Evaluation and Use of Sunn Hemp (*Crotalaria juncea* L.) at the Manhattan Plant Materials Center, Manhattan, Kansas

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Introduction

Sunn hemp (*Crotalaria juncea* L.) is an annual tropical legume that was identified in the 1930's as a green manure and cover crop and also as livestock feed. However, because there has been a limited supply of seed, it has not been widely used in the United States (U.S.). Sunn hemp is very sensitive to frost and does not produce seed above 28 degrees north latitude; therefore, it has little potential to become a weed problem in the continental U.S. Until recently, sunn hemp has not been ideal forage for livestock because it contains high levels of poisonous alkaloids. The variety 'Tropic Sun,' released cooperatively by the University of Hawaii and the U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS) Hawaii Plant Materials Center, produces very low amounts of alkaloids making sunn hemp a viable option for livestock forage, giving it potential for use as a cover crop that can also be grazed. There has been some research conducted to determine the viability of sunn hemp and other summer legumes as a forage biomass crop for biofuel production (Cantrell et al. 2010). Plantings of sunn hemp were established in 2009 and 2010 at the NRCS Manhattan Plant Materials Center (PMC) to measure major characteristics of sunn hemp that are important for biofuel, cover crop, and livestock forage (Figure 1).

Figure 1. Rich Wynia, PMC Manager, standing in sunn hemp with stems from harvest.

Methods

Just prior to planting in both the 2009 and 2010 growing seasons, the sunn hemp seed was inoculated with the *Bradyrhizobium* sp.cow pea-type inoculant. On 21 May 2009 sunn hemp was planted at 56 kg/ha (50 lbs/acre) with 18 cm (7 inch) row spacing. Plant height and above-ground biomass were recorded at 30, 60, and 90 days after planting (DAP). Forage analysis of the sunn hemp was conducted from each of the harvest dates.

Sunn hemp was planted on 12 July 2010 at 22.4, 44.8, and 67.2 kg/ha (20, 40, and 60 lbs/acre, respectively), at 18 cm row spacing, using a split plot design, with four replications. This planting date corresponds with the time period that would allow a producer to plant sunn hemp as a cover crop between continuous wheat harvesting and planting. Measurements on above-ground biomass (AGB), plant intercepted photosynthetically active radiation (FI-PAR), leaf area index (LAI), and height were taken at 45 and 60 DAP. Measurement of plant density using a frequency grid was made on 29 July 2010 (approximately two weeks after planting). Measurements of stem diameter were made on 8 December 2010 (Figure 2).

Results and Discussion

For the 2009 season, AGB at 30, 60, and 90 DAP was 369, 6402, and 13,756 kg/ha, respectively. The mean height of sunn hemp at 30, 60, and 90 DAP was 0.2, 1.8, and 2.8 meters, respectively. The forage analysis for the samples from the 2009 season revealed that crude protein (CP) for sunn hemp was about 17% at 30 DAP, 11% at 60 DAP, and 9% at 90 DAP.

The results of the 2010 growing season for 45 and 60 DAP are presented in Table 1. Two weeks after planting, the plant density was 19.6, 28.0, and 36.6 plants/m^2 for the 22.4, 44.8, and 67.2 kg/ha seeding rates, respectively. Mean stem diameter was 12.23, 10.09, and 8.93 mm for the 22.4, 44.8, and 67.2 kg/ha seeding rates, respectively. Analysis of variance (α=0.05) was used to test for significant difference between seeding rates, harvest dates, and plant densities.

Table 1. Results of 2010 Sunn Hemp Study at the PMC.

DAP	Seeding Rate (kg/ha)	Mean Plant Height (meters)	Mean AGB* (kg/ha)	Mean FI-PAR	Mean LAI
45	22.4	1.8	5239 (A)	0.838	5.43
	44.8	1.8	5420 (A)	0.961	6.98
	67.2	1.8	6049 (A)	0.977	8.05
60	22.4	2.2	7861 (B)	0.961	6.79
	44.8	2.2	8217 (B)	0.988	7.57
	67.2	2.2	8303 (B)	0.992	8.13

*Means within a column followed by the same letter are not significantly different (α=0.05).

Forage analysis in 2009 indicated that sunn hemp starts to lose crude protein content as the plant grows past 30 days. This has implications depending on the intended use of sunn hemp. If the sunn hemp is to be grazed, there is a trade-off between CP content of the plants and the available forage quantity. If sunn hemp is allowed to grow to 90 DAP or more it can gain considerable height and above AGB. However, the CP content is going to decrease. Even at 9% CP sunn hemp could provide the needed protein for typical livestock consumption. 'Tropic Sun' sunn hemp has an alkaloid content of around 0.11% and has been fed to Hereford calves for two months without ill effects (Williams 1978). Using sunn hemp as a grazed cover crop or as a hayed forage crop could be a viable option.

For the 2010 study, although there was a significant difference in plant density between the three seeding rates ($P \leq 0.05$), there was not a significant difference in the AGB related to the three seeding rates at 45 or 60 DAP. The mean plant heights for the three seeding rates were the same and thus there was no difference in height of the plants based on varying levels of seeding rates.

Results and Discussion (cont.)

The mean stem diameter measurements indicate a trend that as seeding rate was increased there was a decrease in the mean stem diameter of the plants. There was a significant difference ($P \leq 0.05$) in the AGB between the sampling dates, as the sunn hemp produced 175, 188, and 150 kg AGB/ day for the 22.4, 44.8, and 67.2 kg/ha seeding rates, respectively, between the 45 and 60 DAP sampling periods.

There is a difference of $120/acre for seed if a producer were to plant a 20 lbs/acre rate instead of a 60 lbs/acre rate. The AGB difference between the 20 lb and 60 lb planting rates at the PMC was 2.5 tons/acre. This equates to $80/ton for the extra 2.5 tons produced. Thus planting at a higher rate is not necessarily economical if the intended use is for livestock forage.

If a producer could quickly and easily use a ceptometer to estimate AGB at a future date, then they might have an opportunity to contract with a biofuel production facility for a certain amount of AGB. Measurements of mean FI-PAR and mean LAI were calculated from ceptometer readings to determine if future AGB yield could be predicted. However, further studies need to be conducted to determine if this method is an option.

Figure 2. Don Garwood, Biological Science Technician (L), Wynia (M), and Jerry Longren, Biological Science Technician (R) harvesting sunn hemp after killing frost. Notice how the leaves have fallen from the stems.

The future of sunn hemp use in the U.S. will be largely determined by the availability and the price of sunn hemp seed, as well as the understanding of how and where it grows. A reasonable expectation of results is also needed in order to market the use of sunn hemp to producers that will grow it. Due to it producing seed only in tropical and sub-tropical climates, there is a limited geographical area in which seed can be harvested. Other studies that look at soil nutrients before and after planting, adaptability, and AGB production need to be conducted to develop the technology needed to make sunn hemp a crop that could be widely used as a cover crop, livestock forage, or bioenergy production.

Literature Cited

Cantrell, K.B, P.J. Bauer, and K.S. Ro. 2010. Utilization of summer legumes as bioenergy feedstocks. Biomass and Bioenergy 34. 1961-1967.

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