

# Production of the Sunn Hemp Cultivars 'AU Golden' and 'AU Durbin' Developed by Auburn University

March 2013 // Agronomy and Soils // Departmental Series No. 328 // Alabama Agricultural Experiment Station // William Batchelor, Director // Auburn University, Auburn, Alabama

## GENERAL INFORMATION ON BIOMASS, FORAGE AND SEED PRODUCTION

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Photo by Dr. J. Mosjidis

**S**unn hemp (*Crotalaria juncea* L.) is the fastest growing species of the genus *Crotalaria* and is the most widely grown green manure in the tropics. It is also grown as a fiber and animal fodder crop. It is thought that this plant originated in the Indo-Pakistani sub-continent, where it has been cultivated for many centuries and grows in the wilderness. Sunn hemp is a legume adapted to a wide range of environmental conditions and soil types. It produces high

biomass yields, fixes N and is resistant to several nematodes. Thus, it can be used as a summer cover crop to protect and conserve soil and water resources, reduce surface water pollutant transport, and improve soil productivity.

Auburn University recently released two cultivars of sunn hemp, 'AU Golden' and 'AU Durbin,' that can produce seed in subtropical/temperate climates of the continental U.S. Until this recent development, this plant was able to produce seed only in tropical environments.

Alabama Agricultural Experiment Station research programs are conducted by scientists at Alabama A&M University, Auburn University and Tuskegee University and at research and extension centers across Alabama. Research is also coordinated with scientists at other state universities, at universities in the Southeast and at USDA Agricultural Research Service locations throughout the state and region. AAES research is supported by the National Institute of Food and Agriculture whose mission is to advance knowledge for agriculture, the environment, human health and well-being and communities by supporting research, education and extension programs in the Land-Grant University System and other partner organizations. The work conducted on sunn hemp was partially supported by The Alabama Farmers Federation, ALFA - Wheat and Grain Committee.

**Seedbed preparation:** Sunn hemp can be planted on a well-prepared seed bed or can be no-till planted after wheat or maize

**Seeding rate for biomass/forage production:** 30-50 lb/a. Sunn hemp seed does not need scarification to germinate.

**Seeding rate for seed production:** 10-20 lb/a. Higher seeding rates tend to reduce stem diameter, thus combining would be easier. Seed yields are higher when the seed is drilled at 15-20 lb/a. Seeding for seed production could also be done in rows spaced 30-40 inches apart using seeding rates of about 4 lb/a.



AU Golden seed (Photo by Dr. J. Mosjidis)



AU Durbin seed (Photo by Dr. J. Mosjidis)

AU Golden and AU Durbin grow very fast (about 12 inches per week under good environmental conditions). They can outgrow and smother weeds. They are resistant to nematodes, especially reniform nematode. AU Golden and AU Durbin can produce seed in subtropical/temperate climates (continental USA)

**Seeding method:** Seed it with a grain drill. Sowing in widely separated rows can also be done. However, weeds will be more of a problem because of reduced early ground shading. Furthermore, this practice is not advisable in the southeastern U.S., where storms with strong winds during summer have the potential to cause stem breakage and plant lodging. The grain drill can be regulated using information from the table below.

SEEDS/FT	ROW LENGTH (FT)	SEEDS NEEDED	SEED(G)/ROW	LB/A
1	30	30	1.02	5.5
1.5	30	45	1.53	8.2
2	30	60	2.04	11.0
3	30	90	3.06	17.0
4	30	120	4.08	22.5
5	30	150	5.10	28.0
6	30	180	6.12	33.5
7	30	210	7.14	39.0
8	30	240	8.16	45.0
9	30	270	9.18	50.5
10	30	300	10.2	56.0
11	30	330	11.2	61.5

Sunn hemp seed rates based on a seed weight of 3.4 g or 0.12 oz/100 seeds and using a grain drill with rows 7" apart.

**Seeding depth:** Half an inch

**Seeding date:** Sunn hemp is a warm-season crop, thus it is intolerant of frosts. For biomass production, it can be planted after the last frost in the spring to about 60 days before the first frost in autumn. In the Gulf Coast states, planting would roughly be from late April to late August (early September in the southernmost locations). Plants will have less growth planted either early or late in the season. Maximum growth is attained from middle May to middle July. For seed production, sunn hemp should be planted as soon as possible after the last frost in the spring. This reduces plant height and facilitates seed harvesting.

AU Golden and AU Durbin can fix up to 160 lb/a of N. Also, they leave residues on top of the ground that add phosphorous, potassium, calcium and magnesium to the top soil. Sunn hemp is quite drought tolerant once it is established.

**Soil types:** Sunn hemp is a legume adapted to a wide range of environmental conditions and soil types. It is drought tolerant once established. However, it is not tolerant of waterlogging, as plants become stunted and yellowish. Sunn hemp is very sensitive to hypoxia, a deficiency of oxygen in the soil due to temporary flooding. Plants become shorter and a perfect stand may be reduced to near nothing if water accumulates for a long time because of poor drainage.

**Production of N and other minerals:** Cowpea-type bacteria infect sunn hemp roots and fix N. Cowpea-type bacteria are commonly found in soils, but it may be in low numbers or lacking in some soils. In the latter case, seeds may need to be inoculated. Cultivars of sunn hemp selected at Auburn University that are adapted to temperate climates have been found to fix about 30-160 lbs N/a depending on plant growth which in turn depends on many other factors, such as planting date, location, etc. For example, 'AU Golden,' averaged across several planting dates and locations, produced 89 lbs/a of N, 22 lbs/a of P<sub>2</sub>O<sub>5</sub>, 83 lbs/a of K<sub>2</sub>O, 38 lbs/a of Ca, and 40 lbs/a of Mg in the plant residue left on top of the ground.

**Growth Habit:** Plants are erect, fast growing and tall and produce a high amount of biomass, which allows them to compete effectively with weeds. We have measured a growth rate of 1 ft (30 cm) per week when moisture and temperature are adequate. Plants can grow 1.5 ft (45 cm) per week after a dry spell if moisture and temperature return to adequate. Plant growth is not that fast for early plantings. Plants seeded in April grow

about 3 inches (7.5 cm) per week in the first 30 days. Sunn hemp plants have the main stem and some branches ending in an inflorescence with yellow flowers. If water is available and temperature is adequate, plants keep on producing new branches that will end in an inflorescence. Plant height may be between 4 and 6 ft (120 and 180 cm) when planted early in the season for seed production. Plant height is highly dependent on seeding date, soil depth, and other environmental factors such as temperature, day length and rainfall.

**Weed control:** Our research has shown that there are two pre-emergence applied herbicides that have been found to be effective but are not labeled specifically for sunn hemp. They are pendimethalin (example of commercial names: Pendant 3.3 EC, Prowl 400) and imazethapyr (example of commercial name: Pursuit). The imazethapyr product label states that it can be "used in forage legumes used as a cover crop." Pendimethalin can be used at rates of 0.8-1.0 lb/a = 0.9-1.12 a.i. kg/ha. Pendimethalin can be lightly incorporated into the soil surface if desired. This may increase efficacy but is not required by the label. Imazethapyr would be particularly useful when nutsedge is present (at 0.06 a.i. lb/a = 0.07 kg/ha) (a.i. is active ingredient).

Sunn hemp is tolerant of 2,4-DB (example of commercial name: Butyrac 200) applied post emergence for control of non-legume broadleaf weeds. Butyrac is labeled for seedlings of forage legumes.

**Sunn hemp for weed control:** Sunn hemp can outgrow and suppress weeds. There are strong indications that sunn hemp can inhibit the growth of some weeds, i.e., it is allelopathic to those weeds. Our research has shown that 4-5 sunn hemp plants per square foot could reduce weed biomass by about 50 percent. Seeding sunn hemp in narrow rows with a grain drill will help to reduce weed problems because it will shade the weeds faster. Weeds such as nutsedge (*Cyperus rotundus* L. and *C. esculentus* L.) will be more difficult to suppress. High densities of this weed may severely limit sunn hemp establishment.

**Weediness:** Although most *Crotalaria* species are wild and some of them have become a weed in the U.S., sunn hemp is a plant that has been cultivated for many centuries. It has a low potential to become a weed where it is introduced. The Pacific



Sunn hemp can be grown as a cover crop (green manure) to fix N and produce surface plant residue that will help to cover and protect the soil from erosion. Planting date is a major determinant of how much biomass the cultivars will produce.

Island Ecosystems at Risk (PIER) program of the Institute of Pacific Islands Forestry (USDA-Forest Service) ([http://www.hear.org/pier/wra/pacific/crotalaria\\_junceae\\_htmlwra.htm](http://www.hear.org/pier/wra/pacific/crotalaria_junceae_htmlwra.htm)) evaluated sunn hemp for its potential to become a weed and determined that it had a score of -3, which indicated low risk. Similar scores were obtained at Auburn University for the new cultivars developed. Nevertheless, plants can volunteer in a field previously cultivated for seed production, though this can happen with most crops. Late plantings, such as those after corn, will not produce seed.

Sunn hemp can be killed if sprayed with a standard rate of glyphosate (example of commercial names: Roundup® or similar product). A rate of 0.75 to 1.00 a.e. lb/a should be more than adequate (a.e. is acid equivalent).

**Seed toxicity:** Sunn hemp seeds do not cause acute toxicity (but other *Crotalaria* species such as showy crotalaria do cause it) in animals. However, seeds should not be considered foodstuff and they should not be included in large amounts (more than 0.5%) and/or for long periods of time in an animal diet. Extended use may cause reduced performance, and prolonged feeding increases the potential for animal death. Sunn hemp seeds contain a small amount of some toxic compounds (pyrrolizidine alkaloids), whereas other *Crotalaria* species have much higher amounts of these compounds. Studies at Auburn University and other places have shown that sunn hemp seeds do not cause acute toxicity, even to broiler chickens, which are very sensitive to pyrrolizidine alkaloids.



Showy crotalaria seed (Photo by Dr. J. Mosjidis)

**Uses:** Sunn hemp can be grown:

- *as a cover crop* (green manure) to fix N and produce surface residue that will help to cover and protect the soil from erosion. It is especially valuable as a cover crop particularly for no-till or other conservation tillage systems. Furthermore, sunn hemp can suppress many plant parasitic nematodes and can control reniform nematode (*Rotylenchulus reniformis*).
- *for weed control*. When temperature and day length are adequate, sunn hemp can outgrow and smother weeds.
- *as a forage*. Preliminary research indicates that it will be readily grazed by goats and sheep before plants start blooming. Goats will eat the top of the stems and all leaves of the more mature stem section.
- *for fiber production*, because stems have a long fiber that can be used to produce high-quality paper.

**Growth Area:** The new cultivars can be grown throughout Alabama and probably in most of the U.S. They have been successfully grown in Alabama, Arkansas, and Arizona, and preliminary observations indicate that they can be grown in Puerto Rico for forage/biomass. The plants need temperatures over 50 F (10 C) for the seed to germinate and grow. Establishment is fast (only a few days) if soil moisture and temperature are adequate.

**Maturity:** Plant height and flowering are highly dependent on day length and temperature. Plants start to flower 5-6 weeks after planting. Additional biomass accumulation is minimal after flowering. Therefore, when growing sunn hemp for biomass production, plants should be killed or cut when they are flowering. For forage production, it is better to harvest when the plants are about 2 feet tall. As the plant gets closer to flowering, the stem will get particularly fibrous and woody.



**Biomass yield:** Plants need to be harvested no later than flowering time because, as the plant matures, the stems become too fibrous and difficult to cut. This is particularly important for late plantings. Sunn hemp can produce biomass yields of 1,800 to over 10,000 lb/a of dry matter in 40-50 days (from planting till the first flowers appear). The actual amount depends on planting date, location, and environmental conditions.

Table 1. Estimates of dry matter biomass yield of new sunn hemp cultivars adapted to temperate climates measured at Shorter and Tallassee, AL, in 2009

PLANTING DATE	*BIOMASS YIELD (LB/A)	N PRODUCTION (LB/A)
Early season (end of April-early May)	1,800-3,000	30-70
Mid season (after wheat, second half of June)	7,800-10,000	130-160
Late season (after corn, second half of August)	2,200-4,100	45-90

Sunn hemp biomass yield is highly dependent on day length (planting date and location), temperature and soil depth.

AU Golden and AU Durbin can produce and leave on top of the ground up to 10,000 lb/a of dry plant residues. Soil Nematodes: These cultivars are either resistant or very poor host of many nematodes. Sunn hemp is used to suppress plant nematodes.

**Seed yield:** Field tests indicate that sunn hemp can produce 700 to 2,000 lb/a of seed when seeded in narrow rows with a grain drill. Sowing it in wide rows has been found to produce lower seed yield. The presence of a large number of pollinators during flowering is critical for good seed setting. Insects reported to be good pollinators of sunn hemp that are present in the U.S. are bumblebees (*Bombus* spp.) and carpenter bees (*Xylocopa* spp.). Honey bees (*Apis mellifera*) are not as effective in pollinating the flowers. Another good pollinator of sunn hemp is *Megachile lanata* Fabr, which has appeared in parts of Florida but does not seem to be established in the U.S. Under field conditions, seed yield has been from about 400 to 1,800 lb/a.

**Forage production:** Sunn hemp plants can be grazed by goats and sheep. Grazing can start when plants are about 1.5-3 ft (45-90 cm) tall. Leaf quality is high (about 4-5% N equivalent to 25-30% protein, 22-28% NDF, 22-27% ADF) whereas stems have low quality (about 1.3-1.7% N equivalent to 8-10% protein, 74-76% NDF, 64-65% ADF); however, stems provide the bulk needed by ruminants. A dense stand that grows until flowering may lose some of the lower leaves, thus the proportion of leaves in relation to stems may be reduced and forage quality may suffer. When 80% of the plants are blooming, 35-40% of the biomass is made up of leaves. As a result, early harvesting is better for forage use because the plants are less mature and they contain a higher proportion of high forage quality leaves.

AU sunn hemp cultivars have leaves with high protein content (up to 30%). In other parts of the world sunn hemp is fed to ruminants. Early harvesting is better for forage use because plants are less mature and contain a higher proportion of high quality leaves.



Goats grazing .AU Golden' sunn hemp (Photo by Dr. J. Burke)

**Regrowth:** Sunn hemp plants may regrow after being cut at least 12 inches (30 cm) from the ground. Thus a field harvested for seed may regrow and produce additional biomass. Regrowth is dependent on stubble size and weather conditions.

**Insects:** Young plants in early plantings can be affected by thrips, but they grow out of the damage as soon as temperatures warm up.

Late plantings for seed production are susceptible to pod infestation by Southern green stink bug (*Acrosternum bilare*) and other species of stink bug. Seeds will mold in the pod due to the damage. The best control is to plant early to prevent the problem.

Bella Moth (*Utetheisa ornatatrix* L.) larvae can damage pods on the plant in some regions. Larvae of this moth are specialized *Crotalaria* seed eaters. Stored seed can be damaged by Indian meal moth larvae (*Plodia interpunctella* Hübner), a common moth that can damage flour, grains, and a variety of seeds and stored foodstuff.

**Nematodes:** Sunn hemp is either resistant to or a very poor host of many plant parasitic nematodes (*Meloidogyne arenaria* race 1, *M. incognita* race 1, and

*M. javanica*). Actually, it can reduce populations of reniform nematode. Sunn hemp is used to suppress plant root nematodes.

**Diseases:** No major problems have been observed up to now, but an occasional plant may show virus symptoms.

**Plant Parasites:** Sunn hemp can be parasitized by dodder (*Cuscuta* spp. L).

**Seed harvesting:** Seeds can be easily harvested with a combine when most of the pods (about 70-80%) are mature. Seed maturity can be recognized by the rattling sound of the seeds within the pods. When seeds are mature, they fall to the lowest end of the pod, thus shaking the plant will produce a rattling sound. If needed, defoliation of the plants can be accomplished by spraying with a mixture of gramoxone and sodium chlorate or with a 50% solution of liquid nitrogen. Plants can be harvested with a combine with a standard header (grain platform) that needs to be raised to reduce the amount of straw going in. Concave clearance and cylinder speed need to be adjusted as needed depending on the crop conditions.

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## Literature

- Balkcom, K., Jessica M. Massey, Jorge A. Mosjidis, Andrew J. Price and Stephen F. Enloe. 2011. Planting Date and Seeding Rate Effects on Sunn Hemp Biomass and Nitrogen Production for a Winter Cover Crop. *International Journal of Agronomy* vol. 2011, Article ID 237510, 8 pages. doi:10.1155/2011/237510.
- Burke, J.M., J.A. Mosjidis, J.E. Miller, and P. Casey. 2011. Sunn hemp with chicory or pearl millet to minimize gastrointestinal nematode infection in weaned goats. *J. Anim. Sci.* 89 (E-Suppl. 2) :17-18 (Abstr.).
- Hess, J.B., and J.A. Mosjidis. 2008. Effect of sunn hemp seed inclusion in broiler starter diets on live performance attributes. *J. Appl. Anim. Res.* 33:105-108.
- Ji, X., I Khan, J.A. Mosjidis, H. Wang, and P. Livant. 2005. Variability for the presence of pyrrolizidine alkaloids in *Crotalaria juncea* L. *Pharmazie* 60:620-622.
- Kelton J. A., A. J. Price, and J. Mosjidis. 2012. Allelopathic Weed Suppression through the use of Cover Crops. pp. 115-130. In: Price (ed.) *Weed Control*. Intech Press, Rijeka, Croatia. 276 pp. ISBN 978-953-51-0159-8 <http://www.intechopen.com/books/show/title/weed-control>.
- Marla, S.R., R.N. Huettel, and J. Mosjidis. 2008. Evaluation of *Crotalaria juncea* populations as a summer cover crop to manage *Meloidogyne incognita* and *Rotylenchulus reniformis*. *Nematropica* 83:155-162.
- Mosjidis, J.A. 2004. Development of Seed-producing Sun Hemp Cultivars for the Southeast. Annual Meeting of the Southern Branch ASA, June 27-29, 2004, Biloxi MS. CD-ROM.
- Mosjidis JA. 2006. Legume breeding and their utilization as forage and cover crops. In: Proc. 60th Southern Pasture and Forage Crop Improvement Conf, Auburn, Alabama, 12 April, 2006. CD-ROM, <http://spfcic.okstate.edu/proceedings/2006/mosjidis.pdf> (verified 19 Sept. 2011).
- Mosjidis, J.A. 2007. Breeding of annual and perennial legumes and their utilization as forage and cover crops. *Field Veg. Crops Res. (Zbornik Radova)* 44 (II): 7-11.
- Mosjidis, J.A. 2010. Performance of Sunn Hemp cultivars developed at Auburn University. Annual Meeting Abstracts. Laguna Beach, CA: ASA, CSSA, SSSA. CD-ROM.
- Mosjidis, J.A., and G. Wehtje. 2011. Weed control in Sunn Hemp (*Crotalaria juncea* L.) and its ability to suppress weed growth. *Crop Prot.* 30:70-73. doi:10.1016/j.cropro.2010.08.021.
- Mosjidis, J. A., and M. L. Wang. 2011. *Crotalaria*. p. 63-69. In: Kole, C. (ed.) *Wild Crop Relatives: Genomic and Breeding Resources, Industrial Crops*, Springer. doi: 10.1007/978-3-642-21102-7\_3.
- Mosjidis, J.A. 2011. Breeding of Forage Legumes and their Use as Green Manure and Cover Crops in the Southeast-USA. *Agrociencias* 2011, October 19-21, Havana, Cuba.
- Mosjidis, J. A., J. M. Burke, and J. B. Hess. 2012. The facts about sunn hemp toxicity. *Crop Science* 52:1469-1474.
- Price, A., J. Kelton and J. Mosjidis. 2012. Utilization of Sunn Hemp for Weed Control in Temperate Climates. pp.101-114. In: Price, A. (ed.) *Weed Control*. InTech, Rijeka, Croatia. 276 pp. ISBN: 979-953-307-318-6 <http://www.intechopen.com/articles/show/title/utilization-of-sunn-hemp-for-cover-crops-and-weed-control-in-temperate-climates>.
- Román, A., H. Ramsurn, R. Gupta, and J. Mosjidis. 2012. Subcritical Water Extraction of Sunn Hemp-Derived Protein. Society of Hispanic Professional Engineers, Nov. 14-18, Fort Worth, TX.
- Wang, M.L., J.A. Mosjidis, J.B. Morris, R.E. Dean, T.M. Jenkins, and G.A. Pederson. 2006. Genetic diversity of *Crotalaria* germplasm assessed through phylogenetic analysis of EST-SSR markers. *Genome* 49:707-715.