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Influence of NPK and plant spacing on growth, yield and quality of sweet basil (*Ocimum basilicum* L.) under Telangana conditions

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Abstract
Sweet basil (*Ocimum basilicum* L.) is an annual plant belonging to the plant family Lamiaceae. There are many varieties of basil, with leaves of colour from green to purple and with small white or pink flower. In field experiment conducted in the year 2020 - 2021 at Medicinal and Aromatic Plants Research Station, Rajendranagar, Hyderabad. Data were recorded on growth parameters like plant height, number of branches per plant, leaf area, yield parameter on fresh yield per hectare, seed yield per hectare and quality parameters like essential oil ratio and essential oil yield. Among the treatment combination 40 cm X 20 cm and supplied with 150:75:75 NPK kg per ha (S_1F_4) was found to record the highest plant height, fresh yield per hectare and seed yield per hectare. The widest spacing of 60 cm x 40 cm and supplied with 150:75:75 NPK Kg per ha (S_3F_4) recorded the maximum number of branches per plant and leaf area. Quality parameters like essential oil ratio and essential oil yield shows non-significant effect with NPK applications and plant spacing.

Keywords: Sweet basil, NPK, plant spacing plant height, yield and quality

Introduction

The Sweet basil is an erect, almost glabrous herb 30-90 cm in height. The plants are highly branched, stems and twigs are quadrangular, leaves are ovate, acute, entire toothed or lobed the exstipulate leaves are opposite and decussate. They possess glandular hairs with stalked or sessile glands which secrete strongly scented volatile oils. The young twigs are greenish purple or brownish in colour. Flowers are also white or pale purple in simple or much branched raceme, often thyrsoid, nutlets ellipsoid, black and pitted. The most important component of basil is essential oil and yield varies from 0.1 to 0.45% based on ecological and agronomical conditions. (Olcay and Emine, 2004) [11].

Medicinal and aromatic plants (MAPs) contribute significantly to rural economy and health security of the country. More than 90% of the formulations under the Indian systems of medicine contain plant-based raw materials. India exports herbal materials and medicines to the tune of nearly 600 crores annually. While about 2000 medicinal plants are used in the Indian systems of medicine, 500 of these are more commonly used. However, less than 50 medicinal plants are considered on priority for development of agro-techniques by National Medicinal Plants Board, Government of India.

Due to the chemicals contained in essential oils of sweet basil it is used for treatment of dry mouth and dental complaints, diarrhea and chronic dysentery, respiratory disorders and effective in the treatment of fungal diseases and stomach discomfort in addition, the influential antitussive, diuretic, anthelminthic, tranquilizer and expectorant roles in medicinal approach, moreover, cease nasal-bleeding, prevents constipation, good for fatigue, insomnia, used for healing migraine headaches and incomplete paraplegia (Telci *et al.* 2006) [14]. However, recently the potential uses of *Ocimum basilicum* L. essential oil, particularly as antimicrobial and antioxidant agents have also been investigated.

Nutrient relations of crops clearly show the interplay between improvement in yield potential and application of fertilizers is an important input in agro-ecosystem. There is enough scope for increasing productivity through balanced use of fertilizers and nutrients to crop and thereby increasing nutrient and water use efficiency along with increased crop yield and net income of farmers. Nitrogen is most recognized nutrient owing to their presence in protein, purine, pyrimidine, porphyrin and co-enzymes and plays important role in protein, cytochrome chlorophyll synthesis thereby influences photosynthesis, respiration, crop productivity and quality.

An important factor affecting the quantity and quality of the French basil yield may be inorganic fertilization. Plant nutrition is closely connected to the quantity and quality to obtain yield, besides its yield creating role, also affects the biological value.
Despite its wide application and utility, not much organized research work has been done on agro - techniques like population to be maintained/ unit area and application of fertilizers to enhance the production and productivity in Telangana region.

Materials and Methods
The experiment entitled "Standardization of Agro techniques for sweet basil (*Ocimum basilicum* L.) in Telangana." was carried out during *Rabi* 2020 - 2021 at Medicinal and Aromatic Crops Research station, Rajendranagar, Hyderabad to analyse quantitative parameters of sweet basil as influenced by spacing and inorganic fertilizers. There were 15 treatment combinations consisting of two factors *viz*., 3 plant spacing (S_1:40 cm X 20 cm, S_2: 50 cm X 30 cm, S_3:60 cm X 40 cm) with 5 fertilizer levels (F_1: 60: 30: 30 NPK Kg/ha F_2: 90: 45: 45 NPK Kg/ha, F_3: 120: 60: 60 NPK Kg/ha, F_4: 150: 75: 75 NPK Kg/ha, F_5: Absolute Control). Treatments were laid in Factorial RBD with replicated thrice on open field conditions. 30 days old seedlings were transplanted in the experimental field.

Data Collected
Plant height (cm)
Plant height was measured from ground level to the tip of the topmost leaf at 30, 60, 90 and 120 DAP of all the five tagged plants and the average per plant was expressed in centimeters.

Number of branches per plant
The numbers of branches from five randomly selected plants were counted and the average was expressed as number of branches per plant.

Leaf area (cm^2)
The leaf area of fully opened leaves per plant was measured by using leaf area meter with transparent belt conveyor utilizing an electronic digital display and expressed in cm^2 /plant.

Fresh yield per hectare (q)
The yield per hectare was computed by multiplying the fresh yield per plant with the number of plants that can be accommodated in one hectare and was expressed in quintals per hectare.

Seed yield per hectare (Kg)
The number of plants per hectare was calculated and multiplied with seed yield per plant and expressed in kilograms.

Essential oil ratio (%)
Oil recovery was estimated by hydro distillation method using Clevenger apparatus (Clevenger, 1928) [6]. To estimate the oil recovery (%) 1000 g of fresh herbage sample, comprising of leaves, inflorescence and small twigs, was taken. The chopped sample was put in 5000 ml capacity round bottom flask half filled with water. Distillation was done for about 2 to 3 hours. The oil being lighter than water got collected in the burette and reading was recorded which were later transferred into a test tube and was recorded as oil recovery %. The essential oil was dried over anhydrous sodium sulphate and stored at 4-6 ºC, until analyzed.
The essential oil content was calculated by using formula:

Essential oil content (% Volume/ Weight basis

$$= \frac{\text{Quantity of essential oil (ml)}}{\text{Weight of herb (g)}} \times 100$$

Essential oil yield (Kg/ha)
The values obtained from essential oil content percentage are used for calculating the essential oil yield in kg / ha by using the formula:

Total oil yield kg/ha = Total dry biomass (kg/ha) x Essential oil content

Results and Discussion
The results of the present investigation regarding the response of NPK and Plant spacing's on growth, yield and quality parameters have been discussed and interpreted in light of previous research work in India. The results of the experiment are summarized below.

Plant height
At 30, 60, 90 and 120 DAP in *Rabi* season, significant variation in plant height was observed among the interaction effects. The treatment combination of 40 cm X 20 cm spacing and 150: 75: 75 NPK Kg/ha (S_1F_4) recorded maximum plant height (38.85 cm, 67.63 cm, 81.83 cm and 97.36 cm) and was followed by S_1F_3 (33.55 cm, 61.33 cm, 76.97 cm and 91.49 cm at 30, 60, 90 and 120 DAP respectively). The lowest plant height (17.78 cm, 43.00 cm, 55.36 cm and 67.27 cm) was observed at treatment combination of 60 cm X 40 cm and absolute control (S_3F_5).
Maximum plant height was obtained in closer spacing 40 cm X 20 cm. Increase in plant height in narrow spacing might be due to less plant canopy which facilitated vertical growth by producing weak, lanky and taller plants due to stiff competition for space, light, nutrients and moisture. On other hand, denser plant stand, leads to more competition for the radiation to rescue the photosynthetic demand of plant that may be a major reason of the upward creeping stem and stem elongation behavior of plants.
Plant height was found to be maximum with application of 150: 75: 75 NPK Kg/ha the positive influence of the nutrients on plant height may be due NPK fertilizers which provide macro-elements necessary for growth and yield. Nitrogen promotes vegetative growth, phosphorus is main constituent of energy compounds, nucleic acids, phospholipids and co-enzymes and potassium increases plant resistance to diseases and prevent excessive water loss. On the other hand, Nitrogen is a constituent part of protein and component of protoplasm, which increases the chlorophyll content in leaves. All this factors led to cell multiplication, cell enlargement and cell differentiation, which resulted in increasing of plant height. While, phosphorus increases the plant height by increasing the cell multiplication in the plant tissue and potassium is involved in protein and carbohydrates metabolism, which leads to cell enlargement and trigger the growth of meristematic tissue.
The interaction effect of spacing and nutrients on plant height was found significant. The plant height was maximum in 40 cm X 20 cm spacing and 150: 75: 75 NPK Kg/ha (S_1F_4)

combination in both the seasons. This may be due to positive effect of closer spacing and higher level of nitrogen individually on plant height and same beneficial effect has been reflected in the combination also. Similar results were reported earlier by Ajimoddin *et al*. (2005) [2], Kailash and Kushwaha (2013) [8], Arularasu *et al*. (2008) [5] and Pooja M. R *et al*., (2018) [12] in *Ocimum species.*

Number of branches per plant

The treatment combination of 60 cm X 40 cm spacing and 150: 75: 75 NPK Kg/ha (S_3F_4) recorded highest number of branches per plant (18.13, 35.48, 49.44, 60.05) and was followed with S_3F_3 (13.39, 31.51, 43.60, 53.66) at 30, 60, 90 and 120 DAP respectively. The lowest number of branches per plant (3.48, 14.32, 25.44 and 32.26 at 30, 60, 90 and 120 DAP) was observed at treatment combination of 40 cm X 20 cm with absolute control (S_1F_5).

The increased branching at wider plant orientation of 60 cm X 40 cm 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 Abbas (2014) [1] in French basil and Kailash and Kushwaha (2013) [8] in *Ocimum species*. On the other hand, it might be due to more availability of space, less competition for nutrients, sunlight and water, which favoured more lateral growth of branches. Wider spacing promotes branching in mint, because of exposure of the plant to light, which affected the plants to promote maximum number of branches. Enhanced branching with wider spacing has also been reported by Rao *et al*., (2003) [13] in Henna (*Lausonia inerniis* L). This indicates that wider interspacing could provide more congenial environment for branching owing to improved sunlight interception by the plants.

The positive response with the application of fertilizers due to increased plant growth through improvement in soil conditions and increased availability of nutrients favoured maximum production of number of branches in sweet basil. On the other hand, the production of more number of branches may be due to the fact that in the initial stages of growth the number of branches produced per plant was minimum and as the growth proceeds, production of secondary, tertiary branches occurs, which adds to the total number of branches per plant which might be attributed to sufficient quantity of nutrient flow in the plants.

The treatment combination of 60 cm X 40 cm spacing and 150: 75: 75 NPK Kg/ha (S_3F_4) resulted in maximum number of branches per plant in both *Kharif* and *Rabi* season. Which may be due to positive effect of spacing and nitrogen individually on number of branches and the same beneficial effect has been reflected in the combination also. These results were in agreement with the findings of Olcay and Emine (2004) [11] in Sweet basil, Amir and Bilal (2013) [3] in Sweet basil, Pooja *et al*., (2018) [12] in Sacred basil, Lokesh and Gangadharappa (2007) [10] in Makoi and Kubsad *et al*., (2010) in Ashwagandha.

Leaf area (cm^2)

The treatment combination of 60 cm X 40 cm spacing and 150: 75: 75 NPK Kg/ha (S_3F_4) recorded maximum leaf area (478.33 cm^2, 1250.50 cm^2, 3457.73 cm^2 and 4560.90 cm^2) and it was followed with other treatment S_3F_3 (442.73 cm^2, 1054.33 cm^2, 3265.33 cm^2 and 4381.87 cm^2 respectively). The lowest leaf area (213.33 cm^2, 721.67 cm^2, 949.00 cm^2 and 1061.66 cm^2) was observed at treatment combination of 40 cm X 20 cm and absolute control (S_1F_5).

Light is important source of photosynthesis for plant growth, wider spaced plant get proper light intensity and nutrient as compare to the closely spaced plant so, maximum leaf area recorded under wider spacing. Similar results have been reported by Kahsay *et al*., (2014) [7] who found that wider spaced plant get more leaf area. On the other hand, the lower leaf area observed in closer spacing may be attributed to overcrowding and mutual shading of plants, which gave very little chance for these plants to grow and spread. But in wider spacing leaf area was maximum due to presence of more number of leaves.

The increase in leaf area with increase in fertilizer dose might be due to the increased auxins, carbohydrates and other organic compounds as a result of inorganic fertilizer application. Further, this may be due to production of more number of branches and plant spread and which enhanced availability of nutrients at the appropriate time, which has increased the leaf area.

Among the interaction of spacing and fertilizers exhibited significant influence on leaf area. This may be due to combined effect of wider spacing supplied with balanced nitrogen leads higher leaf area was recorded in this combination. These are similar to the findings of Kubsad *et al*., (2010) [9] in Ashwagandha and Pooja *et al*., (2018) [12] in sacred basil.

Fresh yield per hectare (q)

In *Rabi* season, significant variation in fresh yield per hectare was observed among the interaction effects. The treatment combination of 40 cm X 20 cm spacing and 150: 75: 75 NPK Kg/ha (S_1F_4) recorded maximum fresh yield per hectare (296.10 q) and was followed with other treatment S_1F_3 40 cm X 20 cm spacing and 120: 60: 60 NPK Kg/ha (281.40 q). The lowest fresh yield per hectare (75.10 q) was observed at treatment combination of 60 cm X 40 cm and absolute control (S_1F_5).

The maximum fresh yield per hectare was noticed with closer spacing of 40 cm X 20 cm (S_1), higher plant population per unit area is noticed under closer spacing when compared to wider spacing which ultimately resulted in higher fresh yield per plot and per hectare. This may be attributed to increase in number of plants per unit area and optimum utilization of above and below ground resources at closer spacing.

From the data it is revealed that, maximum fresh yield per hectare was recorded in F_4 (150: 75: 75 NPK Kg/ha) in both the seasons, the increase in yield may be attributed to the fact that under increasing nitrogen levels, there would be luxuriant vegetative growth of the plant, which leads to production of fresher yield per plot and per hectare. Further it might be due to better vegetative growth in terms of plant height, number of branches through different sources per plant and widen plant spread over other treatments. Moreover, it was due to the application of optimum and balanced nutrients through inorganic sources, promoted better photosynthetic activity that resulted in increased carbohydrate synthesis.

Interaction between spacing and nutrients had significant effect on fresh yield per hectare. The treatment combination of 40 cm X 20 cm spacing and 150: 75: 75 NPK Kg/ha (S_1F_4) recorded maximum fresh yield per plot and per hectare. This may be due to positive effect of closer spacing and nutrients individually on higher vegetative growth and reflection of the same beneficial effect in combination. Similar findings were observed by Olcay and Emine (2004) [11], Amir and Bilal (2013) [3] in Sweet basil, Pooja *et al*., (2018) [12] in Sacred basil, Lokesh and Gangadharappa (2007) [10] in Makoi and Kubsad *et al*., (2010) in Ashwagandha.

Seed yield per hectare (q)

In *Rabi* season, significant variation in seed yield per hectare was observed among the interaction effects. The treatment combination of 40 cm X 20 cm spacing and 150: 75: 75 NPK Kg/ha (S_1F_4) recorded maximum seed yield per plot (420.00 Kg) and was followed with other treatment S_1F_3 40 cm X 20 cm spacing and 120: 60: 60 NPK Kg/ha (390.00 Kg). The lowest seed yield per plant (140.00 Kg) was observed at treatment combination of 60 cm X 40 cm and absolute control (S_3F_5).

The maximum seed yield per hectare was noticed with closer spacing of 40 cm X 20 cm (S_1), an increase in the plant density results in increased competition among the plants for growth requirement factors such as adequate space for growth and development of shoots and roots, light, nutrients and moisture, and as a result, individual plants show less growth and development. But, despite the reduced growth and development of individual plants, the total seed yield per unit area increases due to increased number of plants per unit area

From the data it is revealed that, maximum seed yield per hectare was recorded in F_4 (150: 75: 75 NPK Kg/ha) in both the seasons, which might be due to significant increase in the number of branches and inflorescences. Moreover, it might be due to application of optimum quantity of nutrient sources improved soil physical, chemical and biological properties resulted in higher fertilizer use efficiency, ultimately led to more seed yield.

Interaction between spacing and nutrients had significant effect on seed yield per hectare in *Rabi* seasons. The treatment combination of 40 cm X 20 cm spacing and 150: 75: 75 NPK Kg/ha (S_1F_4) recorded maximum seed yield per plot and per hectare. This may be due to positive effect of closer spacing and nutrients individually on higher vegetative growth and the same beneficial effect has been reflected in the combination also. Similar findings were observed by Olcay and Emine (2004) [11], Amir and Bilal (2013) [3] in Sweet basil, and Pooja *et al*., (2018) [12] in Sacred basil.

Essential oil ratio (%)

Essential oil ratio was found to be more or less unaffected in response to plant spacing and fertilization. Negligible difference in oil content signifies that the character may be genetically controlled.

Essential oil yield (Kg/ ha)

In *Rabi* season, significant variation in essential oil yield was observed among the interaction effects. The treatment combination of 40 cm X 20 cm spacing and 150: 75: 75 NPK Kg/ha (S_1F_4) recorded maximum essential oil yield (54.65 Kg/ha) and was followed with other treatment S_1F_3 - 40 cm X 20 cm spacing and 120: 60: 60 NPK Kg/ha (51.36 Kg/ha). The lowest essential oil yield (12.45 Kg/ha) was observed at treatment combination of 60 cm X 40 cm and absolute control (S_3F_5).

The maximum essential oil yield was noticed with closer spacing of 40 cm X 20 cm (S_1), this may be attributed to increase in number of plants per unit area. Moreover, the increase in essential oil yield at higher plant density was also due to higher leaf yield per hectare at high density.

From the data it is revealed that, maximum essential oil yield was recorded in F_4 (150: 75: 75 NPK Kg/ha) in both the seasons, essential oil is synthesized from products of photosynthesis through enzymatic actions. Inorganic fertilizers enhance the content of macro and micro elements in the soil, play an essential role in the plant growth and development and amount of the essential oil. Further the increase in essential oil due to application of nitrogen chemical fertilizer could increase in agriculture yield. Anita and Anna (2010) [4] documented that highest yield of sweet basil's aerial organs was obtained by applying 150 kg/ ha. Added nitrogen supply increases photosynthesis rate and enables the plant to grow rapidly and produced considerable biomass and basic metabolism, which may increase production and accumulation of essential oil. Moreover, it may be due to increase in the number of oil glands or the enlargement in oil gland.

Interaction between spacing and nutrients had significant effect on seed yield per hectare in *Rabi* seasons. The treatment combination of 40 cm X 20 cm spacing and 150: 75: 75 NPK Kg/ha (S_1F_4) recorded maximum essential oil yield. This may be due to positive effect of high number of plants per unit area and the enhanced accumulation of essential oil under the conditions when plants are well supplied with nitrogen results from the increased production of biomass as well as from the direct impact on the biosynthesis of this substance. Similar findings were observed by Olcay and Emine (2004) [11], Amir and Bilal (2013) [3] in Sweet basil, and Pooja *et al*., (2018) [12] in Sacred basil.

Table 1: Influence of NPK and Spacing on Plant height (cm) in Sweet basil during Rabi 2020-21

Treatments	30 DAP	60 DAP	90 DAP	120 DAP
Spacing's				
S_1	30.20	58.72	74.29	88.74
S_2	27.40	55.55	71.00	85.30
S_3	24.38	52.03	66.94	80.66
S.Em±	0.19	0.36	0.48	0.46
CD at 5%	0.58	1.07	1.45	1.38
Fertilizer Levels				
F_1	24.81	51.83	68.59	82.43
F_2	26.60	56.47	70.91	84.78
F_3	30.03	58.90	74.03	88.72
F_4	34.25	62.00	77.81	92.49
F_5	20.94	47.98	62.37	79.09
SEm±	0.25	0.46	0.62	0.59
CD at 5%	0.75	1.38	1.87	1.78
Interactions (Spacing and Fertilizer levels)				
$S_1 F_1$	26.97	54.73	71.42	85.12
$S_1 F_2$	29.31	58.43	74.50	87.79
$S_1 F_3$	33.55	61.33	76.97	91.49
$S_1 F_4$	38.85	67.63	81.83	97.36
$S_1 F_5$	23.15	51.50	66.81	81.93
$S_2 F_1$	24.75	52.47	68.85	82.70
$S_2 F_2$	26.30	56.27	70.40	84.83
$S_2 F_3$	30.51	59.00	73.83	88.89
$S_2 F_4$	32.71	60.57	76.89	91.03
$S_2 F_5$	21.89	49.43	64.93	79.07
$S_3 F_1$	22.71	48.30	65.50	79.46
$S_3 F_2$	24.19	54.70	67.83	81.73
$S_3 F_3$	26.87	56.37	71.37	85.79
$S_3 F_4$	30.35	57.80	74.63	89.07
$S_3 F_5$	17.78	43.00	55.36	67.27
S.Em±	0.45	0.80	1.12	1.03
CD at 5%	1.32	2.41	3.34	3.10

Spacing's	Fertilizer levels
S_1- 40 cm X 20 cm	F_1- 60: 30: 30 NPK Kg/ha
S_2- 50 cm X 30 cm	F_2- 90: 45: 45 NPK Kg/ha
S_3- 60 cm X 40 cm	F_3-120: 60: 60 NPK Kg/ha
	F_4-150: 75: 75 NPK Kg/ha
	F_5- Absolute control

Table 2: Influence of NPK and Spacing on Number of branches / plant in Sweet basil during Rabi 2020-21

Treatments	30 DAP	60 DAP	90 DAP	120 DAP
Spacing's				
S_1	8.45	22.01	33.64	43.99
S_2	10.25	24.82	37.31	46.86
S_3	12.56	28.10	40.08	49.37
S.Em±	0.06	0.18	0.23	0.34
CD at 5%	0.19	0.54	0.69	1.10
Fertilizer Levels				
F_1	9.56	24.17	36.46	46.17
F_2	10.64	25.78	37.51	47.80
F_3	12.15	29.08	40.71	51.28
F_4	14.21	30.86	43.91	54.05
F_5	5.55	14.98	26.47	34.42
S.Em±	0.08	0.23	0.33	0.44
CD at 5%	0.24	0.69	0.97	1.43
Interactions (Spacing and Fertilizer levels)				
$S_1 F_1$	8.20	20.37	33.28	43.62
$S_1 F_2$	9.05	23.35	34.39	45.48
$S_1 F_3$	10.44	25.47	36.38	47.57
$S_1 F_4$	11.10	26.55	38.69	48.70
$S_1 F_5$	3.48	14.32	25.44	32.26
$S_2 F_1$	9.23	23.40	35.64	45.61
$S_2 F_2$	10.27	24.59	36.48	46.29
$S_2 F_3$	12.74	30.26	42.33	52.61
$S_2 F_4$	13.26	30.55	43.41	53.39
$S_2 F_5$	5.63	15.29	28.51	36.42
$S_3 F_1$	11.26	28.75	40.46	49.26
$S_3 F_2$	12.61	29.41	41.66	51.63
$S_3 F_3$	13.39	31.51	43.60	53.66
$S_3 F_4$	18.13	35.48	49.44	60.05
$S_3 F_5$	7.53	15.34	25.46	34.58
S.Em±	0.14	0.41	0.50	0.76
CD at 5%	0.42	1.21	1.67	2.21

Spacing's	Fertilizer levels
S_1- 40 cm X 20 cm	F_1- 60: 30: 30 NPK Kg/ha
S_2- 50 cm X 30 cm	F_2- 90: 45: 45 NPK Kg/ha
S_3- 60 cm X 40 cm	F_3-120: 60: 60 NPK Kg/ha
	F_4-150: 75: 75 NPK Kg/ha
	F_5- Absolute control

Table 3: Influence of NPK and Spacing on Leaf area (cm^2) in Sweet basil during Rabi 2020-21

Treatments	30 DAP	60 DAP	90 DAP	120 DAP
Spacing's				
S_1	306.08	842.21	1615.65	2260.16
S_2	347.08	904.85	2156.92	2858.39
S_3	398.16	1001.54	2615.61	3524.23
S.Em±	2.31	5.89	14.48	20.09
CD at 5%	6.93	17.65	47.25	62.89
Fertilizer Levels				
F_1	331.82	876.98	1868.60	2581.26
F_2	349.99	895.88	2050.42	2813.63
F_3	406.88	986.63	2757.77	3782.96
F_4	427.83	1073.97	2989.55	3995.77
F_5	235.55	747.53	980.61	1231.01
S.Em±	2.98	7.60	18.70	25.93
CD at 5%	8.94	22.80	60.99	87.79
Interactions (Spacing and Fertilizer levels)				
$S_1 F_1$	277.33	816.83	1295.00	1957.33
$S_1 F_2$	301.84	830.87	1428.20	2021.67
$S_1 F_3$	363.23	908.47	2013.33	2994.83
$S_1 F_4$	374.67	933.23	2392.73	3265.33
$S_1 F_5$	213.33	721.67	949.00	1061.66
$S_2 F_1$	318.20	857.33	1749.93	2315.47
$S_2 F_2$	339.67	884.27	1949.47	2632.73
$S_2 F_3$	414.67	997.10	2994.67	3972.20
$S_2 F_4$	430.50	1038.2	3118.20	4161.10
$S_2 F_5$	232.00	747.33	972.33	1210.47
$S_3 F_1$	399.93	956.79	2560.87	3471.00
$S_3 F_2$	408.47	972.50	2773.60	3786.50
$S_3 F_3$	442.73	1054.33	3265.33	4381.87
$S_3 F_4$	478.33	1250.50	3457.73	4560.90
$S_3 F_5$	261.33	773.60	1020.50	1420.90
S.Em±	5.15	13.16	32.39	44.91
CD at 5%	15.93	39.48	105.65	134.73

Spacing's	Fertilizer levels
S_1- 40 cm X 20 cm	F_1- 60: 30: 30 NPK Kg/ha
S_2- 50 cm X 30 cm	F_2- 90: 45: 45 NPK Kg/ha
S_3- 60 cm X 40 cm	F_3-120: 60: 60 NPK Kg/ha
	F_4-150: 75: 75 NPK Kg/ha
	F_5- Absolute control

Table 4: Influence of NPK and Spacing on Fresh yield/ hectare (q), Seed yield/ hectare (Kg), Essential oil ratio (%) and Essential yield per hectare (Kg) in Sweet basil during Rabi 2020-21

Treatments	Fresh yield/ hectare (q)	Seed yield/ hectare (Kg)	Essential oil ratio (%)	Essential yield per hectare (Kg)
Spacing's				
S_1	256.14	315.00	0.31	46.08
S_2	156.99	263.00	0.32	27.10
S_3	110.28	207.00	0.31	19.06
S.Em±	1.18	2.15	0.002	0.21
CD at 5%	4.11	6.42	NS	0.71
Fertilizer Levels				
F_1	167.83	218.33	0.33	29.50
F_2	172.03	251.67	0.33	30.23
F_3	200.13	313.33	0.34	35.36
F_4	212.90	361.67	0.35	37.53
F_5	119.45	163.33	0.34	21.11
S.Em±	1.52	2.33	0.003	0.27
CD at 5%	5.31	6.74	NS	0.88
Interactions (Spacing and Fertilizer levels)				
$S_1 F_1$	257.15	260.00	0.31	45.29
$S_1 F_2$	262.75	305.00	0.33	46.25
$S_1 F_3$	281.40	390.00	0.35	51.36
$S_1 F_4$	296.10	420.00	0.33	54.65
$S_1 F_5$	183.30	200.00	0.34	32.84
$S_2 F_1$	144.05	215.00	0.31	25.26

S_2 F_2	146.95	255.00	0.35	25.42
S_2 F_3	187.60	320.00	0.33	32.44
S_2 F_4	206.40	375.00	0.34	34.32
S_2 F_5	99.95	150.00	0.32	18.05
S_3 F_1	102.30	180.00	0.31	17.95
S_3 F_2	106.40	195.00	0.32	19.02
S_3 F_3	131.40	230.00	0.33	22.27
S_3 F_4	136.20	290.00	0.35	23.62
S_3 F_5	75.10	140.00	0.34	12.45
S. Em±	2.63	4.80	0.005	0.47
CD at 5%	7.92	14.91	NS	1.46

Spacing's	**Fertilizer levels**
S_1- 40 cm X 20 cm	F_1- 60: 30: 30 NPK Kg/ha
S_2- 50 cm X 30 cm	F_2- 90: 45: 45 NPK Kg/ha
S_3- 60 cm X 40 cm	F_3-120: 60: 60 NPK Kg/ha
	F_4-150: 75: 75 NPK Kg/ha
	F_5- Absolute control

Conclusion
The study highlights the ameliorative effect of NPK and Plant spacing on the growth, yields and quality of the basil. The closer spacing with high doses of chemical fertilizers recorded more yield and essential oil. But, the wider spacing with higher NPK doses recorded better growth parameters except the plant height.

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