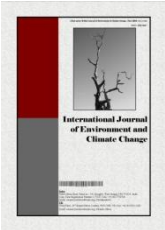

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Effect of Sowing Windows and Nutrient Levels on Growth Parameters of Sunnhemp (*Crotalaria juncea*)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Sunnhemp is the important multifaceted legume crop which is used as fodder, fibre and green manure. While incorporation into the soil, it supplies Nitrogen, Phosphorous and Potassium at the level of 50-75 kgha^{-1}, 15-20 kgha^{-1} and 40-65 kgha^{-1} respectively. In sunnhemp, the seed production was highly affected by improper agronomic management practices and less availability of quality seeds. Hence the present study was carried out to find the suitable agronomic practice for sunnhemp. A field experiment was conducted to study the suitable sowing windows and nutrient levels on growth parameters of sunnhemp during summer 2022 in western zone of Tamil Nadu at Eastern block farm, Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore. The field experiment was laid out in split-plot design with 12 treatments and replicated thrice. Three sowing dates were studied under main plots and four different nutrient levels under sub plot. Growth attributes such as plant height, leaf area index and dry matter production were recorded. From the above study, it is

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concluded that delayed sowing on February 2nd week and the application of nutrients at 30:60:30 NPK kg ha^{-1} recorded higher plant height and dry matter production at harvest over other treatments.

Keywords: Sunnhemp; sowing windows; nutrient levels; growth parameters.

1. INTRODUCTION

Soil fertility is drastically reduced under mono-cropping condition [1]. Rapid increase in the price of inorganic fertilizers and reduced soil fertility by the imbalance use of inorganic fertilizers are important reasons for wide adoption of organic manures in crop production. In this context, adoption of green manuring plays a crucial role to enhance the soil fertility [2]. Green manuring is the field operation in which, in-situ raising and incorporation of legume crops in the soil supplies the nitrogen through biological nitrogen fixation. In India, 38 million tons of nitrogen is depleted every year from the various layers of soil by crop cultivation based on different rooting pattern of the crop. To achieve sustainable agriculture, these nutrients need to be refilled by addition of crop residues into the soil either by green manuring or green leaf manuring without affecting the soil microbial population [3].

Sunnhemp (*Crotalaria juncea*) is originated in India. It is otherwise called as Indian hemp or Bombay hemp [4]. It is a fast growing short day plant, originally belongs to the family Fabaceae and genus Crotalaria means rattle (sound produced while shaking the mature pods). *C. juncea* act as a multipurpose crop, such as fodder, green manure (GM) and fibre [5].

India is the largest country having 10300 ha area under sunnhemp cultivation with the production of 41500 bales and average productivity of 728 kg ha^{-1} followed by Bangladesh and Brazil. Among the Indian states, it is largely cultivated in West Bengal, Orissa, Chhattisgarh, Bihar, Rajasthan, Maharashtra, Uttar Pradesh and Madhya Pradesh [6].

Incorporation of sunnhemp as green manure to the soil provides 50-75 N kg ha^{-1}, 15-20 P kg ha^{-1} and 40-65 kg K kg ha^{-1}. In addition to this it also supply 50-60 kg nitrogen through root nodules alone [7]. It improves the soil fertility, water holding capacity, soil texture and alters salinity and alkalinity of the soil [3]. Apart from green manure, it is used as cover crop due to its fast growing nature, provides organic matter, fixes nitrogen, checks soil erosion and controls root knot nematode [8].

In Sunnhemp, the seed production was highly affected by improper agronomic management practices and less availability of quality seeds. In this regard, It is necessary to standardize the agronomic practices viz. sowing dates, fertilizer level, spacing and other management practices for sunnhemp seed production. Considering the above reasons, the research work was carried to evaluate sowing dates and nutrient levels on sunnhemp seed production.

2. MATERIALS AND METHODOLOGY

2.1 Experimental Site and Soil Analysis

The field experiment was carried out during summer season of 2022 at Eastern block farm, Department of Agronomy, Tamil Nadu Agricultural University (TNAU), Coimbatore. The research site located at 11˚1'6" N latitude and 76˚58'21" E longitude with an altitude of 426.7 m above MSL in western agro-climatic zone of Tamil Nadu. The soil type of the experimental site was sandy clay loam in nature with 8.91 soil pH and 0.28 dSm^{-1} EC values. The initial available nutrient status of soil was 179 N kg ha^{-1} (Low), 27.2 P kg ha^{-1} (High) and 806 kg K kg ha^{-1} (High). The organic carbon content of the soil was 0.49 g kg^{-1}.

2.2 Experiment Details

Experimental design was laid out in split-plot design (three main plots and four sub-plots) with 12 treatments and replicated thrice. Different sowing windows were taken as main plot with various nutrient levels in sub plots. Main plot treatments were D_1 – Sowing at January 4th week, D_2 – Sowing at February 1st week, D_3 – Sowing at February 2nd week and subplot treatments are N_1 – 20:40:20 NPK kg ha^{-1}, N_2 – 25:50:25 NPK kg ha^{-1}, N_3 – 30:60:30 NPK kg ha^{-1} and N_4 – 12.5 tons of FYM/ha.

2.3 Weather Condition Prevailed during Cropping Period

Average maximum and minimum temperature of 36.3˚C & 24.4˚C and wind speed of 5.1 km/hr were prevailed during the entire cropping period. Total precipitation received as rainfall over the entire cropping period was 57.9 mm.

2.4 Agronomic Practices

Local landrace seed was collected from central farm of TNAU and used for this study. Field was prepared by forming of ridges and furrows at 60cm interval and seed was dibbled on both sides of the ridges with the spacing of 30 x 10 cm. The crop was raised fully under irrigated condition. Based on the treatments, required quantity of Farmyard manure (FYM), phosphorous (P) and potassium (K) were fully applied as basal, while the nitrogen (N) was applied in three splits (50% N as basal, 25% N during 20 DAS & 25% N during 40 DAS). The source of nutrients are Urea, SSP and MOP for N, P and K respectively. All the packages of practices were followed as per the TNAU crop production guide, 2020.

2.5 Biometric Observation and Statistical Analysis

Randomly five plants were selected and tagged in net plot area for recording observation and collecting data. Plant height was recorded manually by measuring from surface of the soil to tip of the plant. Randomly five plants were uprooted and used for analysis of dry matter production. Collected plants were kept in room temperature upto three days for drying. Then the samples were kept in hot air oven at 70˚C until reaching constant weight. Dry matter production is expressed in kg ha^{-1}. Those collected plants were used to measure the leaf area, using leaf area meter. Leaf area index was calculated based on the formula (LAI = Leaf length*leaf width*number of leaves/spacing) suggested by Watson [9]. The data of different parameters were statistically analysed by ANOVA method suggested by Gomez and Gomez [10].

3. RESULTS AND DISCUSSION

3.1 Effect of Sowing Windows and Nutrient Levels on Plant Height

The effect of sowing window and nutrient level on plant height is given in Table 1. In the present study, plant height was significantly higher (39.5, 106.9 & 108.7 cm) in delayed sowing (February 2^{nd} week) at all three stages of crop growth (30 DAS, 60 DAS & at harvest) followed by January 4^{th} week and February 1^{st} week. With respect to different nutrient levels, increased dose of nutrient applied to the crop has simultaneously improves the plant height, dry matter production and leaf area index at all stages of plant growth. Among these nutrient levels, 30:60:30 NPK kg ha^{-1} recorded significantly higher plant height followed by 25:50:25 NPK kg ha^{-1}, 20:40:20 NPK kg ha^{-1} and 12.5 t FYM/ha. Interaction effect among sowing window and different nutrient levels are non-significant for plant height. Due to long day condition during delayed sowing (2^{nd} week of February), the plant height has significant increase over than early sowing at all stages. These results were close conformity with the results of Sanggonda *et al.* [5] who got significantly higher plant height and dry matter production in delayed sown sunnhemp. Application of higher dose of nutrients enhances the photosynthetic efficiency which could stimulate higher plant height, LAI and dry matter accumulation than lower doses of nutrients. Increased fertilizer dose (20:80:80 NPK kg ha^{-1}) in sunnhemp produced higher plant height and dry matter accumulation than lower doses of fertilizer (20:40:40 NPK kg ha^{-1}) [7].

3.2 Effect of Sowing Windows and Nutrient Levels on Leaf Area Index

The effect of sowing windows and nutrient levels on LAI is given in Table 2. Significantly (P = .05) higher the leaf area index (LAI) was recorded at late sowing (February 2^{nd} week) at all stages (0.30 & 0.93) followed by February 1^{st} week and January 4^{th} week sown crop. With respect to different nutrient levels, increased dose of nutrient applied to the crop has simultaneously recorded higher leaf area index at all stages of plant growth. Among these nutrient levels, 30:60:30 NPK kg ha^{-1} recorded higher plant height followed by 25:50:25 NPK kg ha^{-1}, 12.5 t FYM/ha and 20:40:20 NPK kg ha^{-1}. Interaction effect among sowing window and different nutrient levels are non-significant for leaf area index. Higher plant height produced more leaves which lead to higher leaf area index in delayed sowing. Banerjee *et al*. [11] stated as relatively larger leaf area index (LAI) has recorded in delayed sowing (March 1^{st} week) over other sowing dates in black gram during 2020 and 2021 respectively. Application of higher dose of nutrients enhances the photosynthetic efficiency

Table 1. Effect of sowing windows and nutrient levels on plant height

Treatments	Plant height (cm)														
	30 DAS					60 DAS					Harvest				
	N_1	N_2	N_3	N_4	Mean	N_1	N_2	N_3	N_4	Mean	N_1	N_2	N_3	N_4	Mean
D_1	34.1	34.4	34.8	32.5	**33.9**	98.7	102.3	104.7	94.8	**100.1**	99.2	104.3	105.6	95.2	**101.1**
D_2	33.8	33.9	35.6	31.3	**33.6**	92.8	94.2	99.6	87.4	**93.5**	94.0	95.0	102.8	87.7	**94.9**
D_3	37.2	40.5	41.3	39.2	**39.6**	104.9	107.1	109.3	106.3	**106.9**	105.8	108.0	110.5	106.7	**108.8**
Mean	**35.0**	**36.2**	**37.2**	**34.3**	**35.7**	**98.8**	**101.2**	**104.5**	**96.2**	**100.2**	**99.7**	**102.5**	**106.3**	**96.6**	**101.2**
	D	**N**	**D x N**			**D**	**N**	**D x N**			**D**	**N**	**D x N**		
SED	**1.6**	**1.3**	**2.5**			**3.0**	**3.4**	**5.9**			**3.1**	**3.3**	**5.8**		
CD (0.05)	**4.3**	**NS**	**NS**			**8.4**	**NS**	**NS**			**8.6**	**NS**	**NS**		

(D_1 – January 4th week, D_2 – February 1st week, D_3 – February 2nd week, N_1 – 20:40:20 NPK kg ha^{-1}, N_2 – 25:50:25 NPK kg ha^{-1}, N_3 – 30:60:30 NPK kg ha^{-1}, N_4 – 12.5 t FYM/ha)

Table 2. Effect of sowing windows and nutrient levels on leaf area index

Treatments	Leaf Area Index									
	30 DAS					60 DAS				
	N_1	N_2	N_3	N_4	Mean	N_1	N_2	N_3	N_4	Mean
D_1	0.23	0.21	0.21	0.23	0.22	0.74	0.70	0.80	0.72	**0.74**
D_2	0.27	0.28	0.28	0.29	0.28	0.79	1.00	1.05	0.90	0.94
D_3	0.32	0.31	0.29	0.30	0.30	0.74	1.05	1.29	0.87	0.99
Mean	0.27	0.27	0.26	0.27	0.27	0.76	0.85	1.05	0.83	0.87
	D	**N**	**D x N**			**D**	**N**	**D x N**		
SED	0.02	0.01	0.03			0.14	0.09	0.19		
CD (0.05)	0.05	NS	NS			NS	0.19	NS		

(D_1 – January 4th week, D_2 – February 1st week, D_3 – February 2nd week, N_1 – 20:40:20 NPK kg ha^{-1}, N_2 – 25:50:25 NPK kg ha^{-1}, N_3 – 30:60:30 NPK kg ha^{-1}, N_4 – 12.5 t FYM/ha)

Table 3. Effect of sowing windows and nutrient levels on dry matter production

Treatments	Dry matter production (kg/ha)														
	30 DAS					60 DAS					Harvest				
	N_1	N_2	N_3	N_4	Mean	N_1	N_2	N_3	N_4	Mean	N_1	N_2	N_3	N_4	Mean
D_1	61.25	84.66	89.61	61.46	**74.25**	3516	3572	3672	2930	**3423**	4282	4354	5203	3594	**4358**
D_2	103.62	109.93	127.46	92.03	**108.26**	2929	3203	3763	3191	**3272**	3875	3972	4207	3511	**3891**
D_3	254.83	275.79	281.33	247.12	**264.77**	2981	3833	3935	3429	**3545**	3716	4524	4970	4322	**4383**
Mean	**139.90**	**156.79**	**166.13**	**133.54**	**149.09**	**3142**	**3536**	**3790**	**3183**	**3413**	**3958**	**4283**	**4793**	**3809**	**4211**
	D	**N**	**D x N**			**D**	**N**	**D x N**			**D**	**N**	**D x N**		
SED	**4.06**	**7.34**	**11.74**			**135.74**	**112.8**	**217.0**			**114.5**	**144.7**	**245.3**		
CD (0.05)	**11.27**	**NS**	**NS**			**NS**	**237.0**	**513.2**			**317.9**	**303.9**	**551.8**		

(D_1 – January 4th week, D_2 – February 1st week, D_3 – February 2nd week, N_1 – 20:40:20 NPK kg ha^{-1}, N_2 – 25:50:25 NPK kg ha^{-1}, N_3 – 30:60:30 NPK kg ha^{-1}, N_4 – 12.5 t FYM/ha)

which could stimulate higher LAI than lower doses of nutrients. These findings were closely with the findings of Kumar *et al*., [12], who reported as increased dosage of fertilizers (37.5:75:37.5 NPK kg ha^{-1}) has significant increase of plant height, leaf area index and dry matter accumulation over absolute control in sunnhemp.

3.3 Effect of Sowing Windows and Nutrient Levels on Dry Matter Production

The effect of sowing window and nutrient levels on dry matter production is given in Table 3. Higher dry matter production (264.8, 3545 & 4383 kg/ha) was obtained at delayed sowing date (February 2nd week) at all three stages of plant growth (30 DAS, 60 DAS & at harvest) due to increased plant height over delayed sowing (February 2nd week). Lowest dry matter production was observed in February 1st week sown crop because of its reduced plant height. With respect to different nutrient levels, increased dose of nutrient applied to the crop has simultaneously improved the dry matter production at all stages of plant growth. Among these nutrient levels, 30:60:30 NPK kg ha^{-1} recorded significantly higher dry matter production followed by 25:50:25 NPK kg ha^{-1}, 20:40:20 NPK kg ha^{-1} and 12.5 t FYM/ha. In interaction effect, D_1N_3 produced significantly higher dry matter followed by D_3N_3 and D_3N_2. In jute plant, August 9th sown has significantly higher yield and dry matter production over July 25th sown crop Das *et al*. [13]. Further, the application of higher amount of fertilizer to sunnhemp recorded significantly increased in plant height and dry matter accumulation Sanggonda *et al*. [5].

4. CONCLUSION

From the results obtained, it may be concluded that delayed sowing of sunnhemp i.e. 2nd week of February and increasing doses of fertilizer at the rate of 30:60:30 NPK kg ha^{-1} has recorded the better growth attributes of sunnhemp in Coimbatore, Tamil Nadu.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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