Effect of time of transplanting and spacing on Tulsi (*Ocimum sanctum*)

ABSTRACT

An experiment investigating the impact of transplanting time and spacing on Tulsi (*Ocimum sanctum*) was conducted over three Kharif seasons from 2018-19 to 2020-21 at AICRP on Medicinal, Aromatic Plants and Betelvine. Twenty treatment combinations were arranged in a FRBD design. Transplanting times varied from June to August, with spacing options ranging from 60x45 cm to 75 x 60 cm. Recorded observations included plant height, primary branches per plant, fresh herbage yield, and dry herbage yield. Results indicated significant differences across all parameters based on transplanting time and spacing. Transplanting during the first fortnight of July (D3) resulted in the highest values for plant height (98.20 cm), branches per plant (16.63), fresh herbage yield (99.98 q/ha), and dry herbage yield (18.91 q/ha). The treatment of transplanting during the second fortnight of June (D2) showed comparable results. Among spacing options, 60 x 45 cm (S1) demonstrated the most favorable outcomes. Notably, the combined treatment of transplanting during the first fortnight of July with 60 x 45 cm spacing (D3S1) yielded the highest plant height (99.21 cm), fresh herbage yield (122.54 q/ha), and dry herbage yield (23.02 q/ha). Economically, this treatment also proved superior, with a net monetary return of ₹91453/- and a B:C ratio of 1.99. Overall, findings suggest that transplanting Tulsi seedlings between the second fortnight of June and the first fortnight of July, coupled with 60 x 45 cm spacing, maximizes productivity and economic returns.

Keywords: Tulsi, transplanting, spacing, dry herbage, FRBD, *Ocimum sanctum*

1.INTRODUCTION

Tulsi (*Ocimum sanctum*) is native to India and Africa, an aromatic perennial plant of Lamiaceae family. In recent years the demand of medicinal plants is go on increasing not only with in India but also in rest of the countries indicated by its export and import. The export of herbs and value-added extracts of medicinal herbs has been gradually increasing over years. In 2017-2018, India exported US$ 330.18 million worth of herbs at a growth rate of 14.22% over the previous year. Also, exports of value-added extracts of medicinal herbs and herbal products in 2017-2018 stood at US$ 456.12 million, recording a growth rate of 12.23% over the previous year. The demand for herbal/value-added extracts of medicinal herbs is gradually increasing in foreign countries, especially in European and other developed countries [15].

After the corona pandemic, the importance of various medicinal plant species has been medically proven. Among these plant species tulsi is one of them. Tulsi is called as “Queen of herb” for its restorative and spiritual properties. It has traditionally been used to support a

healthy respose to stress, natural detoxification & restore balance and harmony. Also, tulsi has been found to protect organs and tissues against heavy metals and physical stress from prolonged physical excerption. The main chemical constituents of Tulsi are: Oleanolic acid, Ursolic acid, Rosmarinic acid, Eugenol, Carvacrol, Linalool, and β caryophyllene, have been used extensively for many years in food products, perfumery, and dental and oral products. Phytochemical screening of the plant leaves reveals the presence of saponins, alkaloids, flavonoids, cardiac glycosides, steroids, phenols and tannins [9]. The farmer entering in the farming of tulsi plants. Moreover, tulsi plant leaves are also use for plant protection/ fungal growth suppression as plant extract for many Phytopathological diseases [16, 17, 18, 19]. The yield and quality of produce is depended upon the various factors like season, spacing and fertilizer requirements etc. The very limited research was conducted on standardization of package of practices on it. Keeping this in mind, the present study on effect of transplanting time and spacing on yield and yield contributing characters of tulsi plant was conducted.

2.MATERIALS AND METHOD

A field experiment entitled was conducted at AICRP on Medicinal, Aromatic Plants and Betelvine project in *Kharif* season from 2018-19 to 2020-21 for consecutive of three years**.** The geographical location of the study area is lie between 74.65' E longitudes and 19.35' N latitude with an average elevation of 511 m above mean sea level (msl). The average annual rainfall is about 621 mm. The Average minimum and maximum temperature during experimental period from June to September were ranged from 35.4^0 C to 25.0^0 C respectively. The soil of experimental field belongs to an inceptisol soil having soil pH was slightly alkaline in reaction pH (8.11), electric conductivity (0.19 dSm^{-1}), low in organic carbon (0.21%), low in available nitrogen (157.67 kg ha^{-1}), medium in available phosphorus (23.0 kg ha^{-1}) and high in available in potassium (238.00 kg ha $^{-1}$). The experiment was laid out with FRBD design with twenty treatment combinations. The main factor consists of different transplanting times *viz.*, D_1: I fortnight of June, D_2: II fortnight of June, D_3: I fortnight of July, D_4: II fortnight of July and D_5: I fortnight of August and sub factor consists of different was spacings S_1: 60 x 45 cm, S_2: 60 x 60 cm, S_3: 75 x 45 cm and S_4: 75 x 60 cm. All the cultural practices related to tulsi was done as per the requirement. The data recorded on the plant height number of primary branches per plant, fresh herbage yield and was statistically analyzed using software for the plant height and no. of primary branches, randomly five plants were selected and for fresh herbage yield per plot was taken and converted into hector.

3.RESULTS AND DISCUSSION

Pooled data of three years, 2018-19, 2019-20, and 2020-21 and individual years results are summarized in Table No. 1 to 5. The data revealed that significant differences were observed in respect of time of transplanting, spacing and their interaction for all the characters studied. However non- significant differences were observed for number of branches per plant at different spacings. The pooled results are summarized head-wise as below.

Table 1: Effect of time of transplanting and spacing on height of plant (cm) and no. of branches of Tulsi

Treatments	Height of plant (cm)				No. of branches/ plant			
	2018-19	2019-20	2020-21	Pooled mean	2018-19	2019-20	2020-21	Pooled mean
A) Main factor (D): Time of Transplanting								
D_1: I fort. of June	92.55	90.55	93.53	92.23	17.00	15.68	17.08	15.98
D_2: II fort. of June	92.05	94.05	95.16	93.75	15.68	17.00	18.08	16.50
D_3: I fort. of July	94.85	98.85	97.56	98.20	17.25	17.25	17.15	16.63
D_4: II fort. of July	91.61	92.12	91.98	91.87	16.05	16.05	16.58	15.59
D_5: I fort.t of Aug	87.75	86.75	88.56	88.02	15.34	15.34	16.42	15.21
SE+	1.35	1.44	1.05	1.04	0.61	0.50	0.31	0.26
CD at 5%	3.91	4.17	3.03	3.62	NS	1.11	0.89	0.53
B) Sub-factor (S): Spacing								
								Pooled mean
S_1 60 x 45 cm	94.76	93.53	97.58	94.29	14.98	16.24	17.73	16.76
S_2 60 x 60 cm	91.13	91.76	92.03	91.63	15.94	15.94	17.13	16.33
S_3 75 x 45 cm	92.34	92.06	94.46	92.91	16.2	14.98	16.27	16.15
S_4 75 x 60 cm	89.57	91.72	89.36	90.55	18.44	18.44	15.42	16.30
SE +	1.35	1.44	0.94	1.04	0.55	0.50	0.31	0.26
CD at 5%	3.91	NS	2.71	3.62	NS	1.11	0.89	0.53
SXD Int.								
SE+	2.72	2.89	2.11	2.40	1.12	1.12	0.69	0.99
CD at 5%	NS	NS	6.06	6.88	NS	NS	NS	NS

Table 2: Effect of time of transplanting and spacing on fresh herbage and dry herbage yield of Tulsi

Treatments	Fresh herbage yield (q/ha)				Dry herbage yield (q/ha)			
	2018-19	2019-20	2020-21	Pooled mean	2018-19	2019-20	2020-21	Pooled mean
Main factor (D): Time of Transplanting								
D_1: I fort. of June	87.63	85.68	92.76	88.69	16.91	15.54	17.79	16.08
D_2: II fort. of June	101.61	95.00	103.33	98.91	19.61	17.33	19.81	17.89
D_3: I fort. of July	99.29	97.31	100.14	99.98	19.16	18.78	18.21	18.91
D_4: II fort. of July	79.02	78.2	83.16	80.12	15.25	15.09	16.33	14.55
D_5: I fort.t of Aug	73.26	71.91	75.94	73.70	14.13	13.88	13.29	13.43
SE+	1.33	1.19	1.18	0.72	0.26	0.23	0.31	0.33
CD at 5%	3.80	3.41	3.39	2.02	0.74	0.66	0.87	1.08
Sub-factor (S): Spacing								
S_1 60 x 45	112.27	108.61	114.58	111.82	21.67	20.96	20.57	20.06
S_2 60 x 60	97.42	92.158	99.39	96.32	18.8	17.79	16.93	17.17
S_3 75 x 45	80.8	80.37	82.26	81.84	15.59	15.51	14.84	14.64
S_4 75 x 60	62.16	61.35	68.03	63.84	11.99	11.84	11.81	11.88
SE +	1.33	1.19	1.18	0.72	0.26	0.23	0.31	0.33
CD at 5%	3.80	3.41	3.39	2.02	0.74	0.66	0.87	1.08
SXD Int.								
SE+	2.97	2.66	2.63	1.60	0.57	0.52	0.67	0.56
CD at 5%	8.51	7.64	7.58	4.49	1.64	1.47	NS	1.94

Table 3: Interaction effect of time of transplanting and spacing on height (cm) of Tulsi

	S_1 (60x 45 cm)	S_2 (60 x 60 cm)	S_3 (75 x 45 cm)	S_4 (75 x 60 cm)	Mean
D_1: I fort. of June	93.33	91.89	91.88	92.31	92.23
D_2: II fort. of June	98.65	93.57	90.07	90.82	93.75
D_3: I fort. of July	99.21	93.25	91.18	90.55	98.20
D_4: II fort. of July	90.51	90.74	91.98	96.06	91.87
D_5: I fort.t of Aug	92.62	89.34	87.68	84.35	88.02
Mean	94.29	91.63	92.91	90.55	92.81
SE +	2.40				
CD at 5%	6.88				

Table 4: Interaction effect of time of transplanting and spacing on fresh herbage yield (q/ha) of Tulsi

	S_1 (60x 45 cm)	S_2 (60 x 60 cm)	S_3 (75 x 45 cm)	S_4 (75 x 60 cm)	Mean
D_1: I fort. of June	111.42	98.04	81.42	63.86	88.69
D_2: II fort. of June	118.94	110.18	95.51	66.68	98.91
D_3: I fort. of July	122.54	113.24	75.37	68.09	99.98
D_4: II fort. of July	105.3	80.57	72.40	62.23	80.12
D_5: I fort. of Aug	100.9	74.55	61.01	58.34	73.70
Mean	111.82	96.32	81.84	63.84	88.28
SE +	1.60				
CD at 5%	4.49				

Table 5: Interaction effect of time of transplanting and spacing on dry herbage yield (q/ha) of Tulsi

	S_1 (60x 45 cm)	S_2 (60 x 60 cm)	S_3 (75 x 45 cm)	S_4 (75 x 60 cm)	Mean
D_1: I fort. of June	21.10	18.58	15.68	12.96	16.08
D_2: II fort. of June	22.38	20.08	17.97	13.18	17.89
D_3: I fort. of July	23.02	20.91	17.83	13.71	18.91
D_4: II fort. of July	19.75	15.49	14.22	12.76	14.55
D_5: I fort. of Aug	19.02	14.32	12.52	11.86	13.43
Mean	20.06	17.17	14.64	11.88	16.17
SE +	0.56				
CD at 5%	1.94				

Table 6. Effect of time of transplanting and spacing on economics of Tulsi

Treatments	Dry leaf yield (q/ha)	Cost of cultivation (Rs/ha)	Gross monetary return (Rs/ha)	Net monetary return (Rs/ha)	B: C ratio
D_1S_1	21.10	97742	168800	71537	1.72
D_1S_2	18.58	97113	148640	51527	1.53
D_1S_3	15.68	96483	125440	28956	1.30
D_1S_4	12.96	95854	103680	07826	1.08
D_2S_1	22.38	95224	179040	83815	1.88
D_2S_2	20.08	94595	160640	77245	1.69
D_2S_3	17.97	93965	143760	49794	1.53
D_2S_4	13.18	93336	105440	12104	1.13
D_3S_1	23.02	92706	184160	91453	1.99
D_3S_2	20.91	92077	167280	75603	1.79
D_3S_3	17.83	91447	142640	51192	1.56
D_3S_4	13.71	90818	109680	18862	1.21
D_4S_1	19.75	90188	158000	67811	1.75
D_4S_2	15.49	89559	123920	34361	1.38
D_4S_3	14.22	88929	113760	24830	1.28
D_4S_4	12.76	88300	102080	13780	1.17
D_5S_1	19.02	87670	152160	64489	1.74
D_5S_2	14.32	87041	114560	27519	1.32
D_5S_3	12.52	86411	100160	13748	1.16
D_5S_4	11.86	85782	94880	09098	1.11

Market price: Rate of dry herbage of Tulsi: Appro. Rs. 80/kg

3.1 Height of plant

Among all the transplanting times, the significantly maximum plant height (98.20 m) was recorded by the treatment D_3 i.e seedlings transplanted in first fortnight of July. The plant height at this transplanting time also showed significantly maximum values (94.85, 98.85 and 97.56 cm) at individual year i.e. 2018-19, 2019-20, 2020-21, respectively. In case of spacings effect on plant height, the significantly maximum plant height (94.29 cm) was observed in S_1 i.e 60 x 45 cm spacing. However, the spacing S_3 (75 x 45 cm), S_2 (60 x 60 cm) were statistically at par with S_1 (60 x 45 cm) which recorded plant height of 92.91 cm 91.63 cm respectively. As regards the interaction effect of time of transplanting and spacing both treatment D_3S_1 i.e seedlings transplanted in first fortnight of July with spacing of 60 x 45 cm showed significantly maximum height (99.21 cm) among all the interactions. However, an interactions D_2S_1 and D_1S_1 were statistically at par with interaction D_3S_1. The D_2S_1 and D_1S_1 recorded plant height of 98.65 cm and 93.53 cm, respectively. The maximum plant height was recorded when the tulsi seedling where transplanting on July reported by [8]. The same results reported by [3,10 and 14] in the Ashwagandha.

3.2 Number of branches

The data regarding number of primary branches per plant revealed that both Factor A ie time of transplanting influenced the number of primary branches on the plant. Among factor A treatment D_3 i.e transplanting of seedlings in first fortnight of July showed significantly maximum number of branches (16.63). However, D_2 i.e transplanting of seedlings in second fortnight of June was found statistically at par with treatment D_3. The treatment D_2 recorded 16.50 branches per plant. The factor B i.e. different spacing did not shown significant differences. But among different spacings, the highest (16.76) number of primary branches was recorded by 60 x 45 cm (S_1) spacing. This might be due to competition for different nutrient space and sunlight. The similar results were found by [12, 2, 13 and 8] in different *Ocimum spp*.

3.3 Fresh Herbage Yield (q/ha)

The results of fresh herbage yield also showed significant differences among the time of transplanting. The results indicated that the transplanting in first fortnight of July showed significantly maximum fresh herbage yield (99.98 q/ha) which was at par with the time of transplanting in second fortnight of June (98.91 q/ha). The spacing had the significant effect on fresh herbage yield. The significantly maximum (118.82q/ha) herbage yield was recorded with 60 x 45 cm spacing. Minimum fresh herbage yield (68.03 q/ha) was obtained with wider spacing of 75 x 60 cm. The interaction between time of planting and spacing had the significant effect on fresh herbage yield. The transplanting of seedlings in first fortnight of July with spacing 60 x 45 cm showed significantly higher fresh herbage yield (122.54 q/ha) which was statistically at par with D_2S_1 (118.94 q/ha) i.e transplanting of seedlings in second fortnight of June with spacing 60 x 45 cm. The fresh leaves yield was significantly influenced by spacing reported by [5]. Similar results are obtained are similar to those reported by [11, 8 and 7].

3.4 Dry Herbage Yield (q/ha)

The results for the dry herbage yield indicated that the dry herbage yield shown the same trend as fresh herbage yield for both the factors. The dry herbage yield was significantly highest in D_3 (18.91 q/ha) ie transplanting in first fortnight of July which was spastically at par with D_2 (transplanting in second fortnight of June) which recorded 17.89 q/ha dry herbage yield. the highest dry herbage yield (20.06 q/ha) was recorded by 60 x 45 cm spacing and superior than other spacing. The interaction between time of transplanting and spacing also had significant effect on dry herbage yield among all the interactions. the D_3S1 transplanting in first fortnight of July with spacing 60 x 45 cm showed significantly highest dry herbage yield (23.02q/ha) which was statistically at par with D_2S_1 and D_1S_1which recorded 22.38 and 21.10 q/ha dry herbage yield. The dry root yield was significantly influenced by different spacing in Ashwagandha reported by [3] and the number of berries per plant, dry root yield and seed yield influenced by spacing reported by Agarwal, 2003 [1, 4 and 6] in Ashwagandha and [8] in Tulsi.

3.5 Monetary returns

The transplanting of tulsi in the first fortnight of July at 60 x 45 cm spacing accommodating 37037 plants per hector recorded higher gross return (₹ 1,84,160), net monetary returns (₹ 91453) and benefit cost ratio (1.99).

4. CONCLUSION

Based on present study it can be concluded that transplanting of tulsi during first fortnight of July with a spacing of 60 X 45 cm was found to be effective to obtained maximum plant height, fresh herbage yield and dry herbage yield with maximum monetary returns. So, it can be recommended as best practice to can be adopted.

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