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Sunn hemp (Crotalaria juncea L.): A summer cover crop for Florida vegetable producers[1]

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Sunn hemp is an excellent choice for a summer cover crop for Florida growers because it returns nitrogen to the soil, suppresses weeds and nematodes, improves soil tilth and water holding capacity, and reduces erosion in fields otherwise left without plant cover. Sunn hemp forms a symbiotic relationship with soil bacteria that remove nitrogen (N) gas from the atmosphere and transforms N to plant-available forms http://edis.ifas.ufl.edu/SS180

This article summarizes the recommended cultural practices to help vegetable growers grow a successful summer cover crop and to optimize the amount of nitrogen that is returned to a vegetable crop.

History and Botanical Overview

Sunn hemp (*Crotalaria juncea* L.) is a member of the family Fabaceae and is a sub-tropical annual legume. Grown historically as a fiber crop in India since 600 BC, it is one of the earliest recorded fiber crops in history (Chaudhury et al., 1978). The generic name *Crotalaria* means "rattle" and refers to the noise made by the seed pods when they have matured. Research has been conducted in the US on sunn hemp since the 1930s when it was reported to improve soil quality (Cook and White, 1996). Sunn hemp is also grown to provide biologically fixed nitrogen (N) to subsequent crops, suppress weeds and nematodes, add organic matter to soils, and in some parts of the world, it is used as a forage crop. The distribution of sunn hemp includes tropical, subtropical and some temperate locations. In North America, production is limited to Hawaii and the deep South including Texas, Florida, and Arkansas. Sunn hemp is also grown in South America, South and Central Africa, China, India and Indonesia.

Sunn hemp can grow to a height of six feet under favorable growing conditions with stem diameters that can reach 2 inches. The root system consists of a long tap root, with many well developed lateral roots (Figure 1). The inflorescence is a terminal raceme, with yellow flowers typical of the sub-order Faboideae (Papilionaceae) or pea group (Figures 2 and 3). There are several flowering types depending on the location of origin and growing conditions. Most commonly they are day-neutral, but some types are short-day. Days to flower ranges from 30-35 days in New Delhi, India (Chaudhury et al., 1978) to 60-70 days in Homestead, Fla. (Abdul-Baki et al.,

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2001). Mature pods bear numerous seeds that are dark grey and loose in the pod (Figure 4) at maturity (Figure5).

Figure 1. Sunn hemp 'Tropic Sun' shoot and root development three weeks after planting in perlite medium in the Horticultural Sciences teaching greenhouse, Gainesville, FL. Credits: Mike Alligood

Figure 2. Sunn hemp 'Tropic Sun' in flower. Credits: Danielle Treadwell

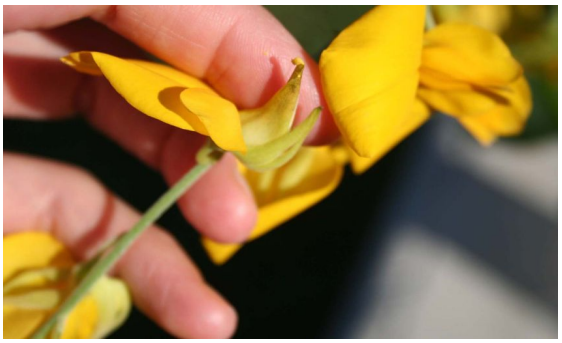

Figure 3. Sunn hemp 'Tropic Sun' flower with pollen. Credits: Danielle Treadwell

Cultivation and Management

In north and south Florida, growers can plant sunn hemp following a spring crop. Sunn hemp can be planted anytime in the spring following the last frost-free date (Figure 6). Typical planting dates are June-July in Florida. Sunn hemp grows well during drought and on marginal soils with a pH between 5.0

Figure 4. Sunn hemp 'Tropic Sun' seed. Credits: Stephanie Shewey

Figure 5. Maturing seed pods of 85-day-old sunn hemp planted in Gainesville, FL. in March. Photo was taken in June, 2007. Credits: Tim Treadwell

and 7.5. Seedlings emerge around 3-7 days after planting and grow very quickly (Figure 7) depending on climate. Germination and establishment are favored by moist but not wet soil conditions. Sunn hemp does not establish well if heavy rains follow planting, especially in the first few weeks.

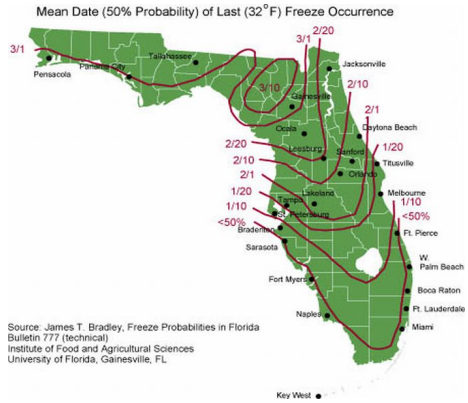

Figure 6. Frost-free dates for Florida. (Courtesy of J.T. Bradley, UF-IFAS Technical Bulletin No. 777.)

Sunn hemp should be inoculated with a cowpea-type inoculant. Seeding rate ranges from 15-40 pounds drilled or 20-50 pounds broadcast of pure live seed per acre. When the intention is to

Figure 7. Sunn hemp 'Tropic Sun' approximately 100 days after planting in Gainesville, FL. Credits: Corey Cherr

accumulate large amounts of biomass and incorporate the cover crop when plants are lush (also called "green manuring"), the heavier seeding rates are used. If drilled, a row spacing of 6 inches is recommended by the USDA NRCS, but Florida producers using sunn hemp typically seed in 18-36 inch rows. The 18 inch row spacing can be used if the desired objective is weed suppression, or if the crop will be terminated less than 60 days after seeding.

The cultivar 'Tropic Sun' was released by the USDA NRCS and the University of Hawaii Institute of Tropical Agriculture and Human Resources in 1983. This cultivar is not toxic to livestock or poultry (USDA NRCS, 2006). 'Tropic Sun' is popular with US growers, but domestic seed production is mostly limited to Hawaii and supply to US producers is often inadequate to meet the demand. Sunn hemp is believed to be a short-day plant; it will not set seed north of 28°N latitude (Alachua County, FL) and therefore poses little risk of becoming a weed in production areas in the south. Long days favor vegetative growth, a desirable characteristic for cover crops. Because sunn hemp is a short-day plant, seed production in the US has been a challenge. Sunn hemp is typically planted in June and July in Florida. When seeded at this time, the plant required more than three months to produce seed in Homestead, FL (Abdul-Baki et al., 2001).

When sunn hemp is grown as a green manure, practices that produce abundant and readily degradable biomass are most desirable. Nitrogen concentrations are generally 2.0-5.0 % in leaves and flowers and between 0.6 -2.0 % in roots and stems (Cherr, C.M., 2004). Increasing the ratio of succulent foliage to woody stems can be accomplished by increasing row width to induce more secondary branching, or by cutting the main stem. In Homestead FL, sunn hemp was seeded at 50 lbs/A on April 15 and produced 8.9 t/A of dry biomass in ten to twelve weeks (70 to 84 days) (Abdul-Baki et al., 2001). If allowed to stand longer than 90 days, main stems become woody and difficult to manage.

Management of woody stems requires a rotary mower to first cut the main stems into pieces and then a disk harrow to incorporate the plant material. Typically multiple passes with the disk are necessary to encourage decomposition in a timely manner prior to rotating to a vegetable crop. An alternative is to mow the sunn hemp periodically during the season to encourage succulent growth. This improves residue quality by increasing secondary branches, and increasing the percent N (Abdul-Baki et al., 2001). Mowing mid-season will also postpone formation of woody stems.

Few serious insects and diseases of sunn hemp have been reported and the benefits of having a sunn hemp cover crop currently outweigh any potential risk of insect or disease carry-over to vegetable crops. Powdery mildew (*Microsphaera diffusa* Cooke & Peck) and a root and stem rot (*Sclerotium rolfsii* Sacc.) are reported by Farr et al. (1989), but the frequency of these occurrences in Florida are not known. The lima bean pod borer (*Etiella zinckenella* Treit.) and the bella moth (*Utetheisa bella* L.) have been reported to attack the pods of sunn hemp and reduce seed production in Florida (Seale et al., 1957). Weed suppression is another popular objective for planting sunn hemp. Increasing biomass is important since sunn hemp suppresses weeds by reducing the light penetration at the soil surface. This can be accomplished by decreasing the row spacing to 18 inches. Sunn hemp can also produce chemical extracts that interfere with germination in small seeded weed species (Alder and Chase, 2007).

Sunn hemp has been demonstrated to reduce populations of sedentary endoparasitic nematodes, a group that remains in one location and feeds on roots throughout their life cycle. This group includes root knot (Meloidogyne spp.), sting (Belonolaimus longicaudatus), stubby root (Paratrichodorous minor), dagger (Xiphinema americanum) and burrowing (Radopholus similis) nematodes. A

summary of the effects of sunn hemp and other cover crops on plant-parasitic nematodes is presented in http://edis.ifas.ufl.edu/NG043, http://edis.ifas.ufl.edu/VH037, and http://edis.ifas.ufl.edu/IN516.

Nitrogen Contributions by Sunn Hemp

Sunn hemp should be grown for at least 60 days to allow for sufficient biomass production if an N contribution is desired. Nitrogen content is greatest (4%) at the onset of floral initiation to mid bloom, and declines as N reserves are allocated to seed production. For this reason, the optimum time to terminate sunn hemp is when approximately 50% of the terminal flower buds have opened. Leaves and flowers account for 50% of the total N throughout the production season, and 50-60% of the biomass during the first four to six weeks (Cherr et al., 2006). Later in the season, stems account for the majority of sunn hemp biomass. Roots extracted from soil samples to 24 inches accounted for 6% of total plant N and 10-13% of total plant biomass by the end of the growing season; little root mass was found below 24 inches (Cherr et al., 2006; Table 1).

To estimate the percentage of total N that will be available for plants to use, one must multiply an availability coefficient to the total N. An availability coefficient is the estimation of the fraction of plant-available nitrogen including nitrate and ammonium. In Florida, best management practices (BMPs) recommend an availability coefficient of 50% for estimating the amount of total N potentially available to a following vegetable crop (FLDACS, 2004). For example, if the total N contribution from a cover crop is 200 lb/A N, then only 50% of that N, or 100 lb/A, would likely be transformed to nitrate or ammonium (N release) during an average growing season. Soil microbes are needed to transform the nutrients in cover crops to plant-available or mineral forms of nutrients. The actual amount of N that will be available to vegetable crops after cover crop termination is difficult to predict due to the variety of biotic and abiotic factors that influence microbial transformations.

In south Florida, sunn hemp accumulated more N than other summer cover crop species tested. When terminated 120 days after planting and incorporated prior to fall tomato, sunn hemp had a total N content of 247-318 lb/A compared to velvetbean (154-255 lb/A) and cowpea (67-217 lb/A) (Wang et al., 2005). In central Florida. (Citra), sunn hemp grown as a summer cover crop before sweet corn accumulated 130-153 lb/A of total N from 3.3-5.4 t/A biomass over a 12-14 week period in 2001 and 2002; respectively (Cherr et al., 2006). On sandy soils in warm climates, even short lag times between the N release from green manures and subsequent crop demand can result in significant leaching losses (Cherr et al., 2006; Wang et al., 2005).

The high N content of the cover crop can pose a risk to water quality if the ratio of carbon (C) to nitrogen is less than 20:1, there is abundant biomass, and termination is followed by heavy precipitation. Excessive nitrate in soil solution is exacerbated when incorporated cover crops are followed by a direct seeded crop. Small seeds and transplants take time to develop a root system. Rainfall and irrigation may drive nitrate to depths beyond the root zone of small seedlings and transplants before they are able to utilize much N.

To increase N retention in the top 12 inches of soil, simple preventative actions such as reducing the seeding rate, limiting overhead irrigation immediately following cover incorporation, planting a mixture of legume and nonlegume species, maintaining cover residue on the surface for reduced tillage operations, and transplanting vegetables rather than direct seeding can mitigate N loss.

Economics

The cultivar 'Tropic Sun' is produced in Hawaii, South America and South Africa. The cost of seed ranges from $1.55 to $2.75 a pound, and the shipping cost is typically a dollar a pound. With sufficient biomass production, it is possible to offset fertilizer, herbicide and nematicide costs due to its N contribution, weed suppressive and nematode suppressive qualities.

Summary

In order for growers to get the best return on their investment, sunn hemp as a summer crop must be terminated prior to the main stem getting too woody for the equipment to manage. Since each operation has its own set of tools and production preferences, the limits of "too woody" will vary among operations. Sunn hemp is a promising summer annual cover crop for the southeast due to the many benefits it provides to the farming system. Seed availability and consequently the higher cost of seed may limit adoption at least in the short term.

Literature Cited

Alder, M.J. and C.C. Chase. 2007. Comparison of the allelopathic potential of leguminous summer cover crops: Cowpea, sunn hemp, and velvetbean. HortScience 42(2):289-293.

Abdul-Baki, A., H. H. Bryan, G. M. Zinati, W. Klassen, M. Codallo, and N. Heckert. 2001. Biomass yield and flower production in sunn hemp: effect of cutting the main stem. J. Veget. Crop Prod. 7:83-104.

Chaudhury, J., D.P. Singh and S.K. Hazra. 1978. Sunn hemp. Central Research Institute for jute and allied fibres (ICAR). Accessed June 10, 2007. http://assamagrbusiness.nic.in/sunn hemp.pdf

Cherr, C.M. 2004. Improved use of green manure as a nitrogen source for sweet corn. M.S. thesis. University of Florida, Gainesville, Fla. Accessed June 21, 2007. http://etd.fcla.edu/UF/UFE0006501/cherr_c.pdf

Cherr, C.M., J.M.S. Scholberg and R. McSorely. 2006. Green manure as nitrogen source for sweet corn in a warm-temperate environment. Agron. J. 98 (5):1173-1180.

Cook, C.G. and G.A. White. 1996. Crotalaria juncea: A potential multi-purpose fiber crop. P.389-394. *In:* J. Janick (ed.). Progress in new crops. ASHS Press, Arlington, VA.

Farr, D.F., G.F. Bills, G.P. Chamuris, and A.Y. Rossman. 1989. Fungi on plants and plant products in the United States. 1252 pp. American Phytopathological Society Press, St. Paul, Minn.

[FLDACS] Florida Department of Agriculture and Consumer Services. 2005. Water quality/Water quantity: Best management practices for Florida vegetable and agronomic crops. Available at: http://www.floridaagwaterpolicy.com/PDFs/BMPs/vegetable&agronomicCrops.pdf

Seale, C.C., J.F. Joyner, and J.B. Pate. 1957. Agronomic studies of fiber plants. Fla. Agric. Expt. Sta. Bul. 590:16-17.

USDA NRCS Plant Guide: Sunn hemp. 2006. Accessed June 20, 2007. http://plants.usda.gov/plantguide/doc/pg_crju.doc

Wang, Q., W. Klassen, Y. Li, M. Codallo and A.A. Abdul-Baki. 2005. Influence of cover crops and irrigation rates on tomato yields and quality in a subtropical region. HortScience 40(7):2125-2131.

Table 1. Sunn hemp nitrogen concentration by tissue type in Citra, Fl. 2001-2002. Adopted from Cherr et al. (2004).

WAE[1]	N Concentration				
	Leaf	Stem	Root	Flower	TOTAL
2001	grams N per kg dry sunn hemp				
2	21.1	12.0	8.5	---	16.2
4	21.8	8.2	7.2	---	14.9
6	21.3	6.2	6.1	---	12.1
8	21.8	5.3	4.9	27.3	10.3
10	21.7	5.0	4.7	24.1	10.0
12	20.1	5.2	4.6	29.0	10.1
2002					
2	37.7	15.3	23.2	---	30.4
4	39.0	14.7	14.7	---	27.6
6	40.3	12.0	10.0	---	22.4
8	34.3	9.0	6.6	---	16.9
10	32.9	6.0	5.4	40.2	13.1
12	31.8	6.0	4.0	42.7	12.5
14	31.3	5.7	6.1	21.1	11.7

[1]WAE = Weeks after sunn hemp emergence