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Effect of planting time and spacing on plant growth, yield and oil yield of tulsi (*Ocimum sanctum*)

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ABSTRACT
The experiment was conducted to studies the effect of planting time and spacing on plant growth, herbage and oil yield of tulsi at Herbal Garden under the project, AICRP on MAP&B, Faculty of Agriculture, Dr. Rajendra Prasad Central Agricultural University, Pusa (Bihar), during the Kharif season of the year 2015-16 and 2016-17. The present investigation was conducted with five date of planting (1st June, 15th June, 1st July, 15th July and 1st August) with three spacing (40 x 20 cm, 40 x 30 cm and 40 x 40 cm) in a factorial RBD with three replications. The result obtained in this study demonstrated that both planting time and spacing seemed to have, more or less, some effect on plant height at flowering, number of branches per plant, fresh and dry herbage yield as well as in oil yield. Greater values of all studied characters were associated with plants grown on 1st of July with a spacing of 40 x 30 cm.
Key-Words: *Tulsi, Growth parameters, date of planting, Spacing and oil yield*

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INTRODUCTION

Sacred tulsi or holy tulsi, *Ocimum sanctum* Linn (family : Lamiaceae) is a biennial or triennial shrub. The species is worshiped by the Hindus and commonly grown in courtyards and temples. The leaves of this plant on steam distillation yield a bright yellow colour volatile oil possessing a pleasant odour with an appreciable note of clove oil. The plant contains mainly phenols, aldehydes, tannins, saponin and fats. The essential oil components are eugenol (71%), eugenol methyl ether (20%), carvacrol (3%) and minor portions of nerol, caryophyllene, selinene, α-pinene, ß-pinene, camphor, cineole, linalool etc. The plant is used as a pot herb; leaves are used as condiment in salads and other foods. O. sanctum is an erect, herbaceous, much-branched, softly hairy biennial or triennial, which grows to a height of 30-75 cm. Leaves are entire, serrate, pubescent on both sides, flowers purplish or crimson, in racemes, fruits are sub-globose or broadly ellipsoid, slightly compressed, nearly smooth, pale brown or reddish with small black markings. O. Sanctum has widest distribution which covers the entire Indian sub-continent, ascending upto 1800 m in the himalayas and in Andaman and Nicobar Islands. This plant can occupy a wide range of habitats.

Growth period of tulsi longs about 6 months and depending on growth condition, it could be harvested up to 3 times. Vegetative yield of dry matter is reported about 1.22 t/, as it could achieve 810 (12) ton/hec for fresh vegetative yield (Prakash, 1990). Vomel and Ceylan (1997) reported that *Ocimum tulsiicum* L. has average of 1551 kg/ ha green herb yield and the highest yield was reached fewer than 15 cm space between rows. Gill and Randhawa (2000) indicated that the highest drug herb yield was obtained from 40×20 cm plant density. El-Gendy et al.(2001) reported that the highest yield of *Ocimum* obtained under 15 cm between rows. Dadvand and coworkers (2006) studied effects of nitrogen fertilizer and plant density on tulsi. They found that density had significant effect on dry matter and essential oil yield of tulsi at 0.01 levels. They reported that density had no significant effect on ratio (percentage) of essential oil; while increasing of essential oil yield had been resulted in increased dry matter yield in a unit area. Chris and coworkers (2002) found that by increasing number of plants from 2 to 16 in m^2, biological yield would increase; but weight of each plant decrease when number of plants reaches to 8 and upper and density had no effect on essential oil level. Farooqi (2005) reported that cultivation spacing by 30×45 cm

is the best for tulsi cultivation with the yields of 75 and 3.73 ton/hec for vegetative and seed production. Omidbaigi (2000) stated that the best interval between rows in direct cultivation is 40 to 50 cm. Arabaci and Bayram (2004) reported that the highest essential oil ratio obtain under non-nitrogen fertilizer condition with 20×20 cm plant spacing. Pancic and Koscuska (1990) in a two years experiment found that maximum yield for vegetative fresh weight obtain in spacing of 30×50 cm and the minimum yield for 30×70 cm. Toghrai (2006) stated that by decreasing plant density in unit area, long time need for early growth. Azizi and colleagues (2004) investigated effects of different levels of vermicompost on growth index and essential oil level in tulsi.

Cultivation of medicinal and aromatic plants for profit has attracted the attention of many growers. The production of aromatic plants for profit on commercial basis involves a number of factors. The value of such crops depends on their active principle content which makes it different from the principle of production of agricultural crops. Various species of this crop are commercialy cultivated in U.P., Jammu and Kashmir, Himachal Pradesh, Punjab and in small scale in Bihar. In Bihar Ocimum is cultivated commercially in North Bihar region particularly in Begusarai, Muzaffarpua and Khagaria district which is increasing year after year. The export of this crop has increased in last decade. The seed of tulsi is exported mainly to Arab countries from India. Cultivation of this crop is also increasing in Bihar at a very steady pace owing its uses and better yield and market potential. There is very little work is done regarding improvement in production technologies of the crop for Bihar is general and North Bihar region in particular. Various researches has been made to study the growth parameters of tulsi, but till date no any proper documented work was done, therefore, the present investigation was taken in consideration.

Very meager systematic agronomic researches were initiated regarding the cultural practices of tulsi plant in India. Therefore, the objectives of this study were intended to shed some lights on the influence of raising tulsi plant on different date of planting at different spacing on growth characteristics, yield and oil content.

MATERIAL AND METHODS

The experiment was carried out in the Herbal Garden at AICRP on MAP&B, Faculty of Agriculture, Dr. Rajendra Prasad Central Agricultural University, Pusa (Bihar), during the Kharif season of the year 2015-16 and 2016-17.Details of experiment: The experiment was conducted in a FRBD design with 15 treatments combinations, replicated thrice. Treatments comprised of plant population for different planting date of planting and spacing was as follows.

Table 1: Treatment and symbols of experiment

	Treatment	**Symbol**
(A)	Five levels of date of planting	
	1st June	M1
	15th June	M2
	1st July	M3
	15th July	M4
	1st August	M5
(B)	Two levels of spacing	
	40X20 cm	S1
	40X30 cm	S2
	40X40 cm	S3

The field was properly ploughed by disc harrow and then pulverized by disking and harrowing. Thereafter, field was levelled properly with heavy wooden plank and plots were prepared according to layout plan. FYM was applied @ 15 q/ha uniformly to all treatments at the time of seed sowing. N:P:K was applied at the rate of 40:30:20 Kg/ha (RDF). Nitrogen was applied in the form of urea in 3 split doses. The first 1/3 of the pertinent level of nitrogen with requisite quantity of urea were mixed and drilled in the furrows at the time of sowing by hand. Remaining quantity of nitrogen was applied in two splits at first irrigation 30 DAP and at 45 DAP. The pure healthy disease and insect free vigorous and good quality seeds of tulsi were used for sowing in nursery. 30 days old seedlings were transplanted in the experimental field at five different dates and the spacing as per treatments. The sowing of the crop in nursery was done on first week of June every year. The recommended pack-age of practices was followed for raising the crop Observations were recorded for Plant height at flowering (cm), number of branches/plant, fresh and dry herbage yield (qha^{-1}) and oil yield of Tulsi as per standard procedure adopted.

RESULT AND DISCUSSIONS

Plant Height

Table 2 displayed plant height measurements recorded at flowering stage showed significant difference at different planting time and spacing. The maximum plant height was recorded when the seedling where transplanting on July (101-78cm) which was at par with M4 (101.00 cm), M5 (96.15 cm) and M2 (90.00 cm) irrespective of spacing. The maximum plant height was recorded when plant where spaced at S2 i.e. 99.42 cm which was at par with spacing S1 (97.44 cm) and minimum was recorded with spacing S3 (93.43 cm) irrespective planting time.When there interaction effect were observed the plant height showed significant difference. Maximum plant height was recorded in treatment combination M3S2 (107.06 cm) followed by M4 S1 (105.55 cm), M4S2 (102.23 cm), M3S1 (101.08 cm) and minimum plant height was recorded in the treatment combination M1S1 (87.38 cm).

The result obtained in this study demonstrated that both planting time and spacing seemed to have, more or less, some effect on plant height at flowering, however, greater values of plant height were associated with plants grown on 1st of July with a spacing of 40 x 30 cm. These results are in agreement with those of Tetio-Kago and Gardeaer (1988) and Salim (1997) and Sedigheh(2009).

Number of branches per plant

The recorded values of no. of branches per plant as affected by planting time and spacing and their combination are displayed in table-2. Number of branches per plant counted after 90 DAP showed significant difference between various planting time. Significantly greater no. of branches was associated when seedling was transplanted on 1st July (M3) i.e. 24.71 which was at par with M4 (24.10) and M2 (22.59) and lesser was recorded in M1 (15.72).When various spacing are concerned, the greater no. of branches / plant was recorded when plant where spaced at 40 x 30 cm i.e. S2 (23.50) followed by S3 (22.08) and lesser in S1 (19.58).

When there interaction effect were observed, the greater no. of branches per plant was recorded in treatment combination M3S2 (27.36) followed by M3S3 (25.88), M2S2 (25.53), M4S2 (25.21), M4S3 (23.88), M4S1 (23.22) and lesser was recorded in M1S1 (14.20). Similar results were obtained by Ibrahim (2000) who found that at wider spacing enough space among them to produce more branches.

Fresh & Dry herbage yield

Fresh and dry herbage yield of tulsi showed significant difference in the values of fresh and dry herbage yield of tulsi among treatments and their combination. Maximum fresh & dry herbage yield were recorded when seedling where transplanted on 1st July i.e. M3 (147.05 & 36.98 q/ha, respectively) and minimum was recorded on M1 (83.72 & 21.59 q/ha, respectively).When spacing are concerned, the maximum fresh & dry herbage yield were recorded when plant were spaced at 40 x 30 cm i.e. S2 (129.71 & 32.83 q/ha, respectively) which was at par with S3 (125.42 & 31.53 q/ha, respectively) and minimum was recorded with S1 (122.89 & 30.41 q/ha, respectively).When there interaction effect were studies, the maximum fresh and dry herbage yield where recorded with a treatment combination M3S2 (160.56 & 39.90 t/ha, respectively) and minimum was recorded with treatment combination M1S1 (79.05 and 20.22 q/ha, respectively). Similar results were achieved by Guenther; 1949 and Davids (1993) and Patel & Kushwah(2013)

Oil yield

Oil yield as affected by planting time and spacing and their combinations are shown in table-4. Maximum oil yield was recorded when seedlings was transplanted on 1st July 2017 i.e. M3 (120.11 kg/ha) which was at par with M2 (104.56 kg/ha) and M4 (104.45 kg/ha) whereas minimum oil yield was recorded in M1 (89.21 kg/ha).Maximum oil yield was recorded when plant were spaced with 40 x 30 cm i.e. S2 (108.35 kg/ha) which was at par with S1 (103.08 kg/ha).In interaction effect the crop planted in the first July with 40 x 30 cm (M3S2) recorded significantly superior oil yield (125.90 kg/ha) followed by M3S1 (121.98 kg/ha) while minimum oil yield (88.84 kg/ha) recorded in M1S1. The increase of oil yield was probably due to the enhancement of the vegetative growth as discussed previously.Similar results were achieved by Kobur (1997), Idris (1989) Tetio-Kago and Gardner (1988).

Table – 2: Effect of Planting time and spacing on Plant height at flowering and number of branches/plant of Tulsi.

Treat Ment	Plant height at flowering (cm)						Number of branches/plants					
	M1	M2	M3	M4	M5	Mean	M1	M2	M3	M4	M5	Mean
S1	87.38	94.01	101.08	105.55	99.21	97.44	14.20	20.38	20.89	23.22	19.23	19.58
S2	93.40	98.54	107.06	102.23	95.87	99.42	17.58	25.53	27.36	25.21	21.85	23.50
S3	89.23	92.06	97.20	95.23	93.45	93.43	15.38	21.88	25.88	23.88	23.38	22.08
Mean	90.00	94.87	101.78	101.0	96.17	96.76	15.72	22.59	24.71	24.10	21.48	
	Main	**Sub**	**M x S**				**Main**	**Sub**	**M x S**			

	(M)	(S)					(M)	(S)				
SEm (±)	3.97	3.07	6.88				1.04	0.80	1.80			
LSD	11.50	8.91	19.93				3.02	2.33	5.23			
CV	12.31						14.40					

Table – 3: Effect of Planting time and spacing on fresh and dry herbage yield (qha^{-1}) of Tulsi.

Treatment	Fresh herbage yield (qha^{-1})						Dry herbage yield (qha^{-1})					
	M1	M2	M3	M4	M5	Mean	M1	M2	M3	M4	M5	Mean
S1	79.05	128.23	136.88	135.33	122.89	120.47	20.22	32.24	35.19	34.20	30.21	30.41
S2	84.86	138.05	160.56	141.57	129.71	130.95	21.85	34.65	39.90	35.53	32.23	32.83
S3	87.26	130.89	143.71	138.38	126.87	125.42	22.70	33.04	34.86	34.86	31.20	31.53
Mean	83.72	132.39	147.05	138.42	126.49	125.6	21.59	33.31	36.98	34.86	31.21	
	Main (M)	**Sub (S)**	**M x S**				**Main (M)**	**Sub (S)**	**M x S**			
S Em (±)	3.06	2.37	5.31				1.08	0.84	1.88			
LSD	8.88	6.88	15.38				3.14	2.43	5.45			
CV	7.32						10.31					

Table – 4: Effect of Planting time and spacing on oil yield (kgha^{-1}) of Tulsi.

Treatment	Oil Yield (kg/ha)					
	M1	M2	M3	M4	M5	Mean
S1	89.11	104.02	118.03	102.02	98.16	103.77
S2	91.02	106.09	122.13	106.21	96.04	111.32
S3	87.10	102.20	120.08	104.05	94.12	97.45
Mean	89.21	104.56	120.11	104.43	96.87	
	Main (M)	Sub (S)	M x S			
S Em (±)	2.98	2.01	2.67			
LSD	10.67	5.87	5.23			
CV	8.12					

REFERENCES

1. Arabaci O, Bayram E.2004. The effect of nitrogen fertilization and different plant densites on some agronomic and technologic characteristic of Ocimum tulsiicumL. (Tulsi). Journal of Agronomy 3,255-262.
2. Azizi M, Volkezian A, Baghani M.2004. Effect of different level of vermicompost on growth parameters and yield of essential oil in ocimum. 2th Iranian congress on medicinal plants 62-63.
3. Dadvand MR, Naghdibadi H, Nasri M, Makkiazdeh M, Omidi H.2006. Variation of essential oil and yield in Ocimum affected by density and nitrogen fertilizers. Iranian research Journal of Medicinal Plants (Jahad Daneshgahi) 27, 70-80 (inPersian).
4. Davis, T. M. (1993). In row plant spacing and yield of fresh market basil. Journal of Herbs, Spices and Medicinal Plants, 2 (1): 35-43.
5. Elamin B. M. (1980). The Effect of Nursery Plant Population Density, Bed Type, Hardening and Transplant Size on Onion Growth and its Subsequent Performance in Field. M.Sc. (Agric) Thesis, University of Khartoum, Khartoum, Sudan.
6. El-Gendy SA, Hosni AM, Ahmed SS, Omer EA, Rehman MS.2001. Variation in herbage yield and oil composition of sweet tulsi (Ocimum tulsiicumL.) var. 'Grande Verde' grown organically in a newly reclaimed land in Egypt. Arab Universities Journal of Agricultural Science 9: 915-933.
7. Farooqi B. 2004. French tulsi. In: Cultivation of Spice Crops. Eds, Ali Farooqi and B.S. Sreeramu, Universities Press, 182-190.
8. Gill BS, Randhawa GS.2000. Effect of different row and plant spacing on yield and quality of French tulsi oil. Journal of Research Punjab Agriculture University 36,191-193.
9. Guenther, E. (1949). The Essential Oils. Robert E. Krieger Publishing Company. Hutington, New York. (3):400-406.
10. Ibrahim, H. A. (2000). The Effect of Some Cultural Practices on Growth and Oil Yield of three Basil's Species.M.Sc. (Agric) Thesis, University of Khartoum, Khartoum, Sudan.
11. Idris, M. O. (1989). Yield of Herb and Essential Oil of Basil in Response to Inter-Plant Spacing and Nitrogen Fertilizer. M.Sc. (Agric) Thesis. University of El-Gazira, Wad Medani, Sudan.
12. Kobur A.O. (1997) Effect of Bed type and Spacing on Growth Characteristics and Oil content of Basil Plant (Ocimum basilicum L.) M.Sc. Thesis. University of Khartoum, Khartoum. Sudan
13. Omidbaigi R. 2000. Production and processing of medicinal plants vol: 2. Astan Ghods Razavi Press. Tehran, 397-398.
14. Pancic J, Koscuska T. 1990. Influence of methods and season for planting establishment on yield and Quality of sweet tulsi.Sciencedirect, 379-385
15. Prakash V.(1990). Leafy spices.CRC press Inc. Boca Raton, 31-32.

16. Patel, K and Kushwaha N.K.(2013). Studies on influence of species, nitrogen and spacing on parameters of plant growth at various stages of basil. Int. J. of Pharm. & Life Sci. 4(10): 3028-3034
17. Salim E. A. (1997). Effect of Bed Type and Spacing on Growth and Oil Contents of Two Mint Cultivars.M.Sc. Thesis. University of Khartoum, Khartoum. Sudan.
18. Simon, T. E. (1995). Basil: A source of essential oil. University of Purdue, West Lafayette. IN 47907-1165, USA.
19. Sedigheh Sadeghi, Aptin Rahnavard and Zoheir Y. Ashraf (2009) The effect of plant-density and sowing-date on yield of Basil (*Ocimum basilicum* L.) In Iran Journal of Agricultural Technology. 5(2): 413-422
20. Tetio- kago, F. and Gardner, F.P. (1988). Response of Maize to plant population density: 1- Canopy development, high relationships, and vegetative growth, Agron. J.80: 930-935
21. Toghrai A.2006. Effect of plant density and nitrogen fertilizer on yield and some agronomic parameters of pepper mint. MSc thesis on Agriculture. Faculty of agriculture, Islamic Azad University, Takestan Branch, 14-32

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