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# Effect of spacing and planting season on growth and leaf yield of sacred basil (*Ocimum sanctum*)

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**Abstract**
A field experiment was carried out during 2019-20 and 2020-21 at College farm, College of Horticulture, Venkataramannagudem, West Godavari Distract of AP. Data were recorded on growth parameters like plant height, number of primary branches per plant, number of secondary branches per plant, leaf area and yield parameter on fresh weight of leaves per plant. Among the treatment combination 40 cm x 30 cm + late *Kharif* ($S_1P_2$) was found to record the highest plant height. The widest spacing of 40 cm x 60 cm + late *Kharif* ($S_4P_2$) recorded the maximum number of primary branches per plant, number of secondary branches per plant, leaf area and fresh weight of leaves per plant.

**Keywords:** Sacred basil, spacing, planting season, growth and yield parameters

## Introduction
The genus *Ocimum* collectively called as "Basil" belongs to the family Lamiaceae (Labiateae) contain about 50 to 150 species of herbs and shrubs from the tropical regions in Asia, Africa, Central and South America (Darrah, 1980). The aromatic herb *Ocimum sanctum* is popularly known as 'Sacred Basil' or 'Holy Basil' as it is worshipped by the Hindus (Pushpangadan and Bradu, 1995) [10].
*Ocimum* is the most important aromatic medicinal plants since the time of ancient civilization. Being a polymorphic group of economically useful herbs, it forms a rich source of many naturally occurring essential oils and aromatic chemicals (Khosla *et al.*, 2000) [4].
O. Sanctum has widest distribution which covers the entire Indian sub-continent, ascending up to 1800 m in the Himalayas and in Andaman and Nicobar Islands. This plant can occupy a wide range of habitats.

## Material and Methods
A field experiment was conducted at College of Horticulture, Venkataramannagudem, Dr. YSRHU, West Godavari District of Andhra Pradesh during 2019-20 and 2020-21 to analyse quantitative parameters of tulasi as influenced by spacing and planting season (*Ocimum sanctum*). There were 16 treatment combinations consisting of two factors *viz*., 4 plant spacing ($S_1$:40 cm x 30 cm, $S_2$: 40 cm x40 cm, $S_3$:40 cm x 50 cm $S_4$:40 cm x 60 cm) with 4 planting season ($P_1$: *Kharif*, $P_2$: late *Kharif* and $P_3$: *Rabi* $P_4$: late *Rabi*). Treatments were laid in Factorial RBD with replicated twice on open field conditions. 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 25 DAS and at 50 DAS. 30 days old seedlings were transplanted in the experimental field.

## Results and Discussions
### Plant height
The data pertaining to plant height as influenced by the spacing, planting season and their interaction are presented in Table 1. Plant height differed significantly at all growth stages (25, 50 and 75 DAS) due to spacing, planting season and interaction effect in the pooled analysis. As per pooled data, the maximum plant height at 75 DAS (75.64 cm) was recorded at the spacing of 40 cm x 30 cm ($S_1$) and the minimum plant height (65.79 cm) was noticed in the plants spaced at 40 cm x 60 cm ($S_4$).

Among the planting seasons, maximum plant height (73.72 cm) at 75 DAS was observed with late *Kharif* ($P_2$) planting significantly superior to *Kharif* ($P_1$) planting (72.03 cm) which in turn was on par with *Rabi* planting ($P_3$) (71.00 cm).
Among interactions at 75 DAS, the highest values were found in the combination $S_1P_2$: 40 cm x 30 cm + late *Kharif* (79.85 cm) which was on par with $S_1P_1$: 40 cm x 30 cm + *Kharif* (76.75 cm). The lowest plant height was observed by $S_4P_4$: 40 cm x 60 cm + late *Rabi* (62.69 cm).
Among plant spacings, the one at 40 cm x 30 cm recorded maximum plant height at all growth stages; which might be due to the reason that the plants under closer spacing tend to grow vertically for more light and air thus growing taller. Widely spaced plants were provided with a better explorable area in terms of rhizosphere as well as micro-climate thus showing a better vegetative growth. Similarly closely spaced ones were prone to stress on account of competition, thus showing lesser horizontal growth. This is in close agreement with the findings of Singh *et al.* (2004) [14], Ajimoddin *et al.* (2005) [1], Mirjalili (2014) [6] in french basil and Arularasu *et al.* (2008) [2] in sacred basil.
The results from the present study indicated that planting season also had exerted the similar significant influence on plant height at all growth stages. Late *Kharif* and *Kharif* planting resulted in taller plants whereas *Rabi* planting made them to remain dwarf. However, greater values of plant height were recorded by those plants planted during late *Kharif* (1st July) with a spacing of 40 cm x 30 cm. These results are in agreement with those Sedigheh (2009) [12] in basil crop under Israel conditions. Similar findings were observed by Mohammad *et al.* (2012) [7] in German chamomile, Sunil *et al.* (2011) [17] in kalmegh. The reasons for increased growth parameters due to early planting were attributed to be due to crop planted on 1st July did not get affected by heavy rainfall during establishment stage as compared to latter and earlier plantings due to which the crop suffered stress during establishment and growth stages resulting in slow growth. Better establishment of seedlings of kalmegh in the field was observed due to congenial temperature with July planting under muzzaffarnagar conditions as reported by (Singh and Singh, 2006) [15].

**Number of primary branches per plant**

A perusal of data on number of primary branches per plant (Table 2) indicated that there was significant effect of spacing, planting season and interaction on this trait at 25, 50 and 75 DAS in pooled analysis. According to pooled analysis, the number of primary branches per plant at 75 DAS was maximum (18.30) in 40 cm x 60 cm spacing ($S_4$) and minimum (16.04) in 40 cm x 30 cm ($S_1$). However, late *Kharif* planting ($P_2$) produced the higher number of primary branches per plant (18.32) which was followed by *Rabi* ($P_3$) (17.33).
The number of primary branches per plant was at the highest (19.70) in $S_4P_2$ combination (spacing of 40 cm x 60 cm + late *Kharif* planting) which was followed by (19.08) in $S_3P_2$ combination (spacing of 40 cm x 50 cm + late *Kharif*) and the lowest number of primary branches per plant was observed by $S_1P_1$ (40 cm x 30 cm + *Kharif*) (15.42).

**Number of secondary branches per plant**

Data pertaining to number of secondary branches per plant (Table 3) revealed significant influence due to spacing, planting season and their interactions at all growth stages (25, 50 and 75 DAS) in pooled analysis.
At 75 DAS, the higher values of secondary branches per plant (84.10) were observed at a spacing of 40 cm x 60 cm ($S_4$) as compared to 40 cm x 50 cm spacing ($S_3$) (78.81) and the least number of secondary branches per plant (70.27) was observed in 40 cm x 30 cm ($S_1$). The highest number of secondary branches per plant at 75 DAS (78.69) was recorded with late *Kharif* planting ($P_2$) which was on par with *Rabi* ($P_3$) (77.61) and lowest number of secondary branches per plant was recorded by late *Rabi* ($P_4$) (75.15).
Among the interactions, $S_4P_2$ treatment combination (40 cm x 60 cm + late *Kharif*) recorded the highest number of secondary branches per plant (86.75) which was on par with the same spacing in other seasons *i.e.* $S_4P_3$ (40 cm x 60 cm + *Rabi*) (85.10) and lowest number of secondary branches per plant was observed by $S_1P_4$ (40 cm x 30 cm + late *Rabi*) (68.75) at 75 DAS.
An examination of data on the number of primary and secondary branches per plant revealed that these characters were significantly influenced at all growth stages by spacing. Significantly higher number of branches per plant was noticed at wider spacing of 40 cm x 60 cm ($S_4$), while, the least branching was observed at 40 cm x 30 cm ($S_1$). The increased branching at wider plant orientations could be attributed to a higher availability of resources from atmosphere and rhizosphere to each plant as compared to those oriented at closer geometry. It is interesting to note that at wider plant spacing, the plants were found to produce more branches but remained dwarf compared to closely spaced ones. Similar results were obtained by Mirjalili (2014) [6] in French basil and Patel and Kushwaha (2013) [9] in *Ocimum* species.
The wider spread at wider spacing in marigold was attributed to congenial growing conditions such as more space available for growth of roots and shoots. Similar result of increasing plant spread and number of branches per plant coupled with decrease in plant height at wide planting geometry was also reported by in chrysanthemum and Srivastava *et al.* (2005), Vasudev *et al.* (2006) [16, 19] in marigold.

**Plant spread ($dm^2$)**

Plant spread differed (Table 4) significantly at all growth stages (25, 50 and 75 DAS) due to spacing, planting season and their interactions in pooled analysis.
According to pooled analysis the maximum plant spread at 75 DAS was noticed in 40 cm x 60 cm spacing ($S_4$) (23.70 $dm^2$) which was followed by 40 cm x 50 cm ($S_3$) (19.35 $dm^2$). However, late *Kharif* ($P_2$) planting resulted in the maximum plant spread (18.09 $dm^2$) which was on par with *Rabi* ($P_3$) (17.64 $dm^2$). Among the interactions between spacing and planting season, the highest plant spread (24.34 $dm^2$) was recorded from the combination $S_4P_2$ (40 cm x 60 cm + late *Kharif*) which was on par with $S_4P_3$ (40 cm x 60 cm + *Rabi*) (23.88 $dm^2$) and the lowest plant spread (11.81 $dm^2$) was recorded by $S_1P_4$ (40 cm x 30 cm + late *Rabi*).
The plant spread was found to be at the highest with $S_4$ *i.e.* 40 cm x 60 cm, which was significantly superior when compared to closer spacing levels. Thus, it is inferred that higher the ground area provided per plant shorter was the plant height and more was the plant spread. The increasing values of plant spread when the plants were spaced at relatively wider intervals might be due to increasing number of branches per plant recorded at these spacing levels. The wider spread at wider spacing was attributed to congenial growing conditions such as more space available for growth of roots and shoots.

The higher plant spread at wider plant orientation was attributed to higher number of branches per plant by Lokesh and Gangadharappa (2007) [5] in makoi. The data on number of branches per plant obtained in the present study also confirmed the same.

**Leaf area (dm$^2$)**

Significant variations were observed in leaf area (Table 5). at 25, 50 and 75 DAS by the influence of spacing, planting season and their interactions.

Plant spacing of 40 cm x 60 cm ($S_4$) was found to have the highest leaf area (58.27 dm$^2$) at 75 DAS which was followed by 40 cm x 50 cm ($S_3$) (54.90 dm$^2$). However, late *Kharif* ($P_2$) planting produced the maximum leaf area (53.75 dm$^2$) which was on par with *Rabi* ($P_3$) (52.03 dm$^2$) and the lowest was recorded by late *Rabi* ($P_4$) (49.03 dm$^2$).

Among the interactions, the treatment combination of $S_4P_2$ (40 cm x 60 cm + late *Kharif*) (59.66 dm$^2$) recorded the highest leaf area which was on par with $S_1P_3$ (40 cm x 60 cm + *Rabi*) (58.21 dm$^2$) and the lowest was recorded by $S_1P_4$ (40 cm x 30 cm + late *Rabi*) (39.04 dm$^2$).

The highest leaf area per plant was observed with $S_4$: 40 cm x 60 cm, followed by $S_3$ 40 cm x 50 cm, while, the least leaf area per plant was recorded at closer spacing of 40 cm x 30 cm ($S_1$). Thus, it is clear that more number of leaves had contributed to higher leaf area and eventually more photosynthetic surface at wide orientation. On the other hand closely spaced plants on account of more dense situation, fresh leaves on lower branches might not fully expanded and as a result of shade casted by higher layers of leaf canopy, functional photosynthetic area might be constrained and such plants were not able to build sufficiently more leaf area at a faster rate. An examination of growth indices makes it more vivid in the present investigation.

Higher leaf area recorded by late *Kharif* and *Rabi* planting might be due congenial weather conditions during the active growth period which could be attributed to the increased growth expressed by increased number of branches and plant spread as a result of favourable weather parameters that determine photosynthetic ability, growth and dry matter production.

Temperature had clear effects on the growth parameters of basil plants. Plant weight, plant height and leaf area were found significantly decreased at temperatures below 25 °C compared to those above 30 °C. Temperature was found to be in the favourable range for the crop planted during late *Kharif* and *Rabi*, when compared to that planted in either extremities i.e. *Kharif* and late *Rabi*. The primary biological effects of temperature are to change rates of enzyme reactions, metabolite transport and diffusion. At low temperatures these processes are slower than at high temperatures. For example, the rate of supply of phosphate ions to chloroplasts at low temperatures could limit photosynthesis, and hence reduce tissue growth. Cooler conditions also lead to decreased stomatal conductance and reduced net rates of photosynthesis, thereby inhibiting growth. Similar findings were observed by Okosun *et al.*, (2006) [8] in roselle, Singh and Singh (2006) [15] in kalmegh, Shamaraj *et al.*, (2010) [13] in ashwagandha.

**Fresh weight of leaves per plant (g)**

Data presented in Table 6 indicates significant effect of spacing, planting season and their interaction on fresh weight of leaves per plant during both the years and in pooled analysis. The mean fresh weight of plant was 239.81 g during first year, 238.23 g during second year and 239.02 g as per pooled analysis.

According to pooled analysis the fresh weight of leaves per plant differed significantly due to different plant spacing. The highest fresh weight of leaves per plant (255.46 g) was recorded at 40 cm x 60 cm ($S_4$) spacing followed by 40 cm x 50 cm ($S_3$) spacing (244.55 g).

The fresh weight of leaves per plant was significantly highest in late *Kharif* ($P_2$) planting (242.35 g) which was on par with *Rabi* ($P_3$) planting (240.48 g). The lowest fresh weight of leaves per plant was recorded by late *Rabi* ($P_4$) (234.95 g).

Among the interactions, fresh weight of leaves per plant (257.65g) was maximum under $S_4P_2$ combination (spacing of 40 cm x 60 cm + late *Kharif*) which was on par with $S_4P_3$ (40 cm x 60 cm + *Rabi*) (256.22 g) and minimum was recorded by $S_1P_4$ (40 cm x 30 cm + late *Rabi*) (217.42 g).

It is interesting to note that the performance of late *Kharif* and *Rabi* sown crops were found better compared to *Kharif* planted crop in respect of fresh weight of leaves and leaf area per plant. *Ocimum* plants exposed to temperatures higher than 30 °C will decrease in net photosynthate accumulation which is resulted from an elevated photo-respiration. Photo-respiration is a minor component of net photosynthesis under cool conditions; but, with increasing temperature, the photosynthetic rate rises and photo-respiration increases more than gross photosynthesis (particularly above 30 °C), resulting in a small increase in net photosynthesis. Such high temperature was recorded during the cropping period of *Kharif* sown crop. But late *Kharif* and *Rabi* sown crops were exposed to mostly temperatures with little deviation from optimum temperature of 25 to 30 °C, as evident from weather data (Annexure I-C) This result supports the findings of Tiwari *et al.*, (2002) [18] from a growth chamber experiment, which measured the fastest growth rate of basil at 27 °C. On the other hand, very cool temperatures also are detrimental due to lessened enzymatic activity leading to a reduced growth and carbohydrate accumulation as evident from the data on late *Rabi* sown crop in the present study.

**Table 1:** Effect of spacing and season of planting on plant height (cm) at different growth stages in sacred basil (*Ocimum sanctum*)

| Pooled data | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Spacing (S) | 25 DAS | | | | | 50 DAS | | | | | 75 DAS | | | | |
| | Season of planting (P) | | | | | | | | | | | | | | |
| | $P_1$ *Kharif* | $P_2$ Late *Kharif* | $P_3$ *Rabi* | $P_4$ Late *Rabi* | Mean | $P_1$ *Kharif* | $P_2$ Late *Kharif* | $P_3$ *Rabi* | $P_4$ Late *Rabi* | Mean | $P_1$ *Kharif* | $P_2$ Late *Kharif* | $P_3$ *Rabi* | $P_4$ Late *Rabi* | Mean |
| $S_1$: 40 cm x 30 cm | 38.17 | 39.70 | 37.25 | 36.08 | 37.80 | 66.88 | 69.68 | 66.38 | 64.20 | 66.78 | 76.75 | 79.85 | 75.90 | 74.09 | 75.64 |
| $S_2$: 40 cm x 40 cm | 36.25 | 37.05 | 34.45 | 34.79 | 35.64 | 63.88 | 65.43 | 63.13 | 62.53 | 63.74 | 74.63 | 74.33 | 72.60 | 71.69 | 73.30 |
| $S_3$: 40 cm x 50 cm | 33.41 | 33.78 | 32.18 | 31.43 | 32.70 | 58.83 | 61.50 | 57.55 | 56.66 | 58.63 | 71.63 | 73.38 | 70.20 | 69.50 | 71.05 |
| $S_4$: 40 cm x 60 cm | 30.59 | 30.61 | 28.36 | 26.26 | 28.95 | 51.97 | 54.58 | 51.43 | 50.82 | 52.20 | 66.10 | 69.34 | 65.50 | 62.69 | 65.79 |
| Mean | 34.60 | 35.29 | 33.06 | 32.14 | 33.77 | 60.39 | 62.80 | 59.62 | 58.55 | 60.34 | 72.03 | 73.72 | 71.00 | 69.49 | 71.44 |
| Factor | S Em(+) | | | CD at 5% | | S Em(+) | | | CD at 5% | | S Em(+) | | | CD at 5% | |
| Spacing (S) | 0.44 | | | 1.32 | | 0.73 | | | 2.20 | | 0.45 | | | 1.36 | |
| Planting season (P) | 0.44 | | | 1.32 | | 0.73 | | | 2.20 | | 0.45 | | | 1.36 | |
| Sp. x Ptg. Sn.(S x P) | 0.74 | | | 2.24 | | 1.24 | | | 3.74 | | 0.77 | | | 2.32 | |

**Table 2:** Effect of spacing and season of planting on primary branches at different growth stages in sacred basil (*Ocimum sanctum*)

| Pooled data | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Spacing (S)** | **25 DAS** | | | | | **50 DAS** | | | | | **75 DAS** | | | | |
| | **Season of planting (P)** | | | | | | | | | | | | | | |
| | **$P_1$ *Kharif*** | **$P_2$ Late *Kharif*** | **$P_3$ *Rabi*** | **$P_4$ Late *Rabi*** | **Mean** | **$P_1$ *Kharif*** | **$P_2$ Late *Kharif*** | **$P_3$ *Rabi*** | **$P_4$ Late *Rabi*** | **Mean** | **$P_1$ *Kharif*** | **$P_2$ Late *Kharif*** | **$P_3$ *Rabi*** | **$P_4$ Late *Rabi*** | **Mean** |
| $S_1$: 40 cm x 30 cm | 9.33 | 9.83 | 9.60 | 9.05 | 9.45 | 12.58 | 13.05 | 12.85 | 11.80 | 12.57 | 15.42 | 16.62 | 16.32 | 15.83 | 16.04 |
| $S_2$: 40 cm x 40 cm | 10.53 | 10.85 | 10.48 | 10.05 | 10.48 | 13.90 | 14.43 | 14.20 | 13.67 | 14.05 | 16.72 | 17.88 | 17.14 | 16.78 | 17.13 |
| $S_3$: 40 cm x 50 cm | 11.48 | 12.10 | 11.78 | 11.13 | 11.62 | 14.48 | 15.53 | 15.18 | 14.70 | 14.97 | 17.61 | 19.08 | 17.75 | 16.97 | 17.85 |
| $S_4$: 40 cm x 60 cm | 12.60 | 13.15 | 12.90 | 12.45 | 12.78 | 15.95 | 16.80 | 16.33 | 15.85 | 16.23 | 17.65 | 19.70 | 18.12 | 17.75 | 18.30 |
| Mean | 10.98 | 11.48 | 11.19 | 10.67 | 11.08 | 14.23 | 14.95 | 14.64 | 14.00 | 14.45 | 16.85 | 18.32 | 17.33 | 16.83 | 17.33 |
| Factor | S Em(±) | | | CD at 5% | | S Em(±) | | | CD at 5% | | S Em(±) | | | CD at 5% | |
| Spacing (S) | 0.12 | | | 0.36 | | 0.13 | | | 0.39 | | 0.08 | | | 0.25 | |
| Planting season (P) | 0.12 | | | 0.36 | | 0.13 | | | 0.39 | | 0.08 | | | 0.25 | |
| Sp. x Ptg. Sn.(S x P) | 0.20 | | | 0.61 | | 0.22 | | | 0.66 | | 0.14 | | | 0.42 | |

**Table 3:** Effect of spacing and season of planting on secondary branches at different growth stages in sacred basil (*Ocimum sanctum*)

| Pooled data | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Spacing (S)** | **25 DAS** | | | | | **50 DAS** | | | | | **75 DAS** | | | | |
| | **Season of planting (P)** | | | | | | | | | | | | | | |
| | **$P_1$ *Kharif*** | **$P_2$ Late *Kharif*** | **$P_3$ *Rabi*** | **$P_4$ Late *Rabi*** | **Mean** | **$P_1$ *Kharif*** | **$P_2$ Late *Kharif*** | **$P_3$ *Rabi*** | **$P_4$ Late *Rabi*** | **Mean** | **$P_1$ *Kharif*** | **$P_2$ Late *Kharif*** | **$P_3$ *Rabi*** | **$P_4$ Late *Rabi*** | **Mean** |
| $S_1$: 40 cm x 30 cm | 18.30 | 20.45 | 19.75 | 16.70 | 18.80 | 63.10 | 66.10 | 65.33 | 61.95 | 64.12 | 69.75 | 71.75 | 70.82 | 68.75 | 70.27 |
| $S_2$: 40 cm x 40 cm | 22.45 | 24.20 | 23.13 | 21.09 | 22.72 | 68.55 | 70.38 | 69.30 | 67.25 | 68.87 | 73.25 | 76.00 | 75.15 | 72.81 | 74.30 |
| $S_3$: 40 cm x 50 cm | 25.80 | 27.90 | 26.95 | 25.10 | 26.44 | 72.45 | 74.32 | 73.38 | 71.58 | 72.93 | 78.37 | 80.25 | 79.38 | 77.25 | 78.81 |
| $S_4$: 40 cm x 60 cm | 29.38 | 31.90 | 30.75 | 28.65 | 30.17 | 76.38 | 79.26 | 77.82 | 75.42 | 77.22 | 82.75 | 86.75 | 85.10 | 81.80 | 84.10 |
| Mean | 23.98 | 26.11 | 25.14 | 22.88 | 24.53 | 70.12 | 72.51 | 71.45 | 69.05 | 70.78 | 76.03 | 78.69 | 77.61 | 75.15 | 76.87 |
| Factor | S Em(±) | | | CD at 5% | | S Em(±) | | | CD at 5% | | S Em(±) | | | CD at 5% | |
| Spacing (S) | 0.41 | | | 1.23 | | 0.47 | | | 1.41 | | 0.50 | | | 1.49 | |
| Planting season (P) | 0.41 | | | 1.23 | | 0.47 | | | 1.41 | | 0.50 | | | 1.49 | |
| Sp. x Ptg. Sn.(S x P) | 0.69 | | | 2.09 | | 0.79 | | | 2.39 | | 0.84 | | | 2.54 | |

**Table 4:** Effect of spacing and season of planting on plant spread ($dm^2$) at different growth stages in sacred basil (*Ocimum sanctum*)

| Pooled data | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Spacing (S)** | **25 DAS** | | | | | **50 DAS** | | | | | **75 DAS** | | | | |
| | **Season of planting (P)** | | | | | | | | | | | | | | |
| | **$P_1$ *Kharif*** | **$P_2$ Late *Kharif*** | **$P_3$ *Rabi*** | **$P_4$ Late *Rabi*** | **Mean** | **$P_1$ *Kharif*** | **$P_2$ Late *Kharif*** | **$P_3$ *Rabi*** | **$P_4$ Late *Rabi*** | **Mean** | **$P_1$ *Kharif*** | **$P_2$Late *Kharif*** | **$P_3$ *Rabi*** | **$P_4$ Late *Rabi*** | **Mean** |
| $S_1$: 40 cm x 30 cm | 5.43 | 5.65 | 5.37 | 5.11 | 5.39 | 10.93 | 13.14 | 10.95 | 10.39 | 11.35 | 11.92 | 12.35 | 11.88 | 11.81 | 11.99 |
| $S_2$: 40 cm x 40 cm | 6.30 | 6.42 | 6.25 | 6.24 | 6.30 | 15.41 | 15.70 | 15.62 | 14.95 | 15.42 | 15.53 | 15.68 | 15.31 | 15.21 | 15.43 |
| $S_3$: 40 cm x 50 cm | 7.36 | 7.58 | 7.55 | 7.24 | 7.43 | 16.58 | 17.80 | 17.05 | 16.70 | 17.03 | 18.98 | 19.98 | 19.51 | 18.93 | 19.35 |
| $S_4$: 40 cm x 60 cm | 8.52 | 8.55 | 8.48 | 8.46 | 8.50 | 18.71 | 20.22 | 19.49 | 18.60 | 19.26 | 23.41 | 24.34 | 23.88 | 23.19 | 23.70 |
| Mean | 6.90 | 7.05 | 6.91 | 6.76 | 6.91 | 15.41 | 16.72 | 15.78 | 15.16 | 15.77 | 17.46 | 18.09 | 17.64 | 17.29 | 17.62 |
| Factor | S Em(±) | | | CD at 5% | | S Em(±) | | | CD at 5% | | S Em(±) | | | CD at 5% | |
| Spacing (S) | 0.06 | | | 0.19 | | 0.16 | | | 0.49 | | 0.21 | | | 0.63 | |
| Planting season (P) | 0.06 | | | 0.19 | | 0.16 | | | 0.49 | | 0.21 | | | 0.63 | |
| Sp. x Ptg. Sn.(S x P) | 0.11 | | | 0.32 | | 0.28 | | | 0.83 | | 0.36 | | | 1.07 | |

**Table 5:** Effect of spacing and season of planting on leaf area ($dm^2$ plant $^{-1}$) at different growth stages in sacred basil (*Ocimum sanctum*)

| Pooled data | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Spacing (S)** | **25 DAS** | | | | | **50 DAS** | | | | | **75 DAS** | | | | |
| | **Season of planting (P)** | | | | | | | | | | | | | | |
| | **$P_1$ *Kharif*** | **$P_2$ Late *Kharif*** | **$P_3$ *Rabi*** | **$P_4$ Late *Rabi*** | **Mean** | **$P_1$ *Kharif*** | **$P_2$ Late *Kharif*** | **$P_3$ *Rabi*** | **$P_4$ Late *Rabi*** | **Mean** | **$P_1$ *Kharif*** | **$P_2$ Late *Kharif*** | **$P_3$ *Rabi*** | **$P_4$ Late *Rabi*** | **Mean** |
| $S_1$: 40 cm x 30 cm | 9.66 | 9.91 | 9.78 | 9.58 | 9.73 | 19.30 | 19.81 | 19.54 | 19.18 | 19.46 | 39.72 | 43.63 | 42.49 | 39.04 | 41.22 |
| $S_2$: 40 cm x 40 cm | 10.90 | 10.94 | 10.98 | 10.04 | 10.72 | 21.85 | 22.40 | 21.92 | 20.06 | 21.56 | 47.26 | 55.92 | 51.82 | 45.84 | 50.21 |
| $S_3$: 40 cm x 50 cm | 11.70 | 12.36 | 11.98 | 11.52 | 11.89 | 23.29 | 24.59 | 23.94 | 23.06 | 23.72 | 54.20 | 55.83 | 55.62 | 53.95 | 54.90 |
| $S_4$: 40 cm x 60 cm | 12.84 | 12.99 | 13.06 | 12.36 | 12.82 | 25.67 | 26.60 | 25.80 | 24.72 | 25.69 | 57.93 | 59.66 | 58.21 | 57.30 | 58.27 |
| Mean | 11.27 | 11.55 | 11.43 | 10.88 | 11.29 | 22.53 | 23.35 | 22.80 | 21.75 | 22.61 | 49.78 | 53.75 | 52.03 | 49.03 | 51.15 |
| Factor | S Em(±) | | | CD at 5% | | S Em(±) | | | CD at 5% | | S Em(±) | | | CD at 5% | |
| Spacing (S) | 0.11 | | | 0.34 | | 0.22 | | | 0.68 | | 0.62 | | | 1.86 | |
| Planting season (P) | 0.11 | | | 0.34 | | 0.22 | | | 0.68 | | 0.62 | | | 1.86 | |
| Sp. x Ptg. Sn.(S x P) | 0.19 | | | 0.58 | | 0.38 | | | 1.15 | | 1.05 | | | 3.16 | |

**Table 6:** Fresh weight of leaves per plant (g) as influenced by spacing and season of planting and their interaction in sacred basil (*Ocimum sanctum*)

| Fresh weight of leaves per plant (g) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Spacing (S) | 2019-20 | | | | | 2020-21 | | | | | Pooled data | | | | |
| | Season of planting (P) | | | | | | | | | | | | | | |
| | $P_1$ *Kharif* | $P_2$ Late *Kharif* | $P_3$ *Rabi* | $P_4$ Late *Rabi* | Mean | $P_1$ *Kharif* | $P_2$ Late *Kharif* | $P_3$ *Rabi* | $P_4$ Late *Rabi* | Mean | $P_1$ *Kharif* | $P_2$ Late *Kharif* | $P_3$ *Rabi* | $P_4$ Late *Rabi* | Mean |
| $S_1$: 40 cm x 30 cm | 220.58 | 225.20 | 223.43 | 217.58 | 221.70 | 219.60 | 223.65 | 222.50 | 217.25 | 220.75 | 220.09 | 224.43 | 222.97 | 217.42 | 221.22 |
| $S_2$: 40 cm x 40 cm | 237.08 | 240.00 | 238.89 | 228.43 | 236.10 | 232.40 | 238.35 | 234.18 | 229.50 | 233.61 | 234.74 | 239.18 | 236.54 | 228.97 | 234.85 |
| $S_3$: 40 cm x 50 cm | 243.79 | 248.75 | 246.50 | 241.13 | 245.04 | 243.60 | 247.51 | 245.93 | 239.18 | 244.06 | 243.70 | 248.13 | 246.22 | 240.16 | 244.55 |
| $S_4$: 40 cm x 60 cm | 255.43 | 259.00 | 258.13 | 253.09 | 256.41 | 253.99 | 256.30 | 254.30 | 253.40 | 254.50 | 252.71 | 257.65 | 256.22 | 252.25 | 255.46 |
| Mean | 239.22 | 243.24 | 241.74 | 235.06 | 239.81 | 237.40 | 241.45 | 239.23 | 234.83 | 238.23 | 237.31 | 242.35 | 240.48 | 234.95 | 239.02 |
| Factor | S Em(±) | | | CD at 5% | | S Em(±) | | | CD at 5% | | S Em(±) | | | CD at 5% | |
| Spacing (S) | 0.89 | | | 2.70 | | 0.70 | | | 2.11 | | 0.79 | | | 2.40 | |
| Planting season (P) | 0.89 | | | 2.70 | | 0.70 | | | 2.11 | | 0.79 | | | 2.40 | |
| Sp. x Ptg. Sn.(S x P) | 1.52 | | | 4.58 | | 1.19 | | | 3.59 | | 1.35 | | | 4.07 | |

## References


1. Ajimoddin I, Vasundhara M, Radhakrishna D, Biradar SL, Rao GGE. Integrated nutrient management studies in sacred basil (*Ocimum sanctum* L.). Indian perfumer 2005;49(1):95-101.
2. Arularasu P, Sambandamurthi S, Palanikumar M, Rajangam J. Response of nitrogen fertilization and spacing on growth and herbage yield of sacred basil (*Ocimum sanctum* L.). Indian perfumer 2008;52:56-60.
3. Darrah HH. The cultivated basils. Buckeye Printing Co. The University of Wisconsin, Madison 1980,55-56p.
4. Khosla MK, Bhasin M, Thappa RK. Essential oil composition of some improved species of Ocimum. Indian Perfumer 2000;44(3):175-81.
5. Lokesh MD, Gangadharappa PM. Effect of plant density and nutrients on growth and herbage yield in makoi (*Solanum nigrum* L.). Journal of Asian Horticulture 2007;3(3):169-173.
6. Mirjalili SA. Assessment of density and cultivation type on growth and yield of two cultivars of basil (*Ocimum basilicum* L.). International Journal of Agronomy and Agricultural Research 2014;5(1):74-79.
7. Mohamad F, Morteza F, Elias A, Hossin T. Effect of drought stress and types of fertilizers on the quantity and quality of medicinal plant Basil (*Ocimum basilicum* L.). Indian Journal Innovations Development 2012;1(9):696-99.
8. Okosun LA, Magaji MD, Yakubu AI. Effect of sowing date and planting distance on growth and yield of two cultivars of roselle (*Hibiscus sabdar*(ffa var. sabdarifla). Journal of Plant Sciences 2006;1(4):297-305.
9. Patel K, Kushwaha NK. Studies on influence of species, nitrogen and spacing on parameters of plant growth at various stages of basil. International Journal of Pharmocology and Life Sciences 2013;4(10):3028-34.
10. Pushpangadan P, Bradu B. Basil. In: Chadha K, Gupta R (eds) Advances in horticulture, medicinal and aromatic plants, Malhotra Pub House, New Delhi, India 1995, 628 -57p.
11. Rajanna PH. Effect of spacing and levels of N and P on growth, flower and seed yield of China aster. M.Sc (Agril.) thesis. Univ. of Agric. Sci., Dharwad 2001.
12. Sedigheh Sadeghi, Aptin Rahnavard, Zoheir Y. Ashraf. The effect of plant-density and sowing-date on yield of Basil (*Ocimum basilicum* L.) In Iran Journal of Agricultural Technology 2009;5(2):413-422
13. Shamaraj, Chandranath HT, Pujari BT, Halepyati AS. Influence of planting dates and stage of harvesting on growth, dry matter production and its distribution of ashwagandha (*Withania somnifera* Dunal.). Karnataka Journal of Agricultural Sciences 2010a;23(2):343-344.
14. Singh K, Singh PP, Beg SU, Patra DD. Effect of NPK fertilizers on growth, oil yield and quality of french basil (*Ocimum basilicum* L.). Journal of Spices and Aromatic Crops 2004;13(1):52-54.
15. Singh V, Singh RK. Effect of season, time of planting and plant density on the growth, yield and andro grapholide content of Kalmegh (*andrographis paniculata* nees) under North Indian condition. International Journal of Plant Sciences 2006;1(1):6-9.
16. Srivastava SK, Singh HK, Srivastava AK. Spacing and pinching as factors for regulating flowering in marigold Cv. Pusa Basanti Gainda. Haryana J Hort. Sci 2005;34(1-2):75-77.
17. Sunil JN, Gangadharappa PM, Kattimani, Hegde KN, Hegde NK, Mastiholi AB. Effect of dates of planting and nitrogen levels on growth and yield of kalmegh. J Asian Hart 2011;7(4):221-226.
18. Tiwari, Pankaj Shah, Tiwari JP. Effect of sowing method and seed rate on growth and yield of ashwagandha {*wfthania somnifera* (L.) dunal.} under rainfed condition Agric. Sci. Digest 2002;22(3):201-202.
19. Vasudev HS, Umashankar N, Venkteshamurthy P, Shivanna MB. Influence of fertilizer and spacing levels on growth of marigold in Mysore district. Journal of Asian Horticulture 2006;2(3):218-221.
20. Vijayakumar KT, Patil AA, Hulmani NC. Effect of plant density of nitrogen on growth characters and flower yield of China aster (*Callistephus chinensis* Nees.) cv. Ostrich Plume Mixed. South Indian Hort 1988;36(6):318-320.