Cover Crop Diversity through Evaluation and Increase from Breeder Stocks and Germplasm Repositories

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Introduction

Cover crops can contribute to a sustainable cropping system by providing ecosystem services such as improved soil health and suppression of weeds and nematodes. The existing cover crop cultivars exhibit certain constraints, which may be addressed by introducing alternative germplasm after appropriate evaluation. The sunn hemp (*Crotalaria juncea*) cultivars Tropic Sun and AU Golden have the respective shortcomings of the short-day cultivar's inability to consistently set seed within the continental US and the day neutral cultivar having low biomass production. 'Iron Clay' cowpea (*Vigna unguiculata*) produces hard seed that can cause volunteer plants to emerge in subsequent cash crops. Therefore, the objective of this study was to compare alternative germplasm lines of sunn hemp (Sanni) and cowpea (US-1136, US-1137 and US-1138) with the commercially available cultivars to determine their capability in suppressing weeds and producing equivalent or higher biomass. A commercially available slenderleaf rattlebox (*Crotalaria ochroleuca*) cultivar 'Mini Red Hemp' was also assessed.

Materials and Methods

- **Study Location**: University of Florida, IFAS Plant Science Research and Education Unit, Citra, FL in Summer, 2017.
- **Experimental Design**: Randomized complete block with four replications. Plot size was 20 ft × 20 ft with 5 ft alleys between plots.
- **Treatments**: Four commercial cultivars along with four germplasm lines of different species were tested (Table 1). Seeds were broadcast by hand on June 22.
- **Data collected**: Cover crop biomass, weed biomass and weed density were collected using two randomly placed quadrats 0.5 m × 0.5 m per plot at 4 and 8 weeks after planting (WAP). Weeds and cover crop samples were dried in oven at 65ºC and weighed. Weeds were counted separately for each group of broadleaf, grass, and sedge. Photosynthetically active radiation (PAR) was measured using an AccuPAR ceptometer at 2, 4, 6, and 8 weeks after planting. Data were subjected to the GLIMMIX procedure of SAS (version 9.2 SAS Institute Inc., Cary, NC) and means were separated by using DIFF option of the LSmeans statement at $P \leq 0.05$. Means followed by same letter were not significantly different at $P \leq 0.05$.

Table 1. Cover crop species and seed rates.

Treatment	Seed rate (lb/ac)
Sanni	40
AU Golden	40
Tropic Sun	40
US-1136	49
US-1137	41
US-1138	32
Iron Clay	22
Slenderleaf Rattlebox	20

Results

Table 2. Cover crop biomass accumulation at four and eight weeks after planting.

Treatment	4 WAP	8 WAP
	kg ha^{-1}	
Sanni	724 a	3534 ab
AU Golden	419 bc	2801 b
Tropic Sun	548 ab	3922 a
US-1136	178 cd	1424 cde
US-1137	412 bc	1636 cd
US-1138	333 bc	1768 c
Iron Clay	279 c	741 de
Slenderleaf Rattlebox	11 d	462 e
P-value	< 0.0001	< 0.0001

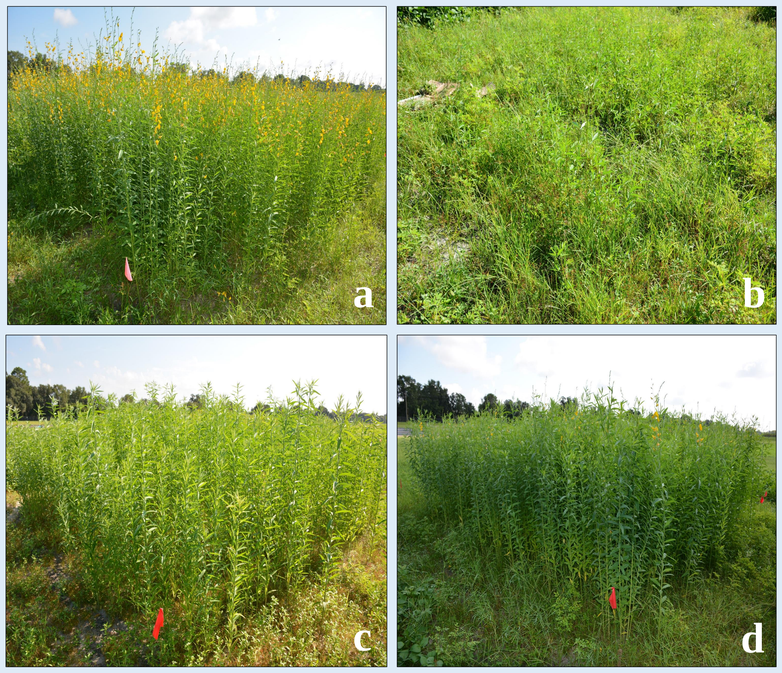

Figure 1. Cover crop species at 8 weeks after planting: *Crotalaria juncea* cv. AU Golden (a), *C. ochroleuca* cv. Mini Red Hemp (b), *C. juncea* cv. Tropic Sun (c), and germplasm line Sanni (d).

Figure 2. Cover crop species at 8 weeks after planting: *Vigna unguiculata* germplasm lines: US-1136 (e), US-1137 (f), US-1138 (g), and cv. Iron clay (h).

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Table 3. Weed biomass in response to cover crop species at 4 and 8 weeks after planting.

Treatment	4 WAP				8 WAP			
	Broadleaf	Grass	Sedge	Total	Broadleaf	Grass	Sedge	Total
	kg ha^{-1}							
Sanni	152	175 a	318	646 a	244 cd	257	495	996 c
AU Golden	123	136 ab	194	453 bc	392 bc	267	352	1011 c
Tropic Sun	114	117 abc	234	465 abc	375 bcd	280	444	1099 bc
US-1136	137	139 ab	252	527 ab	324 bcd	402	504	1231 abc
US-1137	114	124 ab	163	401 bc	317 cd	413	372	1102 bc
US-1138	100	133 ab	300	533 ab	207 d	162	569	938 c
Iron Clay	116	42 c	145	303 c	503 ab	226	802	1531 ab
Slenderleaf Rattlebox	180	82 bc	169	430 bc	595 a	394	691	1680 a
P-value	0.67	0.049	0.22	0.04	0.0012	0.15	0.26	0.02

Table 4. Weed density in response to cover crop species at 4 and 8 weeks after planting.

Treatment	4 WAP				8 WAP			
	Broadleaf	Grass	Sedge	Total	Broadleaf	Grass	Sedge	Total
	plants m^{-2}							
Sanni	249	54	146	450	158 bc	69	148	376 abc
AU Golden	215	50	104	370	206 ab	72	113	391 abc
Tropic Sun	203	88	182	473	173 ab	68	138	379 abc
US-1136	194	64	137	395	144 bc	80	117	341 bc
US-1137	188	73	109	371	128 bc	68	142	338 bc
US-1138	173	79	219	472	83 c	46	154	284 ab
Iron Clay	169	46	156	371	181 ab	62	208	451 ab
Slenderleaf Rattlebox	215	54	100	369	246 a	80	185	511 a
P-value	0.92	0.28	0.17	0.43	0.017	0.88	0.5	0.05

Table 5. Percent photosynthetically active radiation penetrating the cover crop canopy at 2, 4, 6, and 8 week interval.

Treatment	2 WAP	4 WAP	6 WAP	8 WAP
Sanni	87 d	49 d	65	51 bcd
AU Golden	92 bc	75 bc	63	55 abc
Tropic Sun	91 bcd	63 cd	66	49 d
US-1136	93 abc	71 bc	64	54 abcd
US-1137	92 bcd	61 cd	63	56 ab
US-1138	89 cd	68 bc	63	54 abcd
Iron Clay	95 ab	83 ab	65	50 cd
Slenderleaf Rattlebox	97 a	91 a	64	58 a
P-value	0.0011	<0.0001	0.12	0.012

Conclusions

- **Among sunn hemp cultivars, Tropic Sun produced considerably higher shoot biomass than AU Golden by 8 weeks after planting (WAP); however, Sanni biomass was not significantly different from Tropic Sun.**
- **Suppression of weed biomass and density was not statistically different among sunn hemp cultivars.**
- **Slenderleaf rattlebox had low shoot biomass accumulation and weed suppression as compared to other *Crotalaria* species.**
- **No significant difference was found in biomass accumulation among the alternative cowpea germplasm lines, but only US-1138 produced more biomass than 'Iron Clay'.**
- **Broadleaf weed density with US-1138 cowpea was significantly lower than with 'Iron Clay' by 8 WAP and may account for the lower broadleaf and total weed biomass with US-1138 than with 'Iron Clay'.**
- **At 4 WAP, Sanni had the lowest PAR penetrating the canopy which was not significantly different from 'Tropic Sun' and US-1137.**