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Evaluation of Sunnhemp (*Crotalaria juncea* L.) Genotypes for Green Manuring

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ABSTRACT

The study was aimed to evaluate the sunnhemp genotypes suitable for green manuring. Fourteen sunnhemp genotypes were evaluated for morphological traits and it's nutritional status during *kharif*-2021. The actual growth period for green manuring purpose was ranged between 65.00 and 68.00 days. The effective growth periods were 35.81 and 40.54, 38.44 and 41.74, 21.38 and 22.71 for plant height, number of branches per pant and number of leaves per plant, respectively. The genotypes, JRJ-610, SIN 28, SIN-37, SIN-44 and SUIN-053 were superior for green biomass production along with contributing characters (Plant height, number of branches or number of leaves). The genotypes, JRJ-610 and JRJ-25 for nitrogen content, SIN-37, JRJ-610 and SIN-21 for phosphorus content and SIN-25 and JRJ-610 for potassium content were promising for respective characters. The genotypes, SIN-25 and SIN-45 added maximum nitrogen, while, JRJ-610 and SIN-37 added maximum phosphorus and potassium content in soil. On the basis of overall performance, the genotype JRJ-610 and SIN-37 attained maximum green manuring characters.

Keywords: Green biomass, Green manuring, Growth period, Nutritional status, Percent improvement, Sunnhemp

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INTRODUCTION

Green manuring and cultivation of quick growing crops for this purpose, chiefly of the leguminous family, has been an ancient practice in most parts of the world associated with agriculture (Sarkar and Ghoroi, 2007). Green manure has the potential to increase soil organic matter (Marshall and Lynch, 2020; Sheng-nan *et al*. 2018), increase microbial activity (Raviv. 2015) suppress weeds and reduces weed seed bank (Kumar and Ladha, 2011; Pratt *et al*. 2016; Songjuan *et al*. 2021) and suppress plant diseases, reduce erosion, improve the physical characteristics of the soil and reduce plant diseases. The Organic Carbon content (%) and Available Nitrogen content (kg/ha) was increased considerably due to incorporation of green manure in rice field (Borthakur *et al*. 2018). The soil fertility under integrated nutrient package (25% RDF +7.5 tonnes/ha) FYM and Sesbania or Robinea leaf green manuring improved significantly in terms of OC and available N, P and K to provide available nutrients to harvest a comparable yield of rice nearer to RDF treatment (Singh *et al*. 2015). Sunnhemp adds organic manure thus increasing its twofold utility in sustaining productions in organic systems (Wang *et al*. 2004). Of the large number of crops used for this purpose, probably none suits the purpose better than sunnhemp (*Crotalaria juncea*), a fairly rapid growing plant with relatively short life cycle capable of being raised without any special soil preparation. Sunnhemp, a tropical plant primarily grown as a cover crop or green manure, has increased dramatically in popularity over the last decade (Creamer *et al*. 1997). Sunn hemp is used primarily as a green manure cover crop in the United States, because of its rapid growth rate and high rate of N fixation (Shekinah and Stute, 2018). Sunnhemp is adapted to a wide variety of soil and environmental conditions, thriving through hot, dry summers and continuing to grow until the first frost. But sunnhemp isn't just a soil builder; it also offers benefits as a forage producer. Sunnhemp is a strong nitrogen fixer with a reported resistance to root knot nematodes and can be incorporated into the soil with little more than a month of growth and it can be used rotationally between primary crop plantings (Recalde *et al*. 2015; Longa *et al*. 2017). The use of *Crotalaria juncea* as green manure and fibre had led the agriculture scientists to advocate its cultivation in areas deficient in manurial constituents and in such localities where other crops may not be successfully grown. Therefore, these investigations were carried out to evaluate the sunnhemp genotypes for green manuring on the basis of morphological and nutritional characters.

MATERIALS AND METHODS

Fourteen sunnhemp genotypes were evaluated for morphological and nutritional characteristics of plants in randomized block design with two replications at MPKV, Rahuri, Ahmednagar (Maharashtra) during kharif 2021. Geographically, Project is situated at latitude between 19°47'

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and 19°57' North and longitude between 74°82' and 74°9' East. The altitude is 532 m above the mean sea levels. This tract is on the eastern side of western ghat and falls under rain shadow area. Climatically, the area falls in semi-arid tropics with annual rainfall ranging between 307 and 619 mm, the average being 520 mm which is erratic and unevenly distributed in 15 to 45 rainy days in different years. Out of the total annual rainfall, above 80% is received from South West monsoon from June to September. The mean annual temperature and annual rainfall of the study area are 27. 6°C. The field operations, one ploughing and one harrowing were given before sowing in summer season and field was fertilized with 5 t/ha farm yard manure. The crop was fertilized with 20:60:60 kg/ha N: P_2O_5: K_2O of which half N and full dose of P_2O_5 and K_2O to be applied as basal and remaining N to be applied in at 35-40 days of crop-age. The plot size was 3.00 x 1.50 m with rows 30 cm apart and 5-7 cm between plants. The observations on plant height, number of branches and leaves per plant were recorded a 7 days interval from date of germination till days to 50% flowering.

The data on green biomass production was recorded at the time of harvesting. The green plant samples were collected and estimated for NPK content. The harvested green plant material was buried in the same plots for decomposition for one month and soil samples were collected to study the nutritional status of the soil. The data on periodical plant height, number of branches and leaves was utilized for the estimation of actual and effective growth period and lag period of growth in days (Wien and Ackaih, 1978).

Actual growth period (AGP): Actual seed growth period is the period from seed germination to harvesting for green manuring.

Effective growth period (EGP): The effective growth period was expressed as final growth divided by the rate of increase in growth per day in linear phase.

$$\text{Effective growth period (days)} = \frac{\text{Final Growth}}{\text{Rate of increase in growth per day}}$$

Lag period: Lag period= AGP- EGP

The data available on individual characters were subjected to the method of analysis of variance commonly applicable to the randomized block design (Panse and Sukhatme, 1985).

RESULTS AND DISCUSSION

Actual growth, effective growth and lag periods

Yield production in grain legumes is governed by the length of the reproductive period which in turn depends on the time from anthesis to maturity is the actual growth period, while effective growth period was expressed as final growth divided by the rate of increase in growth per day in linear phase (Wien and Ackaih, 1978). In the present investigations, the actual growth period for green manuring purpose ranged between 65.00 and 68.00 days. The effective growth periods were 5.81 and 40.54, 38.44 and 41.74, 21.38 and 22.71 for plant height, number of branches per pant and number of leaves per plant, respectively. The genotype SIN-21 had required maximum actual growth periods for plant height, number of branches per plant and number of leaves per plant (68.00 days). The genotype, SH-4 had minimum effective growth period for plant height (35.81 days), number of branches per plant (38.19 days) and number of leaves per plant (42.46 days). The genotypes, SH-4 (28.69 days), SIN-36 (27.17 days) and SIN-28 (22.81 days) recorded maximum length of lag periods for plant height number of branches per plant and number of leaves per plant, respectively (Table 1).

Morphological characters and NPK content

The differences among the genotypes were statistically significant for days to initiation of flowering, days to 50% flowering and green biomass yield, whereas it was non-significant for plant height, number of branches and leaves and N, P and K content (Table 2). The check variety JRJ-610 (490.00 q/ha) recorded higher green biomass yield followed by SIN-28 and SIN-37. The days to initiation of flowering ranged between 54.50 (SH-4) and 58.00 (SIN-21) days. The highest number of leaves was recorded by the genotypes JRJ-610,

Table 1: Actual, effective and lag periods of growth influenced by sunhemp genotypes for plant growth characters

Genotype	Plant height			Number of branches per plant			Number of leaves per plant		
	AGP	EGP	LPG	AGP	EGP	LPG	AGP	EGP	LPG
SIN-21	68.00	40.36	27.64	68.00	41.16	26.84	68.00	45.29	22.71
SIN-24	66.50	40.29	26.21	66.50	39.54	26.96	66.50	43.75	22.75
SIN-25	65.50	39.53	25.97	65.50	40.11	25.39	65.50	43.35	22.15
SIN-28	67.50	40.54	26.96	67.50	41.74	25.76	67.50	44.69	22.81
SIN-36	66.00	38.44	27.56	66.00	38.83	27.17	66.00	43.31	22.69
SIN-37	65.50	38.41	27.09	65.50	38.70	26.80	65.50	42.73	22.77
SIN-39	66.50	39.05	27.45	66.50	39.62	26.88	66.50	43.89	22.61
SIN-40	66.50	39.07	27.43	66.50	39.77	26.73	66.50	43.81	22.69
SIN-44	67.00	39.46	27.54	67.00	40.51	26.49	67.00	44.25	22.75
SIN-45	65.50	37.62	27.88	65.50	38.85	26.65	65.50	43.74	21.76
SUN053	67.00	40.27	26.73	67.00	40.42	26.58	67.00	45.62	21.38
SH4	64.50	35.81	28.69	64.50	38.19	26.31	64.50	42.46	22.04
SUIN037	65.50	38.22	27.28	65.50	38.76	26.74	65.50	43.62	21.88
JRJ610	65.00	37.53	27.47	65.00	38.44	26.56	65.00	43.49	21.51

AGP : Actual growth period in days, EGP: Effective growth period in days, LPG: Lag period of growth in days

SUIN-053, SIN-45 and SUIN-037. The genotypes, SIN-37 (1.64%), JRJ 610 (1.38%) and SIN-25 (1.37%) recorded higher total sugars. However, JRJ-610 and SIN-25 (2.17%) recorded maximum nitrogen content. The genotypes, JRJ-610 and SIN-21 (0.27%) recorded higher phosphorus content and SIN-25 (1.55%) recorded higher percentage of potassium content (Table 2). On the basis of overall performance, the genotypes JRJ-610, SIN-37 and SUN-25 were promising for green manuring. Maximum biomass at a given DAP was produced from May and June plantings in the Piedmont and from April and May plantings in the coastal plains. Maximum biomass and N ranged from 8.9 to 13.0 Mg ha^{-1} and 135 to 285 kg ha^{-1}, respectively (Schomberg *et al.* 2007). An equation for estimating sunnhemp biomass as a linear function of cumulative degree days (CDD) and cumulative solar radiation (CSR) was verified. Pereira *et al.* (2016) suggested that measurement of total plant biomass is a good parameter can be used as an indicator of plant growth.

Table 2: Green biomass yield and NPK content influenced by sunhemp genotypes

Genotypes	Days to initiation of flowering	Days to 50% flowering	Plant height (cm)	No. of branches /plant	No. of leaves/ plant	Green biomass (q/ha)	Total sugars (%)	N Content (%)	P content (%)	K Content (%)
SIN-21	58.00	68.00	215.78	12.10	116.50	374.44	0.70	1.40	0.27	1.23
SIN-24	56.50	66.50	201.69	11.80	116.60	380.00	0.74	1.82	0.26	1.35
SIN-25	55.50	65.50	203.66	12.10	118.60	393.44	1.37	2.17	0.25	1.55
SIN-28	57.50	67.50	220.76	12.20	116.20	465.56	1.29	1.75	0.24	1.41
SIN-36	56.00	66.00	219.95	11.90	117.50	358.89	1.04	1.47	0.25	1.41
SIN-37	55.00	65.50	223.25	11.80	117.70	448.44	1.64	1.33	0.31	1.41
SIN-39	55.50	66.50	220.32	12.20	116.40	429.89	0.94	1.26	0.24	1.24
SIN-40	56.50	66.50	220.02	12.50	117.10	361.22	1.30	1.47	0.24	1.28
SIN-44	57.00	67.00	222.43	11.90	116.40	447.56	0.73	1.40	0.25	1.27
SIN-45	55.50	65.50	223.60	12.10	119.80	410.11	1.04	2.03	0.26	1.35
SUN 053	57.00	67.00	229.93	12.00	119.90	427.89	1.35	1.68	0.24	1.12
SH 4	54.50	64.50	255.48	12.30	117.60	428.78	1.34	1.47	0.26	1.36
SUIN 037	55.50	65.50	227.15	12.20	119.70	379.22	0.83	1.75	0.26	1.37
JRJ 610	55.00	65.00	229.23	12.30	119.90	490.00	1.38	2.17	0.27	1.43
SE±	0.58	0.58	1.67	0.312	0.419	20.46	1.12	0.221	0.023	0.124
CD@5%	1.791	1.791	N/A	N/A	1.293	61.93	0.011	NS	NS	NS

Improvement in soil nutrient status

Previous research has found that sunhemp can accumulate 4.5 Mg ha^{-1} of biomass and fix 120 kg ha^{-1} of N in as little as 60 d (Shekinah and Stute, 2018). In the present investigation, the data on nutrient accumulation influenced by the sunnhemp genotypes are statistically significant for nitrogen,

Table 3: Soil nutrient status improvement by various sunhemp genotypes

Genotypes	Nitrogen	Percent increase	Phosphorus	Percent increase	Potassium	Percent increase
SIN-21	177.18	22.56	23.97	47.78	596.50	1.41
SIN-24	200.70	38.83	22.04	35.88	634.00	7.79
SIN-25	215.97	49.39	20.67	27.44	638.50	8.55
SIN-28	194.43	34.49	19.71	21.52	623.00	5.92
SIN-36	181.89	25.81	18.32	12.95	637.00	8.30
SIN-37	170.91	18.22	25.08	54.62	640.00	8.81
SIN-39	196.00	35.57	19.53	20.41	611.00	3.88
SIN-40	191.30	32.32	18.88	16.40	622.50	5.83
SIN-44	180.32	24.73	23.56	45.25	599.50	1.92
SIN-45	198.13	37.05	17.22	6.17	644.00	9.49
SUN-053	189.73	31.24	19.81	22.13	604.00	2.69
SH-4	202.27	39.91	22.46	38.47	645.50	9.74
SUIN-037	197.57	36.66	23.42	44.39	647.00	10.00
JRJ-610	210.11	45.33	25.76	58.82	666.00	13.23
Initial soil status	144.57	--	16.22	--	588.20	--
SE±	3.104		0.403	--	5.048	--
CD@5%	9.58		1.244	--	15.581	--

phosphorus and potassium content in soil (Table 3). The highest nitrogen accumulation was genotypes SIN-25 (215.97) followed by JRJ-610, SH-4 and SIN-24 and percent improvement was 49.39, 44.33, 39.91 and 38.83, respectively. The highest phosphorus accumulation was recorded by the genotypes JRJ-610 (25.76), SIN-37, SIN-21, SIN-44 and SUIN-037 k against initial soil status (16.22) and percent improvement was 58.52, 54.62, 47.78, 45.25 and 44.39 percent, respectively. The highest potassium accumulation was genotype JRJ-610, SIN-37, SUIN-037, SH-4, SIN-45 and SIN-37 against initial soil status (588.20) and percent improvement is 13.23, 10.00, 9.74, 9.49, 8.81, respectively. Sumarni (2014), Syahri *et al.* (2016) and Adekiya *et al.* (2019) reported that green manure derived from *C. juncea* improve soil quality including: physical properties in the form of aggregate stability, chemistry (organic matter, nitrogen, phosphorus and cation exchange capacity) and soil biology (inhibit development of soil borne pathogens).

CONCLUSIONS

SH-4 has minimum effective growth periods, JRJ-610 and SIN-45 had minimum lag periods, branches and leaves per plant maintaining considerable plant height, branches and leaves and green biomass. JRJ-610, SIN-37 and SIN-25 recorded higher total sugars, nitrogen, phosphorus and potassium content in plant material. The incorporation of JRJ-610 improves NPK content by 45.33, 58.82 and 13.23%. Therefore, incorporation of variety JRJ-610 in soil at 65 DAS was found better for green manuring purpose over other genotypes.

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