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Cape May Plant Materials Center

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Effect of Seeding Rates and Termination Dates on Productivity of ‘Tropic Sun’ Sunn Hemp in Southern New Jersey

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ABSTRACT

The use of sunn hemp (*Crotalaria juncea*) has widely been recommended for green manure and cover crop applications for its rapid growth rate and ability to fix N. The anticipated use of sunn hemp in the Mid-Atlantic region is as a 45-60 day summer cover crop or green manure crop that will provide soil health benefits and contribute to N accumulation. The Plant Materials Program conducted a national study from 2009-2010 to evaluate ‘Tropic Sun’ sunn hemp for cover crop and green manure applications throughout the United States. Tropic Sun was drilled at 20, 40, and 60 lb pure live seed (PLS) per acre and terminated at 45 and 60 days after planting (DAP). Seeding rates evaluated had less impact on performance attributes monitored (biomass production and absolute height) than termination dates. Seeding rate treatments did not significantly affect biomass production. Plant height was significantly reduced at the 60 lb/ac treatment. Both height and biomass production were significantly greater at the 60 DAP termination compared to the 45 DAP termination treatment. The lower seeding rates and later termination date provided the most optimal and economical agronomic strategy for summer cover crop or green manure crop applications in southern New Jersey.

INTRODUCTION

The New Jersey Plant Materials Center (NJPMC) was one of 25 USDA Natural Resources Conservation Service (NRCS) Plant Materials Centers (PMC) to participate in a national regional adaptability evaluation of Tropic Sun. Sunn hemp is a tropical or sub-tropical legume adapted to a wide range of soils (Cook & White, 1996). It displays several key beneficial attributes making it an ideal candidate as a green manure or cover crop species. It is capable of rapid production of large biomass yields. It is also capable of fixation of N, resulting in plant usable N in amounts that can reduce the need for application of nitrogenous fertilizers (Balkcom & Reeves, 2005; Berriel et al., 2020; Perin et al., 2004; Rotar & Joy, 1983; Singh et al., 1992). Its fast growth makes it a viable option to have vegetative cover on fields in the Mid-Atlantic region to fill the short window between the harvest of a summer production crop and planting of a fall cover crop or production crop (Clark, 2007). Sunn hemp is also drought resistant and displays a high tolerance for root-knot nematodes, even demonstrating nematode population reductions (Cook & White, 1996). When utilized as a cover crop or green manure, sunn hemp can produce 4,000-7,500 pounds of biomass and 140-225 pounds of N per acre in southeastern United States climates (Watkinsville and Tifton, GA; USDA Plant Hardiness Zones 8a and 9a respectively) 60-90 days after planting (Schomberg et al., 2007). Tropic Sun was developed for use in cover crop applications and as a green manure in rotation with production crops to increase organic matter and N, suppress weeds, and reduce root-knot nematodes (NRCS, 2021). Appropriate seeding rate and timing of termination are critical for the use of Tropic

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Sun in the Mid-Atlantic coastal region to harness the potential cover crop and green manure benefits. The objective of this study was to examine the effect of seeding rates and termination dates on biomass yield and height of Tropic Sun in the Mid-Atlantic coastal region.

MATERIALS AND METHODS

The study was conducted at the NJPMC in Cape May Court House, NJ (39.123470, -74.783196; MLRA 153D Northern Tidewater Area) in a Downer sandy loam (Soil Survey Staff, n.d.). A weed free planting area for the study was prepared using tillage equipment in the spring. The study used a split plot randomized complete block design (Figure 1) with four replications of three primary treatments (seeding rates of 20, 40, and 60 lb PLS/ac) assigned to main plots. Biomass harvest (termination) dates at 45 and 60 DAP were assigned as sub-plot treatments. Study seeding rates were based on the recommended range of Tropic Sun seeding rates (NRCS, 2021; Rotar & Joy, 1983). Tropic Sun seed was treated with a cowpea type inoculant (*Bradyrhizobium* sp.) and seeded on July 19, 2010, using a grain drill with row spacing of 7 in. The seeding date selected is an approximate date for planting a cover crop between an early summer production crop and fall production crop or winter cover crop. The entire study plot area was 90 x 200 ft with individual plots measuring 28 x 40 ft.

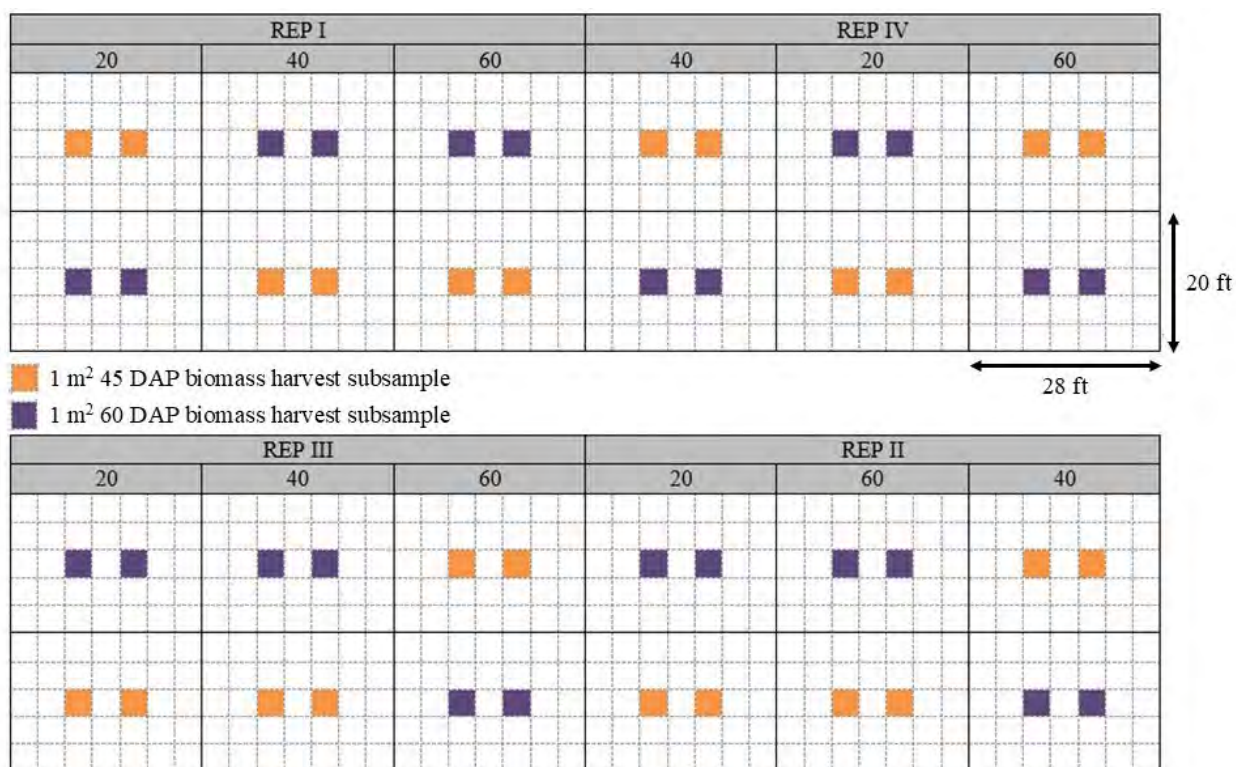


Figure 1. A diagram of the study plots from a Tropic Sun sunn hemp productivity study at the New Jersey Plant Materials Center, Cape May Court House, NJ.

Precipitation the week prior to planting provided sufficient soil moisture for germination. Regular precipitation made irrigation unnecessary for most of the study. The study area was irrigated the week of August 9, 2010, after 2 weeks of minimal (0.07 in) precipitation (Table 3, Appendix) (Office of the New Jersey State Climatologist [ONJSC], 2026).

Height and biomass data were collected on September 2, 2010, and September 17, 2010. Two 1 m²

sample quadrats near the center of each sub-plot (Figure 1) were used to assess plant attributes at the two termination dates. All samples were collected near the center of the sub-plot to avoid skewed results due to any edge effect at the perimeter of the plots. The absolute height of three randomly selected plants in each quadrat was measured from the soil surface as described in the “Plant Height” section of Plant Materials Evaluation Procedures (NRCS, 2019). Biomass production was determined following the “dry matter yield” protocol described in Plant Materials Evaluation Procedures (NRCS, 2019). The sampling procedure was conducted by collecting above ground biomass from each sample quadrat cut at 2 in above soil level. Fresh cut material was weighed and recorded for each quadrat sample. A grab sample (250 g) was pulled from each quadrat sample and oven dried at 140 °F (60 °C) until the weight remained constant. The difference of fresh weight and dry weight for each grab sample was used to calculate percent moisture and dry weight of each quadrat biomass sample.

Statistical analysis of data was conducted using Statistix 10 data analysis software (Version 10.0, Analytical Software, Tallahassee, FL). Prior to analysis, the distribution of residuals for both dependent variables (biomass and height) was evaluated using the Shapiro-Wilk test to determine if the data sets were normally distributed. An ANOVA for a split-plot design test assigned the whole-plot error to the replication × seeding rate interaction, while the sub-plot error was calculated using the residual pool (replication × seeding rate × termination date). Tukey’s Honestly Significant Difference (HSD) test was conducted at the 5% level of significance to determine statistically significant differences of homogeneous groups based on the effect of seeding rate and termination date treatments on height and biomass production.

RESULTS AND DISCUSSION

Initial emergence was observed 2 DAP on July 21, 2010, and reached a full stand (approximately 70% emergence) 9 DAP on July 28, 2010.

Biomass Production

Statistical analysis revealed that the main plot treatment effect of seeding rate and its interaction with termination date significantly influenced Tropic Sun biomass production (Table 2). The standalone main plot treatment effect of seeding rate was not statistically significant (Table 1). Across all treatments, delaying termination from 45 to 60 DAP significantly increased overall average Tropic Sun biomass production from 2,868.4 to 3,510.7 lb/ac.

The seeding rate and termination date interaction displayed distinct biomass production patterns across treatments. At the early termination date (45 DAP), the 60 lb/ac seeding rate resulted in the lowest Tropic Sun biomass production (2,419.6 lb/ac). This was significantly lower than the maximum biomass achieved by the 20 lb/ac rate at 60 DAP (3,611.5 lb/ac). However, when termination was delayed to 60 DAP, biomass at the 60 lb/ac rate increased to 3,514.3 lb/ac, statistically matching all other treatment combinations. Individually, seeding rate treatments between 45 and 60 DAP were statistically negligible for biomass production.

Absolute Height

Tropic Sun absolute height was significantly affected by seeding rate, termination date (Table 1), and their subsequent interaction (Table 2). For the primary treatment effects, the 60 lb/ac seeding

rate resulted in significantly reduced average absolute plant height (37.9 in) compared to the lower seeding rates: 47.1 and 43.5 in at 20 and 40 lb/ac respectively. Delaying termination from 45 to 60 DAP resulted in greater average absolute plant height, increasing from 39.6 to 46.1 in.

The significant seeding rate and termination date interaction indicates a negative correlation between seeding rate and absolute plant height at 45 DAP but that correlation fades when plants are allowed to grow to 60 DAP. At 45 DAP, Tropic Sun plots seeded at 60 lb/ac displayed the least average absolute height at 33.0 in. However, when termination was delayed to 60 DAP, average height at the 60 lb/ac rate increased to 42.8 in, statistically matching all other treatment combinations. Likewise, Tropic Sun plots seeded at 40 lb/ac displayed a significant increase in average height from 40.0 in at 45 DAP to 47.0 in at 60 DAP. In contrast, plots seeded at 20 lb/ac achieved maximum average height potential earlier, displaying no statistical difference between 45 DAP (45.8 in) and 60 DAP (48.5 in).

Table 1. Average biomass and height of Tropic Sun sunn hemp at varied seeding rates and termination dates during a productivity study at the New Jersey Plant Materials Center, Cape May Court House, NJ.

Treatment Factor	Level	Avg. Biomass (lb/ac)	Avg. Height (in)
Rate (lb/ac)	20	3,294.8 a	47.1 a
	40	3,307.3 a	43.5 a
	60	2,966.5 a	37.9 b
Termination Date (DAP)	45	2,868.4 b	39.6 b
	60	3,510.7 a	46.1 a

Means in the same column followed by the same letter are not significantly different at $P < 0.05$ using Tukey's Honestly Significant Difference test.

Table 2. Interaction effects of varied seeding rates and termination dates on biomass production and height during a productivity study of Tropic Sun sunn hemp at the New Jersey Plant Materials Center, Cape May Court House, NJ.

Rate (lb/ac)	Termination Date (DAP)	Avg. Biomass (lb/ac)	Avg. Height (in)
20	45	2,979.0 ab	45.8 ab
20	60	3,611.5 a	48.5 a
40	45	3,207.4 ab	40.0 bc
40	60	3,406.3 ab	47.0 a
60	45	2,419.6 b	33.0 c
60	60	3,514.3 ab	42.8 ab

Means in the same column followed by the same letter are not significantly different at $P < 0.05$ using Tukey's Honestly Significant Difference test.

The statistically insignificant effect of seeding rate on biomass production in this study aligns with the results of other research examining the impact of similar seeding rates on biomass production (Balkcom et al., 2011). The lack of a significant impact of seeding rate on biomass production coupled with the significant effect of seeding rate and termination date interaction indicates that time (DAP) is a critical factor affecting how the resulting plant density influences Tropic Sun performance. These results align closely with the complementary study conducted concurrently at the Big Flats Plant Materials Center near Corning, NY (42.131052, -76.955285; MLRA 140 Glaciated Allegheny Plateau and Catskill Mountains) with termination date demonstrating a stronger impact on both biomass production and absolute height than seeding rate (Clark, 2016).

Results indicate that Tropic Sun plots seeded at the 60 lb/ac rate were subject to overcrowding, suggesting early-stage intraspecific competition for resources. This suppressed absolute height and biomass production at the 45 DAP termination date. However, biomass production and absolute height displayed insignificant differences compared to the lower seeding rates at the later termination date (60 DAP). This interaction has a practical application if weed suppression is the primary objective for the use of Tropic Sun. While the higher seeding rate lagged in biomass production and height compared to lower seeding rates in the early establishment stage, the eventual dense canopy of the higher seeding rate may provide more complete shading to smother weed competition. Additionally, the intense early resource demand from the dense Tropic Sun stand could scavenge resources away from volunteer weed species further reducing weed competition. Research indicates that sunn hemp seeding rates are inversely related to weed biomass due to physical and allelopathic means (Cho et al., 2015; Mosjidis & Wehtje, 2011).

For cover crop and green manure applications, results from this study indicate that the lower seeding rates (20 and 40 lb/ac) combined with the later termination date (60 DAP) provide the most optimal agronomic strategy, reducing seed cost while providing equivalent biomass production compared to the 60 lb/ac rate. Furthermore, delaying termination to 60 DAP allows for additional N fixation and accumulation (Mansoor et al., 1997; Rotar & Joy, 1983).

CONCLUSION

The results of this study demonstrated that Tropic Sun is a viable option for cover crop and green manure applications in the Mid-Atlantic coastal region. Overall, the seeding rates evaluated had less impact on performance attributes monitored than the termination dates. Biomass production was not significantly affected by seeding rate treatments while absolute height was significantly less at the 60 lb/ac rate than lower rates. Termination date significantly affected both plant attributes with the 60 DAP termination resulting in greater biomass production and absolute height.

The primary purpose of this study was to develop information as a resource for NRCS field staff to provide science-based guidance regarding recommended seeding rates and termination dates of Tropic Sun for implementation of NRCS conservation practices Cover Crop (340) and Nutrient Management (590) in the Mid-Atlantic region. However, the most appropriate seeding rate and termination date depend upon the hierarchy of objectives of a Tropic Sun planting. If weed suppression is the primary objective of the planting, a higher seeding rate that results in a shorter stature, denser stand would be preferable to a taller, less compressed stand that will result from a lower seeding rate. If meeting the guidelines and accomplishing the purpose of the conservation practice standard in the most agronomically efficient manner is the primary objective, the lower seeding rates and later termination date provide the most optimal and economic strategy.

The data for the two plant attributes reported in this study are also applicable for plant selection for several other NRCS conservation practices.

Height data are also applicable for plant selection for Conservation Cover (327), Contour Buffer Strips (332), Critical Area Planting (342), Field Border (386), Riparian Herbaceous Cover (390), Riparian Forest Buffer (391), Filter Strip (393), Hedgerow Planting (422), Streambank and Shoreline Protection (580), Cross Wind Trap Strips (589C), Vegetative Barrier (601), and Herbaceous Wind Barriers (603) (NRCS, 2019).

Biomass production data are also applicable for plant selection for Conservation Cover (327), Contour Buffer Strips (332), Critical Area Planting (342), Field Border (386), Riparian Herbaceous Cover (390), Herbaceous Wind Barriers (603), and Vegetated Treatment Area (635) (NRCS, 2019).

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APPENDIX

The following table displays the recorded weather data over the course of the study.

Table 3. Recorded weather data during a Tropic Sun sunn hemp productivity study at the New Jersey Plant Materials Center, Cape May Court House, NJ (ONJSC, 2026).

Date	High °C	Low °C	Relative Humidity Max (%)	Relative Humidity Min (%)	Precipitation (in)
7/12/2010	28.9	15.0	97	55	0
7/13/2010	26.1	20.0	95	71	0
7/14/2010	26.1	15.0	98	63	0.33
7/15/2010	25.6	15.6	96	71	0
7/16/2010	28.9	16.1	98	58	0
7/17/2010	31.1	18.9	95	36	0.04
7/18/2010	33.3	22.8	84	45	0
7/19/2010	32.8	23.3	85	54	0
7/20/2010	31.7	20.6	96	46	0.2
7/21/2010	31.7	17.8	98	49	0.01
7/22/2010	32.8	21.7	86	31	0
7/23/2010	33.9	19.4	97	54	0
7/24/2010	36.1	26.1	85	45	0
7/25/2010	35.6	17.2	97	41	0.43
7/26/2010	30.0	14.4	96	29	0
7/27/2010	30.0	16.7	92	32	0
7/28/2010	30.6	22.2	88	57	0
7/29/2010	32.2	20.0	95	53	0.05
7/30/2010	26.7	17.8	89	38	0
7/31/2010	26.7	15.0	95	51	0
8/1/2010	28.3	16.7	94	41	0
8/2/2010	27.8	13.9	97	46	0
8/3/2010	29.4	20.0	87	46	0
8/4/2010	30.6	21.1	92	61	0.02
8/5/2010	34.4	21.7	93	41	0
8/6/2010	33.3	21.7	91	34	0
8/7/2010	29.4	15.6	90	47	0
8/8/2010	29.4	16.7	98	57	0
8/9/2010*	29.4	16.1	98	45	0
8/10/2010	32.8	20.0	94	47	0
8/11/2010	30.6	20.0	95	51	0
8/12/2010	26.1	17.2	97	63	0.04
8/13/2010	26.7	21.7	78	49	0
8/14/2010	26.7	17.8	83	47	0
8/15/2010	28.9	19.4	89	51	0
8/16/2010	31.1	21.1	91	59	0

8/17/2010	32.2	20.0	95	54	0
8/18/2010	22.2	12.8	99	80	2.71
8/19/2010	25.6	11.7	99	51	0
8/20/2010	30.6	15.0	97	38	0
8/21/2010	27.2	17.2	97	68	0
8/22/2010	25.0	16.1	97	76	0.14
8/23/2010	27.2	11.7	98	45	0.15
8/24/2010	20.0	13.3	97	72	0
8/25/2010	24.4	14.4	94	57	0
8/26/2010	27.8	15.0	98	43	0
8/27/2010	26.1	13.3	90	36	0
8/28/2010	27.2	13.3	96	37	0
8/29/2010	31.1	14.4	97	39	0
8/30/2010	31.7	17.2	97	39	0
8/31/2010	33.3	19.4	87	32	0
9/1/2010	33.9	18.3	93	32	0
9/2/2010	31.1	18.9	96	49	0
9/3/2010	26.7	19.4	95	58	0
9/4/2010	26.7	15.6	83	27	0
9/5/2010	25.0	10.6	90	29	0
9/6/2010	26.1	11.7	83	46	0
9/7/2010	28.9	15.0	96	55	0
9/8/2010	31.7	20.6	78	29	0
9/9/2010	23.9	15.6	67	36	0
9/10/2010	23.3	13.3	80	42	0
9/11/2010	25.0	12.8	81	36	0
9/12/2010	18.9	14.4	98	75	0.4
9/13/2010	24.4	11.1	98	39	0
9/14/2010	26.1	11.7	98	30	0
9/15/2010	25.0	11.1	97	34	0
9/16/2010	26.1	12.2	98	71	0.05
9/17/2010	26.7	16.1	98	42	0

*Study plots were irrigated the week of August 9, 2010 after 2 weeks of minimal (0.07 in) precipitation.

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