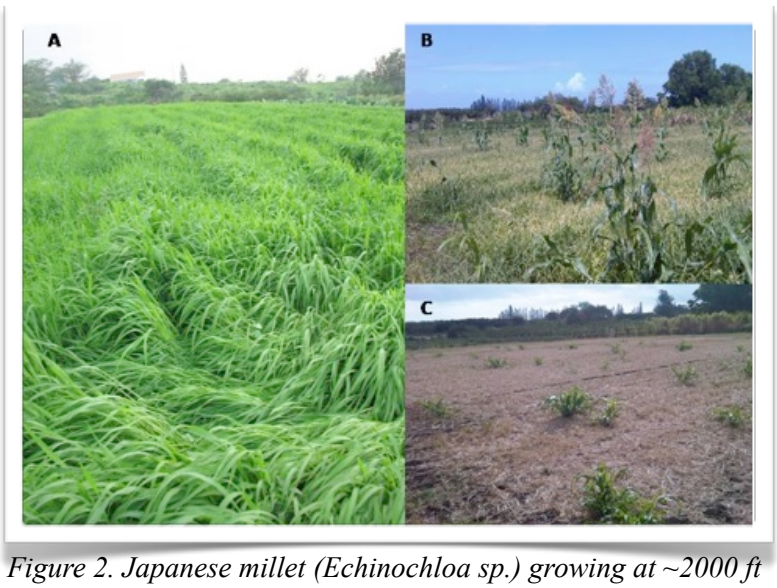

Figure 2. Japanese millet (Echinochloa sp.) growing at ~2000 ft in Kula, Maui (A), growing at ~60 ft in Waimānalo, O'ahu with taller volunteers of sorghum x sudangrass (B), and Japanese millet killed by mowing while root mat of sorghum x sudangrass regrows (C).

An important factor that impacts decision-making with regard to cover crop selection is the extent to which the crop is tolerant to important pests. Sunn hemp is the superstar of Hawai'i cover cropping, in part because of its ability to suppress root-knot nematodes. Many other legumes with high potential for use in Hawai'i are susceptible to this important pest (Sipes and Arakaki, 1997). Marigold is another good nematode suppressing crop, but is a host for thrips and mites (Wang et al., 2007). Hairy vetch has potential as a vigorous weed suppressor and nitrogen fixer in rotation with nematode suppressing covers, but is a host to *Sclerotinia minor* which causes lettuce drop, and may be unsuitable for systems where lettuce is a primary cash crop.

So, there is a lot to consider with no easy answers when it comes to cover crop selection. Nevertheless many producers in Hawai'i have successfully included cover cropping into their systems, and CTAHR researchers and others continue to address questions to assist with selection (see marigold and Pioneer articles in this issue). The list of references and resources below is intended to provide a representative sampling of materials available to help with decision-making in cover crop selection and management.

FMI: Dr. Theodore Radovich,
Email: theodore@hawaii.edu

References and Resources

1. Boyd, C., P. Rotar, R. Guyton, J, Thompson, R. Kimoto. 1992. The influence of seeding rates and cutting heights on dry matter yields of alfalfa in Hawaii. CTAHR research series 068.
2. Cassman, K., A. S. Whitney and R. L. Fox. 1980. Symbiotic nitrogen fixation requires extra phosphorus. http://www.ctahr.hawaii.edu/oc/freepubs/pdf/IC-17.pdf

3. Crop Care Hawai'i. 2007. Accelerating the Adoption and Implementation of Proven Cover Crop Technologies in Hawaii. http://www.ctahr.hawaii.edu/sustainag/NewFarmer/downloads/Accelerating%20_Adoption_of%20_Cover%20Crops.pdf.
4. Evans, D.O., R. J. Joy, and C. L. Chia. 1988. Cover crops for orchards in Hawaii. http://www.ctahr.hawaii.edu/oc/freepubs/pdf/RES-094.pdf.
5. Glover, N. 1994a. Cover crops for weed control in dry land taro fields. On-farm Research Leaflet #3. In: N. Glover and L. Ferretinos (eds.). Pacific Islands Farm Manual. Agricultural Development in the American Pacfic (ADAP). http://www.ctahr.hawaii.edu/adap/Publications/ADAP_pubs.htm
6. Glover, N. 1994b. Glycine. Cover Crop Leaflet #6. In: N. Glover and L. Ferrentinos (eds.). Pacific Islands Farm Manual. Agricultural Development in the American Pacific (ADAP). http://www.ctahr.hawaii.edu/adap/Publications/ADAP_pubs.htm
7. Guyton, R., J, Thompson C. Boyd, P. Rotar, D. Matsuyama and R. Kimoto. 1992. Performance of 15 alfalfa varieties in 31 consecutive harvests in Hawai'i. CTAHR research series 067.
8. Habte, M. 2000. Mycorrhizal fungi and plant nutrition. http://www.ctahr.hawaii.edu/oc/freepubs/pdf/pnm14.pdf
9. Hooks, C.R.R. , K. Chandarab, D. Fallon, K-H. Wang, and R. Manandhar. 1997. The impact of sunn hemp cover cropping on belowground organisms and nutrient status associated with a cucumber planting. http://www.ctahr.hawaii.edu/oc/freepubs/pdf/SCM-21.pdf
10. Hooks, C.R.R., K.-H. Wang, and D. Fallon. 2006. An ally in the war against nematode pests: Using sunnhemp as a cover crop to suppress root-knot nematodes. http://www.ctahr.hawaii.edu/oc/freepubs/pdf/PD-32.pdf
11. Hooks, C.R.R., A. Fereres, and K.-H. Wang. 2007. Using protector plants to guard crops from aphid-borne non-persistent viruses. http://www.ctahr.hawaii.edu/oc/ freepubs/pdf/SCM-18.pdf
12. Leary, J. K.; DeFrank, J.; Sipes, B. 2006. Tropical eggplant (Solanum melongena L.) production with a buffelgrass (*Pennisetum ciliare* L.) living mulch system in Hawai'i. Biol. Agric. & Horticulture 24: 105-116,
13. NIFTAL. 2000. Biological nitrogen fixation. University of Hawai'i at Mānoa, College of Tropical Agriculture and Human Resources (CTAHR). http://www.ctahr.hawaii.edu/oc/freepubs/pdf/pnm13.pdf
14. Radovich, T., L.J. Cox, J Sugano and T. Idol. 2009. Benefits and costs of using perennial peanut as living mulch for fruit trees in Hawai'i. http://www.ctahr.hawaii.edu/oc/freepubs/pdf/SCM-27.pdf
15. Sipes, B. and Arakaki, A. 1997. Root-knot nematode management in Dryland Taro with Tropical Covercrops. Journal of Nematology 29:721-724.
16. Smith, J. (ed.). 2002. Cover crops and green manures for Hawai'i. http://www.ctahr.hawaii.edu/sustainag/cc-gm/index.html.
17. Valenzuela, H., R. Hamasaki and T. Radovich. 1999. Cover Crop Studies. Pp 32-42 in: Organic Farming Compost Experiments in Waimanalo, Hawai'i. http://www2.hawaii.edu/~hector/sustain%20site/MOA%205%20yr%20report%20pm6.pdf
18. Wang, K-H., C. Hooks and Antoon Ploeg. Protecting Crops from Nematode Pests: Using Marigold as an Alternative to Chemical Nematicides. http://www.ctahr.hawaii.edu/oc/freepubs/pdf/PD-35.pdf
19. Yost, R.S., D.O. Evans, N.A. Saidy and R.L. Fox. 1981. Greenmanuring- renewed interest in an old concept. http://www.ctahr.hawaii.edu/oc/freepubs/pdf/IC-25.pdf
20. Yost, R and D. Evans. 1988. Green Manure and legume covers in the tropics. CTAHR research series 055.

Table 1. Select characteristics and notes on management of some cover crops used Hawai'i. For additional crops and detail see: Smith (2002), and other references as noted by numbered superscript. Superscript number refers to relevant resource in references section. Superscript letters in heading refer to notes at base of table.

Common name	Species	Seed Rate[Z]	Weed Risk Assessment[Y]	Notes
Grasses				
Oats	*Avena sativa*	70-140	N/A	Excellent weed suppression, good biomass production. Can host rust and root knot nematode. [12]
Sorghum x Sudangrass	*Sorghum bicolor x* S. *bicolor var. sudanense*	40-50	N/A	Excellent nutrient scavenging, heavy biomass production. Poor host for root knot nematode. [12] Large root mass tolerates mowing, resists incorporation (Figure 2).
Cereal Rye	*Secale cereale*	70-160	N/A	Reportedly good biomass production and weed suppression, though performance at sea level has been mediocre[17]. Less utilized than oats. May suppress growth and germination of other plants via alleopathy. Good host for root knot nematode. [12]
Annual ryegrass	*Lolium multiflorum*	5-30	9: High	Excellent erosion control. Good host for root knot nematode. [12]
Japanese millet	*Echinochloa spp.*	10-30	8: High	Excellent weed suppression, good biomass production (Figure 2) May host root knot nematodes.
Legumes				
Sunnhemp	*Crotolaria juncea*	30-60	-3: Low	Good N-fixation capacity, excellent suppression of nematodes and weeds[9,10]. Lower biomass production under short-days, which initiates flowering. Incorporation is challenging as plants age and become fibrous.
Lablab	*Lablab purpureus,*	5-20	-1: Low	A good host for root knot nematode. [12] Aggressive, climbing nature makes it challenging to manage in vegetable systems.[6]
Velvet bean/ *Mucuna*	*Mucuna spp.*	45-90	7:high	Slow to establish, good biomass over long-term.
Alfalfa	*Medicago sativa*	20-50[1]	N/A	Varieties differ in their adaptability to local conditions[1,7]. Good host of root knot nematode. [12]
Sweet clover	*Melilotus alba*	30-70	N/A	Very deep tap root, drought tolerant after establishment. Tolerates mowing well.
Hairy Vetch	*Vicia villosa ssp. dasycarpa*	30-60	N/A	Aggressive, climbing, good early weed suppression. Host to root knot nematode[12] and *Sclerotinia minor* which causes lettuce drop.
Glycine	*Neonotonia wightii*	40[5]	7:High	A poor host for root knot nematode. [12] Aggressive, climbing nature makes it challenging to manage in living mulch systems. May host *Sclerotinia* and *Scercospera.* [5]
Cowpea	*Vigna unguiculata*	70-120	N/A	High suceptibility to a range of pests and diseases has limited the use of cowpea despite its potential for biomass production and N-fixation.
Other				
Buckwheat	*Fagopyrum esculentum*	50-100	N/A	Extremely fast canopy closure, good weed suppression attracts beneficial insects. Canopy senesces quickly. Used for early (nurse) cover in mixed plantings. Good host of root knot nematode. [12]
Mustard, rape, radish	*Brassica spp. Raphanus sativus*	5-20	16: High	Rapid ground cover, good early weed suppression. Some potential for biofumigation that may temporarily reduce soil biological activity. Can host nematodes, a wide range of caterpillars, white rust and other pests of the *Brassicacea*.
Marigold	*Tagetes spp.*	2-10	N/A	Supresses nematodes. Suppressant effect is dependent on marigold and nematode species[18]. Hosts mites and thrips.

[Z] Seed rates listed are for broadcast application. Rates for drilling seed may be considerably lower (Valenzuela and Smith, 2002; http://www.ctahr.hawaii.edu/sustainag/cc-gm/index.html)

[Y] http://www.botany.hawaii.edu/faculty/daehler/WRA/full_table.asp. NOTE: Weed risk assessment can be a valuable tool for minimizing invasive plant problems, but should not be used as primary justification for removing or unconditionally excluding trees or other plants from agricultural systems; A "High" risk designation is an indication of risks in some environments, but should not be interpreted to mean "do not plant under any circumstances."