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Optimization of Sowing Date and Crop Geometry Management for Herbage Production of Fenugreek cv Kasuri (*Trigonella corniculata*) in a Subtropical Region

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ABSTRACT

Sowing date and crop geometry are critical factors in the production of Kasuri methi as development, yield and quality of crop may be hampered by crop spacing and early or late sowing. So, to achieve the goal of doubling farmers' income, a study was conducted at Horticulture Research Farm, College of Horticulture Mandsaur, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior (MP), India during the year 2021-2022 to evaluate the effect of sowing dates and spacing on (*Trigonella corniculata*) fenugreek cv Kasuri with three dates of sowing viz. D_1 - 15th October, D_2 - 30th October and D_3 - 15th November as main plot and four different spacings S_1 (15 × 10 cm), S_2 (20 × 10 cm), S_3 (25 × 10 cm) and S_4 (30 × 10 cm) as sub-plot in Factorial Randomized Block Design with three replications. The result obtained during experiment showed significant effect to growth and herbage yield and most of the parameters were found maximum in main treatment D_2 – 30th October and sub treatment S_4 – 30 × 10 cm. The interaction of 30th October + S_3 – 25 × 10 cm observed maximum values in growth parameters while herbage yield was found maximum in 30th October + S_1 –15 × 10 cm.

Keywords Kasuri methi, Date of sowing, Spacing, *Trigonella corniculata*.

INTRODUCTION

Trigonella corniculata L., sometimes referred to as Kasuri, *Pan methi*, *Champa methi*, *Marwari methi* or sickle fruited fenugreek is an annual herbaceous, bushy, slow-growing legume seed spice crop that is native to the Mediterranean region and belongs to the family Fabaceae, subfamily Papilionaceae. It is farmed mostly for green herbage as well as dry herb. The chromosomal number for this species is 2n=16. It is a self-pollinating crop. During most of the vegetative growth period, it stays in rosette form (Anupama *et al.* 2017). It is a semi-arid crop that grows to a height of 30 cm, has pinnate leaves with leaflet sizes ranging from 1.25 to 2.0 cm and has bright orange-yellow flowers (Chandan *et al.* 2021). In the Nagaur District of Rajasthan (India), it is cultivated under the name of *Pan methi* because only the

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leaves are harvested four to five times during the crop season and after drying, the leaves are used as a food flavoring agent in food preparation (Kumawat *et al.* 2018). Fresh green leaves are used as a condiment to add a delightful flavor to dishes.

Kasuri methi is usually planted in the winter. Early on, dry, cold conditions encourage vegetative growth, while dry, somewhat hot conditions encourage seed production (Al-Dalain *et al.* 2012). For vegetative growth and final yield manifestation, seeding time is crucial (Aggarwal *et al.* 2013). When growing vegetatively, the crop prefers a chilly climate, and when it is mature, it prefers a warm, dry climate (Halesh *et al*. 2000). It is advised to sow in October during the *rabi* season to produce both seeds and leaves.

Spacing is one of the most crucial elements affecting interplant competition, development and ideal yield of fenugreek (Singh *et al.* 2005). The maximum number of plants that can be grown on a specific unit of land for maximum yield depends on the plant spacing. Inadequate plant spacing can lead to populations that are either too dense or too sparse, which lowers the output of fenugreek seeds. By effectively utilizing moisture, nutrients and light, optimal plant density, on the other hand, guarantees that the plants grow equally and appropriately, leading to a larger fenugreek production.

MATERIALS AND METHODS

All the methods were carried out in accordance with relevant guidelines. The influence of three dates of sowing as main plot viz., D_1 - 15th October, D_2 - 30th October and D_3 - 15th November, 2021 and four spacing viz., S_1 (15 × 10 cm), S_2 (20 × 10 cm), S_3 (25 × 10 cm) and S_4 (30 × 10 cm) as sub-plot was examined on Akfg-1 variety of kasuri methi. The source of this variety is National Research Center on Seed Spices, Ajmer (India). The experiment was laid in Factorial Randomized Block Design with three replications and 12 treatments in the year 2021-22. Plot size was kept 3 × 1.5 m^2 and susceptible seeds were used as per requirement of plant spacing with the seed rate of 11 kg ha^{-1} at 15 × 10 cm spacing (S_1), 9.5 kg ha^{-1} at 20 × 10 cm spacing (S_2), 8 kg ha^{-1} at 25 × 10 cm spacing (S_3) and 6.5 kg ha^{-1} at 30 × 10 cm spacing (S_4). The growth parameters were calculated by standard methods mentioned below.

Leaf area (cm^2 $plant^{-1}$)

The five plants were uprooted from each plot and detached their leaves. Then the fifteen leaves were selected from each plant for the measurement of leaf area using leaf area meter (LAM-211). Calculate the arranged leaf area and multiplying by total number of leaves per plant and expressed as cm^2 $plant^{-1}$.

Leaf area index

Leaf area index expresses the ratio of leaf surface (one side only) to the ground area occupied by the plant or crop stand (Gardner *et al.* 1985).

$$LAI = \frac{(LA_2 + LA_1)}{2P}$$

Where, the LA_1 and LA_2 represent the leaf area of two consecutive intervals and ‘P’ stands for ground area (Watson 1974).

Leaf area duration (cm^2 $days^{-1}$)

Leaf area duration expresses the magnitude and persistence of leaf area of leafiness during the period of crop growth. It reflects the extent or seasonal integral of light interception and correlates with yield (Watson 1952). LAD as computed as:

$$LAD = \frac{(LA_2 + LA_1)}{2} \times (t_2 - t_1)\ (cm^2\ day^{-1})$$

Where,
LA_1 and LA_2 are leaf areas at times t_1 and t_2 respectively.

Crop growth rate (g cm^{-2} day^{-1})

The gain in weight of a community of plants on a unit of land in a unit of time is termed to as crop growth rate (Gardner *et al.* 1985). It is estimated by calculating the average daily increment of plant biomass

Table 1. Leaf area (cm^2 $plant^{-1}$), Leaf area index and Leaf area duration (cm^2 $days^{-1}$) at different treatments and their interactions.

	Leaf area (cm^2 $plant^{-1}$)				Leaf area index			Leaf area duration (cm^2 $days^{-1}$)		
	30 DAS	60 DAS	90 DAS	At harvest	30-60 DAS	60-90 DAS	90 DAS-harvest	30-60 DAS	60-90 DAS	90 DAS-harvest
	Main plot - Date of sowing (D)				Main plot - date of) sowing (D)			Main plot - date of sowing (D)		
D_1 (15th Oct.)	18.38	629.97	2101.76	1954.63	1.43	6.21	9.35	9400.09	40166.18	60364.41
D_2 (30th Oct.)	23.67	828.73	2425.41	2247.98	1.90	7.38	10.81	12336.54	47423.11	69161.46
D_3 (15th Nov.)	16.97	544.67	1955.98	1829.82	1.20	5.56	8.68	7772.19	35675.69	55603.65
SEm ±	**0.24**	**12.33**	**22.25**	**19.57**	**0.03**	**0.09**	**0.10**	**189.52**	**529.27**	**645.87**
CD at 5%	**0.69**	**36.17**	**65.25**	**57.40**	**0.08**	**0.28**	**0.31**	**555.83**	**1552.28**	**1894.27**
	Sub plot - spacing (S)				Sub plot - spacing (S)			Sub plot - spacing (S)		
S_1 (15×10 cm)	17.74	552.02	1971.87	1837.72	1.87	8.35	12.66	8411.67	37559.25	56982.12
S_2 (20×10 cm)	18.86	603.27	2061.28	1919.48	1.52	6.52	9.84	9108.97	39094.56	59062.20
S_3 (25×10 cm)	20.42	724.79	2250.99	2093.12	1.35	5.59	8.46	10126.02	41898.94	63473.94
S_4 (30×10 cm)	21.68	791.08	2360.04	2192.92	1.30	5.09	7.48	11698.44	45800.54	67321.10
SEm±	**0.27**	**14.24**	**25.69**	**22.60**	**0.03**	**0.11**	**0.12**	**218.84**	**611.14**	**745.78**
CD at 5%	**0.80**	**41.76**	**75.34**	**66.28**	**0.10**	**0.32**	**0.35**	**641.82**	**1792.42**	**2187.31**
	Interactions (D × S)				Interactions (D × S)			Interactions (D × S)		
D_1S_1	16.29	462.76	1831.02	1707.27	1.71	7.97	12.01	7683.13	35870.10	54047.06
D_1S_2	17.08	545.91	1965.65	1830.27	1.41	6.27	9.48	8451.02	37599.40	56864.85
D_1S_3	18.63	693.19	2204.12	2048.15	1.31	5.51	8.33	9827.33	41322.47	62496.86
D_1S_4	21.52	818.01	2406.24	2232.82	1.29	5.10	7.56	11638.90	45872.75	68048.87
D_2S_1	21.18	756.81	2303.54	2136.71	2.39	9.68	14.48	10767.45	43543.86	65144.85
D_2S_2	22.84	758.18	2329.68	2160.33	1.95	7.57	11.08	11694.69	45413.28	66466.18
D_2S_3	25.22	880.43	2502.70	2318.69	1.69	6.46	9.45	12709.76	48460.58	70909.53
D_2S_4	25.45	919.50	2565.72	2376.20	1.57	5.81	8.24	14174.27	52274.71	74125.26
D_3S_1	15.74	436.48	1781.06	1669.19	1.51	7.39	11.50	6784.42	33263.80	51754.46
D_3S_2	16.66	505.73	1888.52	1767.82	1.20	5.71	8.98	7181.20	34271.02	53855.55
D_3S_3	17.41	600.75	2046.15	1912.51	1.05	4.79	7.60	7840.98	35913.77	57015.43
D_3S_4	18.06	635.73	2108.18	1969.75	1.03	4.36	6.64	9282.17	39254.17	59789.16
SEm ±	**0.47**	**24.66**	**44.49**	**39.14**	**0.06**	**0.19**	**0.21**	**379.03**	**1058.53**	**1291.74**
CD at 5%	**1.39**	**72.34**	**130.50**	**114.80**	**0.17**	**NS**	**0.61**	**NS**	**NS**	**NS**

(W_1 and W_2) per unit ground area (P) per unit time interval (t_1 and t_2).

$$CGR = \frac{(W_2 - W_1)}{(t_2 - t_1)} \times \frac{-1}{A}$$

Relative growth rate (g g^{-1} day^{-1})

It expresses the dry weight increase in a time interval in relation to the initial weight. The mean relative growth rate is calculated from measurements taken at time t_1 and t_2 (Beadle *et al*. 1985).

$$RGR = \frac{\log_e W_2 - \log_e W_1}{t_2 - t_1} \qquad (g\ g^{-1}\ day^{-1})$$

Where,

W_1 = Dry weight of the plan at time t_1

W_2 = Dry weight of the plan at time t_2

RESULTS

Sowing date and crop geometry are critical factors in the production of kasuri methi. However, only a little amount of research has been done on these

Table 2. Crop growth rate (g cm^{-2} day^{-1}) and Relative growth rate (g g^{-1} day^{-1}) at different treatments and their interactions.

Treatments	Crop growth rate (g cm^{-2} day^{-1}) 30-60 DAS	60-90 DAS	90 DAS-harvest	Relative growth rate (g g^{-1} day^{-1}) 30-60 DAS	60-90 DAS	90 DAS-harvest
	Main plot - date of sowing (D)			Main plot - date of sowing (D)		
D_1 (15th Oct)	0.25	0.46	0.51	0.016	0.0361	0.03888
D_2 (30th Oct)	0.28	0.49	0.50	0.020	0.0375	0.03854
D_3 (15th Nov)	0.23	0.45	0.50	0.014	0.0353	0.03852
SEm ±	**0.004**	**0.01**	**0.0070**	**0.0005**	**0.0004**	**0.00049**
CD at 5%	**0.01**	**0.02**	**NS**	**0.001**	**0.0012**	**NS**
	Sub plot - spacing (S)			Sub plot - spacing (S)		
S_1 (15×10 cm)	0.33	0.63	0.71	0.013	0.0344	0.03876
S_2 (20×10 cm)	0.26	0.49	0.54	0.015	0.0360	0.03886
S_3 (25×10 cm)	0.23	0.40	0.43	0.018	0.0370	0.03877
S_4 (30×10 cm)	0.20	0.35	0.35	0.019	0.0378	0.03820
SEm ±	**0.004**	**0.01**	**0.01**	**0.001**	**0.0005**	**0.00056**
CD at 5%	**0.01**	**0.02**	**0.02**	**0.002**	**0.0013**	**NS**
	Interactions (D × S)			Interactions (D × S)		
D_1S_1	0.31	0.62	0.71	0.011	0.0344	0.03876
D_1S_2	0.25	0.49	0.55	0.014	0.0359	0.03971
D_1S_3	0.23	0.40	0.43	0.018	0.0366	0.03875
D_1S_4	0.20	0.34	0.35	0.020	0.0374	0.03829
D_2S_1	0.37	0.67	0.71	0.017	0.0369	0.03884
D_2S_2	0.30	0.51	0.53	0.019	0.0371	0.03843
D_2S_3	0.25	0.41	0.42	0.020	0.0376	0.03858
D_2S_4	0.21	0.35	0.35	0.021	0.0385	0.03831
D_3S_1	0.30	0.58	0.71	0.010	0.0320	0.03869
D_3S_2	0.24	0.48	0.53	0.012	0.0350	0.03845
D_3S_3	0.21	0.40	0.43	0.015	0.0367	0.03897
D_3S_4	0.18	0.34	0.35	0.016	0.0376	0.03798
SEm ±	**0.01**	**0.01**	**0.014**	**0.0009**	**0.0008**	**0.00097**
CD at 5%	**0.02**	**0.03**	**NS**	**NS**	**NS**	**NS**

topics. Keeping the foregoing in mind, the study was carried out with the goal of determining the appropriate sowing time and row spacing for the growth and development of fenugreek cv kasuri in the Malwa Region of Madhya Pradesh in the year 2021-22, so that farmers can obtain adequate yields and avoid crop damage caused by spacing, late sowing or too early sowing.

Effect of sowing dates and spacing on growth parameters

Leaf area (cm^2 $plant^{-1}$)

The leaf area of plant was recorded periodically at 30, 60, 90 DAS and at harvest which showed significant effect to date of sowing, spacing and combination of treatments as shown in Table 1. The maximum leaf area (23.67, 828.73, 2425.41 and 2247.985 cm^2 $plant^{-1}$) were found in main treatment D_2–30th October while minimum (16.97, 544.67, 1955.98 and 1829.818 cm^2 $plant^{-1}$) in D_3–15th November. Among the sub treatments, S_4–30 × 10 cm spacing recorded maximum leaf area (21.68, 791.08, 2360.04 and 2192.92 cm^2 $plant^{-1}$) while S_1–15 ×10 cm spacing recorded minimum (17.74, 552.02, 1971.87 and 1873.72 cm^2 $plant^{-1}$). Under the different treatment combinations, D_2S_4–30th October with 30 × 10 cm spacing had obtained maximum leaf area (25.45, 919.50, 2565.72 and 2376.20 cm^2 $plant^{-1}$) which was at par with treatment D_2S_3-30th October with 25 × 10 cm spacing (25.22, 880.43, 2502.70 and 2318.69) but

Table 3. Fresh herbage yield (g plant^{-1}), Dry herbage yield (g plant^{-1}), Fresh herbage yield (q ha^{-1}) and Dry herbage yield (q ha^{-1}) at different treatments and their interactions.

Treatments	Fresh herbage yield (g plant^{-1}) 1st cutting 75 DAS	Fresh herbage yield (g plant^{-1}) 2nd cutting 90 DAS	Dry herbage yield (g plant^{-1}) 1st cutting 75 DAS	Dry herbage yield (g plant^{-1}) 2nd cutting 90 DAS	Fresh herbage yield (q ha^{-1}) 1st cutting 75 DAS	Fresh herbage yield (q ha^{-1}) 2nd cutting 90 DAS	Dry herbage yield (q ha^{-1}) 1st cutting 75 DAS	Dry herbage yield (q ha^{-1}) 2nd cutting 90 DAS
	Main plot - date of sowing (D)		Main plot - date of sowing (D)		Main plot - date of sowing (D)		Main plot - date of sowing (D)	
D_1 (15th Oct)	9.45	11.67	1.32	1.63	42.35	52.33	5.93	7.33
D_2 (30th Oct)	10.63	13.53	1.49	1.89	55.76	68.69	7.81	9.62
D_3 (15th Nov)	7.85	9.95	1.10	1.39	32.37	41.39	4.53	5.79
SEm±	**0.19**	**0.18**	**0.03**	**0.02**	**1.24**	**1.21**	**0.18**	**0.17**
CD at 5%	**0.57**	**0.52**	**0.08**	**0.07**	**3.64**	**3.56**	**0.52**	**0.51**
	Sub plot - spacing (S)		Sub plot - spacing (S)		Sub plot - spacing (S)		Sub plot - spacing (S)	
S_1 (15×10 cm)	6.85	8.58	0.96	1.20	55.75	65.95	7.81	9.23
S_2 (20×10 cm)	8.50	10.90	1.19	1.53	46.39	57.23	6.50	8.01
S_3 (25×10 cm)	10.51	12.98	1.47	1.82	39.16	50.05	5.48	7.01
S_4 (30×10 cm)	11.38	14.39	1.59	2.01	32.67	43.31	4.57	6.06
SEm ±	**0.22**	**0.20**	**0.03**	**0.03**	**1.43**	**1.40**	**0.21**	**0.20**
CD at 5%	**0.66**	**0.60**	**0.09**	**0.08**	**4.20**	**4.11**	**0.60**	**0.59**
	Interactions (D × S)		Interactions (D × S)		Interactions (D × S)		Interactions (D × S)	
D_1S_1	6.54	8.28	0.92	1.16	58.59	66.74	8.20	9.34
D_1S_2	8.79	10.77	1.23	1.51	43.56	53.85	6.10	7.54
D_1S_3	10.21	12.33	1.43	1.73	36.52	47.63	5.11	6.67
D_1S_4	12.24	15.29	1.71	2.14	30.74	41.11	4.30	5.76
D_2S_1	7.93	10.01	1.11	1.40	68.07	81.41	9.53	11.40
D_2S_2	9.22	12.21	1.29	1.71	63.11	76.44	8.83	10.70
D_2S_3	12.62	15.93	1.77	2.21	51.04	63.70	7.15	8.92
D_2S_4	12.76	15.96	1.79	2.23	40.81	53.19	5.71	7.45
D_3S_1	6.09	7.46	0.85	1.04	40.59	49.70	5.68	6.96
D_3S_2	7.48	9.73	1.05	1.36	32.52	41.41	4.55	5.80
D_3S_3	8.71	10.69	1.22	1.50	29.93	38.81	4.19	5.43
D_3S_4	9.13	11.92	1.28	1.67	26.44	35.63	3.70	4.99
SEm ±	**0.39**	**0.35**	**0.05**	**0.05**	**2.48**	**2.43**	**0.36**	**0.35**
CD at 5%	**1.14**	**1.04**	**0.16**	**0.15**	**7.28**	**7.12**	**1.05**	**1.01**

significantly superior to left over treatments while, it was minimum (15.74, 436.48, 1781.06 and 1669.19 cm^2 plant^{-1}) in the treatment combination of D_3S_1–15th November with 15 × 10 cm spacing.

Leaf area index

The different dates of sowing, spacing and combination treatment showed significant effect at all the growth stages except interaction at 60–90 DAS which were non-significant depicted in Table 1. The maximum leaf area index (1.90, 7.38 and 10.81) was registered in main treatment D_2–30th October while, it was minimum (01.20, 5.56 and 8.68) in D_3-15th November. From the sub treatment, S_1–15 × 10 cm spacing had obtained higher (1.87, 8.35 and 12.66) while S_4–30 × 10 cm spacing obtained lower (1.30, 5.09 and 7.48) leaf area index. Among the different treatment combinations, the maximum (2.40, 9.68 and 14.47) and minimum (1.03, 4.36 and 6.64) leaf area index were recorded in the treatment D_2S_1–30th October with 15 × 10 cm spacing and D_3S_4–15th November with 30 × 10 cm spacing at 30–60, 60–90 DAS and 90 DAS harvest respectively.

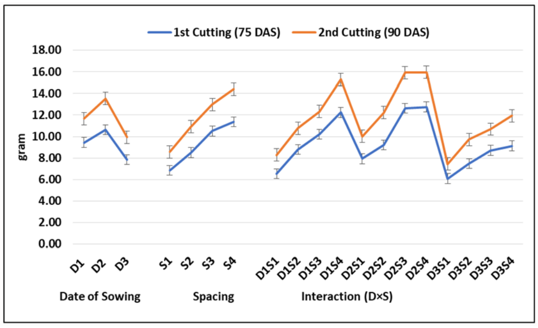

Fig. 1. Fresh herbage yield (g plant^{-1}) at different treatments and their interaction.

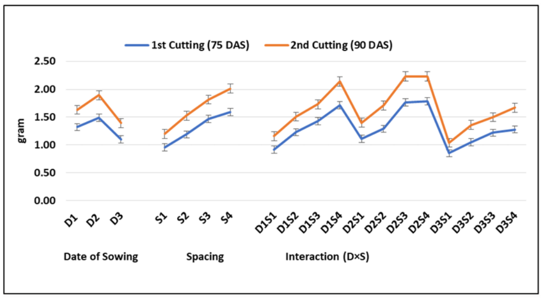

Fig. 2. Dry herbage yield (g plant^{-1}) at different treatments and their interaction.

Leaf area duration (cm^2 day^{-1})

Leaf area duration were significantly influenced with the different dates of sowing and spacing but showed non-significant effect to the interaction treatments mentioned in Table 1. The leaf area duration was found maximum (12336.54, 47423.11 and 69161.46 cm^2 day^{-1}) and minimum (7772.19, 35675.69 and 55603.65 cm^2 day^{-1}) in main treatment D_2–30th October and D_3–15th November. In the sub treatments, S_4–30 × 10 cm spacing had obtained maximum leaf area duration (11698.44, 45800.54 and 67321.10 cm^2 day^{-1}) while S_1–15 ×10 cm spacing had the minimum (8411.67, 37559.25 and 56982.12 cm^2 day^{-1}). Among the different treatment combinations, D_2S_4-30th October with 30 × 10 cm spacing were accumulated higher leaf area duration (1474.27, 52274.71 and 74125.26 cm^2 day^{-1}) while it was lower (6784.42, 33263.80 and 51754.45 cm^2 day^{-1}) in D_3S_1-15th November with 15 × 10 cm spacing at 30–60, 60–90 DAS and 90 DAS harvest respectively.

Crop growth rate (g g^{-1} day^{-1})

The crop growth rate significantly influenced by the different dates of sowing and their interaction during all the growth stages except at 90 DAS harvest but spacing shows significant effect throughout growth periods as shown in Table 2. The maximum crop growth rate (0.28, 0.49 and 0.50 g g^{-1} day^{-1}) was observed in main treatment D_2–30th October while the minimum (0.23, 0.45 and 0.50 g g^{-1} day^{-1}) in D_3–15th November. Among the sub treatments, S_1–15 × 10 cm spacing and S_4–30 × 10 cm spacing recorded maximum (0.33, 0.62 and 0.71 g g^{-1} day^{-1}) and minimum (0.19, 0.34 and 0.35 g g^{-1} day^{-1}) crop growth rate respectively. Under the different treatment combinations, D_2S_1–30th October with 15 × 10 cm spacing was recorded maximum crop growth rate (0.37, 0.67 and 0.71 g g^{-1} day^{-1}) followed by treatment D_1S_1–15th October with 15 × 10 cm spacing (0.31, 0.62 and 0.71) but was significantly superior to remaining treatments while the minimum (0.18, 0.34 and 0.35 g g^{-1} day^{-1}) in D_3S_4–15th November with 30 × 10 cm spacing at 30–60, 60–90 DAS and 90 DAS harvest respectively.

Relative growth rate (g cm^{-2} day^{-1})

The relative growth rate showed significant effect to different dates of sowing and spacing except at 90 DAS harvest while showed non-significant effect to their interaction. The maximum relative growth rate (0.019, 0.037 and 0.0389 g cm^{-2} day^{-1}) was recorded in main treatment D_2–30th October while, minimum (0.013, 0.035 and 0.0385 g cm^{-2} day^{-1}) in D_3-15th November. In the sub treatments, S_4–30 × 10 cm spacing had obtained maximum relative growth rate (0.019,0.038 and 0.038 g cm^{-2} day^{-1}) while S_1–15 × 10 cm spacing obtained minimum (0.013, 0.034 and 0.039 g cm^{-2} day^{-1}). Under the different treatment combinations, D_2S_4–30th October with 30 × 10 cm spacing was recorded maximum relative growth rate (0.0214 and 0.0385 g cm^{-2} day^{-1}) while the minimum (0.0105 and 0.0320 g cm^{-2} day^{-1}) was recorded in the treatment combination of D_3S_1–15th November with 15 × 10 cm spacing at 30–60 and 60–90 DAS respectively. At 90 DAS harvest, the maximum relative growth rate (0.0397 g cm^{-2} day^{-1}) was observed in interaction treatment D_1S_2–15th October with 20 × 10 while the minimum (0.0383 g cm^{-2} day^{-1}) was

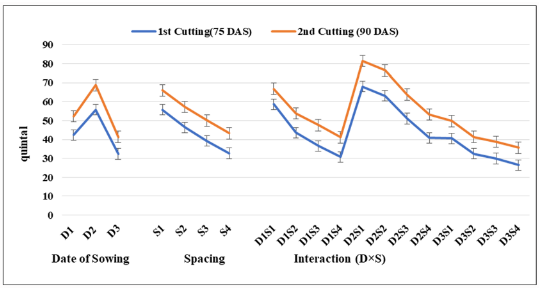

Fig. 3. Fresh herbage yield (q ha^{-1}) at different treatments and their interaction.

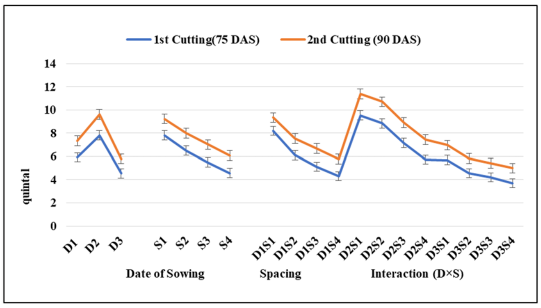

Fig. 4. Dry herbage yield (q ha^{-1}) at different treatments and their interaction.

observed in treatment D_1S_4–15th October with 30 × 10 cm spacing as shown in Table 2.

Effect of sowing dates and spacing on herbage yield parameters

The significant variations were observed on herbage yield viz., fresh and dry leaf yield (g $plant^{-1}$ and q ha^{-1}) with the different date of sowing, spacing and their interaction at 75 and 90 days after sowing. The data of herbage yield parameters are mentioned in Table 3 and graphically depicted in a Figs. 1, 2, 3 and 4.

Leaf yield (g plant^{-1})

The maximum fresh (10.63 and 13.53 g $plant^{-1}$) and dry (1.49 and 1.89 g $plant^{-1}$) leaf yield was observed in main treatment D_2–30th October while the minimum fresh (7.85 and 9.95 g $plant^{-1}$) and dry (1.10 and 1.39 g $plant^{-1}$) leaf yield was in D_3–15th November. Among the sub treatments, S_4–30 × 10 cm spacing recorded maximum fresh (11.38 and 14.39 g $plant^{-1}$) and dry (1.59 and 2.01 g $plant^{-1}$) leaf yield while S_1–15 × 10 cm spacing recorded minimum fresh (6.85 and 8.58 g $plant^{-1}$) and dry (0.96 and 1.20 g $plant^{-1}$) leaf yield. Under the different treatment combinations, D_2S_4–30th October with 30 × 10 cm spacing was recorded maximum fresh (12.76 and 15.96 g $plant^{-1}$) and dry (1.79 and 2.23 g $plant^{-1}$) leaf yield which was followed by treatment D_2S_3–30th October with 25 × 10 cm spacing and D_1S_4–15th October with 30 × 10 cm spacing but was significantly superior to remaining treatments while the minimum fresh (6.09 and 7.46 g $plant^{-1}$) and dry (0.85 and 1.04 g $plamt^{-1}$) leaf yield was recorded in D_3S_1–15th November with 15 × 10 cm spacing at 75 and 90 DAS respectively.

Leaf yield (q hectare^{-1})

Similarly, the maximum fresh (55.76 and 68.69 q ha^{-1}) and dry (7.81 and 9.62 q ha^{-1}) leaf yield was observed in main treatment D_2–30th October whereas the minimum fresh (32.37 and 41.39 q ha^{-1}) and dry (4.53 and 5.79 q ha^{-1}) leaf yield was in D_3–15th November. Unlike leaf yield g $plant^{-1}$, the sub treatment S_1–15 × 10 cm spacing recorded maximum fresh (55.75 and 65.95 q ha^{-1}) and dry (7.81 and 9.23 q ha^{-1}) leaf yield while S_4–30 × 10 cm spacing recorded minimum fresh (32.67 and 43.31 q ha^{-1}) and dry (4.57 and 6.06 q ha^{-1}) leaf yield q ha^{-1}. From the interaction treatments, the maximum fresh (68.07 and 81.41 q ha^{-1}) dry (9.53 and 11.40 q ha^{-1}) herbage yield were obtained in treatment D_2S_1–30th October with 15 × 10 cm spacing while minimum fresh (26.44 and 35.63 q ha^{-1}) and dry (3.70 and 4.99 q ha^{-1}) herbage yield were found in treatment D_3S_4–15th November with 30 × 10 cm spacing at 75 and 90 DAS respectively.

DISCUSSION

In our studies, crop sown on D_2 - 30th October recorded maximum growth and herbage yield and S_4–30 × 10 cm spacing had obtained maximum leaf area, leaf area duration, relative growth rate and herbage yield $plant^{-1}$. While, higher leaf area index, crop growth rate $plant^{-1}$ and herbage yield ha^{-1} was observed in S_1–15 × 10 cm spacing. This could be because the kasuri methi crop experienced conductive environmental conditions throughout its growth when sown at the correct time and at wider spacing, which might have given the plants an adequate opportunity of photosynthesis, so the leaves bearing capacity increased resulting in magnificent growth and the production of the more leaves, leaf area, leaf area index and leaf area duration per plant. Improvements in overall growth, i.e., plant height, number of primary branches plant^{-1} and number of leaves plant^{-1} due to optimal date of sowing and spacing, along with improved net photosynthesis towards reproduction structure allow the plant to gather more heat units by utilize soil nutrients and moisture, accumulating more glucose in their tissue, which is reflected in total plant biomass and economic yield, might have greatly increased the fresh and dry weight of plants whereas delayed sowing did not allow enough time for vegetative growth, resulting in a weak plant canopy and a decrease in fresh and dry weight (Sowmya *et al.* 2017). Widest spacing gives maximum number of leaves and herbage yield per plant as we seen in our observation but herbage yield per ha were found maximum in interaction treatment D_2S_1–30th October with 15 × 10 cm spacing could be due to the reduction in the number of plants per unit area coupled with low plant-to-plant competition (Al-Dalain *et al.* 2012). The closer spacing produced significantly higher fresh and dry herb yield per hectare, as compared to wider spacing might be due to a greater number of plants per unit area. Similar results were observed earlier by Rana (2015), Varghese *et al.* (2015) in fenugreek and Sharma *et al.* (2016) in coriander.

CONCLUSION

Based on one year of research data from twelve treatments of varied date of sowing and spacing, following conclusion could be drawn :

The most effective date of sowing for best growth and yield of kasuri methi plant was 30th October (D_2).

However, Kasuri methi plant seeded at 30 × 10 cm spacing (S_4) was found ideal for crop development and herbage yield plant^{-1} because wider spacing gave proper place for spreading which resulted in a greater number of branches, florets per plant, pods per floret and seeds per pod, resulting in more seed yield per plant.

Whereas, 15 × 10 cm spacing (S_3) was effective for herbage yield hectare^{-1}. It may be because closer spacing produced greater number of plants per unit area.

For leaf purpose, the most effective interaction treatment was D_2S_1–30th October with 15 × 10 cm spacing.

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