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Growth response of sweet basil cv. cim-saumya to varied NPK levels and application strategies

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Abstract
A field experiment was conducted at the PSMA block, Dr. YSRHU - College of Horticulture, Anantharajupeta, from February to May 2025 to evaluate the optimal nutrient level and application method of NPK on the growth characteristics of sweet basil (*Ocimum basilicum* cv. Cim-Saumya). The study employed a randomized block design with 11 treatment combinations and three replications. The recommended dose of fertilizer 80:40:40 kg ha^{-1} was applied through varying soil application levels (100%, 80%, 60%, and 50%) and foliar spray concentrations (1% and 2%). Results indicated that combined soil and foliar application significantly enhanced plant growth. Treatment T4 (80% soil application + 2% foliar spray) recorded the highest values for plant height (68.23 cm and 70.67 cm), plant spread (45.27 cm East-West, 41.87 cm North-South at 45 days after transplanting; 54.93 cm East-West, 48.87 cm North-South at 60 days after transplanting), number of primary and secondary branches (10.13 and 60.00 at 45 days after transplanting; 15.27 and 77.00 at 60 days after transplanting), and total number of branches (70.13 and 92.27 at 45 and 60 days after transplanting, respectively). The lowest values were observed in the control (T11). These findings suggest that nutrient use efficiency can be improved and optimized recommended dose of fertilizer with a 20% reduction in soil-applied fertilizer when supplemented with foliar application.

Keywords: Sweet basil, NPK, soil and foliar application, fertilizer

1. Introduction
Sweet basil (*Ocimum basilicum* L.) belongs to the family Lamiaceae (Labiatae) (Marotti, 1996) [8]. Over 60 species and many variants are found in the genus Ocimum (Jakowienko *et al.*, 2011) [7] and also known as a Royal herb or King of herbs, which is used in cooking, cosmetics, medicinal uses and for fragrance. As an ornamental plant, it is planted in gardens as well as in containers. Originating in the tropical and subtropical regions of Africa, Asia, and South America, basil is cultivated worldwide. In India, *O. sanctum* and *O. basilicum* L. are the two most commonly cultivated species in the states of Uttar Pradesh, Uttarakhand, West Bengal, Jharkhand, Chhattisgarh, Madhya Pradesh, Rajasthan and Andhra Pradesh (Purushothaman *et al.*, 2018) [11]. Numerous natural products, including polyphenols like flavonoids and anthocyanins, as well as a variety of essential oils rich in phenolic compounds, can be found in Ocimum species. (Bahl *et al.*, 2000) [4].
Traditional uses for *O. basilicum* include antispasmodic, aromatic, carminative, digestive, galactagogue, stomachic and tonic properties (Simon *et al.*, 1999) [12]. Basil output has increased dramatically in recent years as consumer demand has risen. Basil is grown in home gardens, commercial greenhouses, fields, hydroponic facilities and soilless substrates.
However, macronutrients and micronutrients must be applied to promote growth and productivity are highly influenced by nutrient management, particularly Nitrogen (N), Phosphorus (P), and Potassium (K), which play pivotal roles in vegetative development, branching and spread of a plant canopy.
Traditional soil application of NPK ensures basal nutrient availability, but recent studies suggest that foliar nutrition can complement root uptake by delivering nutrients directly to the photosynthetically active tissues. Combining these two application strategies may enhance

nutrient use efficiency, stimulate physiological processes, and improve overall plant architecture. This also helps in optimising the cost of cultivation and increasing the benefits of higher Nutrient Use Efficiency.

Despite the known benefits of NPK fertilization, limited research has explored the combined impact of soil and foliar application on sweet basil's growth traits under field conditions. Therefore, the present study was undertaken to evaluate the effect of integrated NPK application on key growth parameters such as plant height, spread, and branching behaviour in sweet basil.

2. Materials and Methods

The field experiment was laid out in a completely randomized block design (RBD) with 11 treatments *viz*. T_1 -NPK(100%SA), T_2 -NPK (80%SA), T_3 -(80%SA + 1%FA), T_4-NPK (80%SA + 2%FA), T_5-NPK (60%SA), T_6 -NPK (60%SA + 1%FA) T_7-NPK (60%SA + 2%FA), T8-NPK (50%SA) T_9-NPK (50%SA + 1%FA), T_{10}-NPK (50%SA + 2%FA) T_{11}-Control without application and three replications at the PSMA block, Dr. YSRHU - College of Horticulture, Anantharajupeta, from February 2025 to May 2025. The field was divided into plots with a size of 2 x 1.6 m. Thirty days old (30) healthy and uniformly rooted seedlings of sweet basil were transplanted at a spacing of 40 cm between the rows and the plants. The RDF (Recommended Dose of Fertilizer) 80:40:40 Kg ha^{-1} was divided into different percentages for the soil application with 100, 80, 60 and 50. For foliar application, the percentages of 1 and 2 are selected for better assessment, combined with the soil application. 19:19:19 was used for the source of foliar application and for soil application, chemical fertilizers *viz*., Urea, MOP and SSP are used. These treatment combinations are applied as 50% of the Soil application as a basal dose and the remaining 25% each at 30 and 70 DAT as top dressing. Foliar application at 30 and 80 DAT. Cim-Saumya was used as the test variety released by CIMAP Lucknow. It is a well-adapted variety to our climatic conditions and its field performance was excellent. Observations for plant height, plant spread, No. of primary and secondary branches, and total branches were collected at 45 DAT and at harvest (60 DAT).

3. Results and Discussion

3.1 Plant height (cm)

A perusal of data (Table 1 and Figure 1) revealed that the influence of different NPK levels on plant height was found significant at all growth stages. The mean plant height was found to increase from 59.94 cm (45 DAP) to 61.93 cm (60 DAP).

3.1.1 Plant height at 45DAP

Sweet basil plants applied with NPK (80%SA + 2%FA) – T4 has recorded highest plant height (68.23 cm) followed by those grown with NPK dosage of (80%SA + 1%FA) – T3 (63.63 cm) which was on par with NPK (100%SA) – T1 (62.69 cm). The lowest plant height (55.14 cm) was recorded at control.

3.1.2 Plant height at 60DAP

The tallest plants were observed when applied with NPK (80%SA + 2%FA) – T4 (70.67 cm) succeeded by NPK (80%SA + 1%FA) – T3 (65.87 cm) which was on par with NPK (100%SA) – T1 (64.90 cm). Whereas control - T11 has exhibited the shortest plant height (57.27 cm).

In this study, plant height increased with increasing NPK rates. Plants grown under the highest NPK rate with a combination of soil and foliar application were the tallest. Soil application ensures long-term nutrient availability. Foliar application delivers nutrients directly to leaves, accelerating photosynthesis, cell elongation and shoot expansion, key drivers of vertical growth. These results are similar to the findings of Alhasan *et al.* (2021) [1] in the sweet basil crop.

Gunda *et al.* (2022) [5] reported that sweet basil supplied with 150:75:75 kg ha^{-1} NPK under 40 × 20 cm spacing recorded the highest plant height.

Nurzynska-Wierdak *et al.* (2011) [9] demonstrated that foliar feeding with 0.5% urea significantly increased plant height.

Applying NPK through both soil and foliar routes ensures dual nutrient delivery. Soil provides sustained release, while foliar offers rapid absorption during critical growth stages.

Table 1: Effect of different NPK levels and application methods on plant height (cm) of *Ocimum basilicum* cv. Cim-Saumya at 45 days after planting (DAP) and at harvest, SA=Soil Application; FA=Foliar Application.

Treatments		45 DAP	60 DAP (At harvest)
T_1	NPK (100%SA)	62.69	64.90
T_2	NPK (80%SA)	61.00	63.47
T_3	NPK (80%SA + 1%FA)	63.63	65.87
T_4	NPK (80%SA + 2%FA)	68.23	70.67
T_5	NPK (60%SA)	58.51	61.27
T_6	NPK (60%SA + 1%FA)	58.83	61.90
T_7	NPK (60%SA + 2%FA)	60.81	63.00
T_8	NPK (50%SA)	55.18	57.47
T_9	NPK (50%SA + 1%FA)	56.47	58.93
T_{10}	NPK (50%SA + 2%FA)	57.79	60.70
T_{11}	Control	55.14	57.27
	Mean	59.94	61.93
	S.Em±	1.29	1.27
	CD at 5%	3.99	3.93

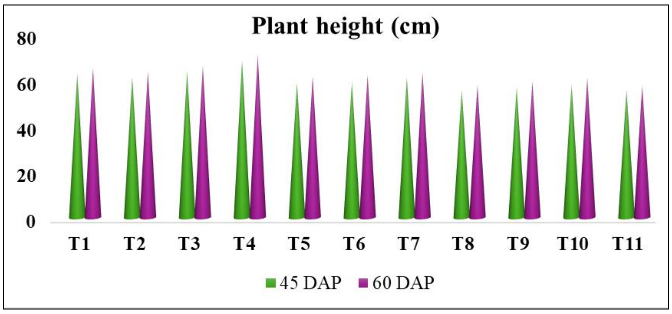

Fig 1: Plant height (cm) as influenced by different NPK levels and application methods.

3.2 Plant spread (cm)

Plant spread varied significantly among all the treatments and ranged from 36.08cm to 45.93 cm in E-W direction and 34.97cm to 41.32cm in N-S directions respectively at 45 days after planting and at harvest and relevant data presented in Table 2 and Figure 2.

3.2.1 Plant spread at 45DAP

Among different treatments NPK (80%SA + 2%FA) – T4 (45.27 cm, 41.87cm) has recorded maximum plant spread followed by NPK (80%SA + 1%FA) – T3 (39.67 cm, 41.40cm) which was on par with NPK (100%SA) – T1 (38.27 cm, 38.27 cm) in both E-W and N-S directions. However, minimum plant spread was recorded in control - T11 (31.60 cm, 30.07cm).

3.2.2 Plant spread at 60DAP

From the perusal of data at harvest maximum plant spread was recorded in NPK (80%SA + 2%FA) – T4 (59.93 cm, 48.87cm) followed by NPK (80%SA + 1%FA) – T3 (48.13 cm, 46.48cm) minimum plant spread was recorded in control - T11 (40.20 cm, 36.81cm) in both E-W and N-S directions respectively.

Foliar NPK application ensures rapid nutrient absorption, especially during active vegetative growth stages, while soil-applied NPK maintains root zone fertility. The synergy between these methods enhances nutrient translocation, supporting uniform shoot elongation and branching, which directly contributes to increased plant spread.

Gunda *et al.* (2022) [5] reported that sweet basil supplied with 150:75:75 kg ha⁻¹ NPK under wider spacing (60 × 40 cm) recorded the highest number of branches and leaf area, which directly contributed to increased plant spread under Telangana conditions. Similarly, Hassan *et al.* (2022) [6] found that 100% RDF combined with biofertilizers significantly improved vegetative traits, including leaf area and branching, indirectly enhancing canopy spread.

Table 2: Effect of different NPK levels and application methods on plant spread (cm) of *Ocimum basilicum* cv. Cim-Saumya, SA=Soil Application; FA=Foliar Application; E-W= East to West; N-S= North to South.

Treatments		45DAP		60DAP	
		E-W	N-S	E-W	N-S
T_1	NPK (100%SA)	38.27	38.27	46.73	44.23
T_2	NPK (80%SA)	37.87	37.00	46.27	42.57
T_3	NPK (80%SA + 1%FA)	39.67	41.40	48.13	46.48
T_4	NPK (80%SA + 2%FA)	45.27	41.87	54.93	48.87
T_5	NPK (60%SA)	33.47	33.20	44.33	39.08
T_6	NPK (60%SA + 1%FA)	35.87	34.80	45.67	39.30
T_7	NPK (60%SA + 2%FA)	37.87	35.13	46.00	42.25
T_8	NPK (50%SA)	31.67	30.27	42.20	37.56
T_9	NPK (50%SA + 1%FA)	32.00	30.47	42.60	38.27
T_{10}	NPK (50%SA + 2%FA)	33.40	32.20	43.20	39.06
T_{11}	Control	31.60	30.07	40.20	36.81
	Mean	36.08	34.97	45.93	41.32
	S.Em±	2.64	2.26	2.49	2.13
	CD at 5%	7.85	6.73	7.41	6.35

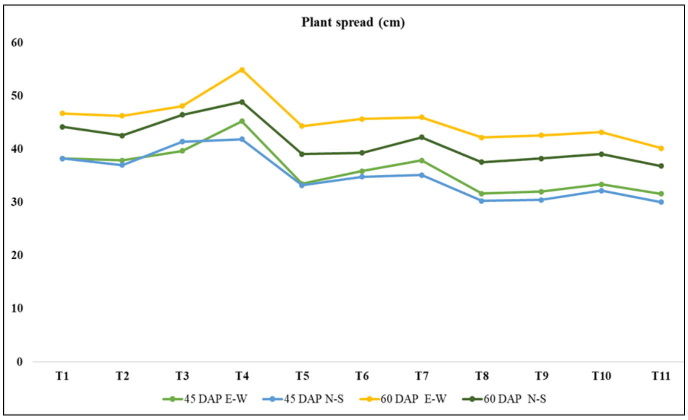

Fig 2: Plant spread (cm) as influenced by different NPK levels and application methods.

3.3 No. of Primary branches

The number of primary branches on main shoot of sweet basil as influenced by different NPK dosages were non-significant throughout the entire growth period (45DAP and at harvest), as illustrated in the table 3a, b. The number of primary branches found to increase from 9.28 (45 DAP) to 14.19 (60 DAP).

3.3 No. of Primary branches at 45DAP

With regards to various treatments NPK (80%SA + 2%FA) – T4 has recorded more number of primary branches (10.13) followed by NPK (80%SA + 1%FA) – T3 (9.93) and less number of primary branches were observed in NPK (50%SA) – T8(8.67), NPK (50%SA + 1%FA) - T9 (8.67), control - T11(8.67).

3.3.2 No. of Primary branches at harvest

As evident from the above data, plants grown with NPK (80%SA + 2%FA) – T4 has recorded more number of primary branches (15.27) followed by NPK (80%SA + 1%FA) – T3 (14.67) and less number of primary branches were observed in control - T11(13.33).

3.4 No. of Secondary branches

Significant differences were observed in number of Secondary branches (45 DAP and at harvest) under the influence of different NPK application methods as presented in Table 4.3a, b and Figure 4.3. The mean number of Secondary branches were found to increase from 51.10 at 45DAP to 66.56 at 60 DAP.

3.4.1 No. of Secondary branches at 45DAP

The data pertaining to number of Secondary branches NPK (80%SA + 2%FA) – T4 has recorded maximum (60.00) succeeded by NPK (80%SA + 1%FA) – T3 (58.20) which was on par with NPK (100%SA) – T1 (56.50). Minimum number of Secondary branches were observed in control - T11 (45.00).

3.4.2 No. of Secondary branches at harvest

At harvest, plants received with application of NPK (80%SA + 2%FA) – T4 has developed more number of Secondary branches (77.00) followed by NPK (80%SA + 1%FA) – T3 (74.50) and less number of Secondary branches were observed in control - T11(60.00).

Soil-applied NPK ensures sustained nutrient availability for root development and early vegetative growth. Foliar NPK provides rapid nutrient uptake during critical branching phases, especially nitrogen and potassium, which are key for shoot elongation and bud activation. Together, they create a nutrient-rich environment that stimulates both apical dominance and axillary bud development, leading to robust primary and secondary branching. Similar findings were seen in the recordings of Ali (2020) [2] in the Rose plant (*Rosa hybrida* L.), Pegu *et al.* (2020) [10] in Rapeseed.

Table 3a: Effect of different NPK levels and application methods on the number of primary and secondary branches (cm) of *Ocimum basilicum* cv. Cim-Saumya at 45 days after planting (DAP), SA=Soil Application; FA=Foliar Application

Treatments		No. of Primary branches	No. of secondary branches
T_1	NPK (100%SA)	9.87	56.50
T_2	NPK (80%SA)	9.87	54.70
T_3	NPK (80%SA + 1%FA)	9.93	58.20
T_4	NPK (80%SA + 2%FA)	10.13	60.00
T_5	NPK (60%SA)	8.80	49.60
T_6	NPK (60%SA + 1%FA)	9.13	51.30
T_7	NPK (60%SA + 2%FA)	9.60	53.00
T_8	NPK (50%SA)	8.67	45.20
T_9	NPK (50%SA + 1%FA)	8.67	46.40
T_{10}	NPK (50%SA + 2%FA)	8.80	48.00
T_{11}	Control	8.67	45.00
	Mean	9.28	51.10
	S.Em±	-	0.82
	CD at 5%	NS	2.38

Table 3b: Effect of different NPK levels and application methods on the number of primary and secondary branches (cm) of *Ocimum basilicum* cv. Cim-Saumya at harvest 60 (DAP), SA=Soil Application; FA=Foliar Application

Treatments		No. of Primary branches	No. of secondary branches
T_1	NPK (100%SA)	14.53	73.20
T_2	NPK (80%SA)	14.27	70.30
T_3	NPK (80%SA + 1%FA)	14.67	74.50
T_4	NPK (80%SA + 2%FA)	15.27	77.00
T_5	NPK (60%SA)	14.13	65.00
T_6	NPK (60%SA + 1%FA)	14.13	66.00
T_7	NPK (60%SA + 2%FA)	14.13	66.70
T_8	NPK (50%SA)	13.80	62.00
T_9	NPK (50%SA + 1%FA)	13.87	63.60
T_{10}	NPK (50%SA + 2%FA)	14.00	64.00
T_{11}	Control	13.33	60.00
	Mean	14.19	66.56
	S.Em±	-	1.63
	CD at 5%	NS	5.04

3.5 Total no. of branches

Among different treatments, NPK (80%SA + 2%FA) – T4 (70.13 cm, 92.27 cm) has recorded maximum branches plant^{-1}, followed by NPK (80%SA + 1%FA) – T3 (68.13 cm, 89.17 cm) at both 45 and 60 DAP. However, the minimum branches plant^{-1} was recorded in control - T11 (53.67 cm, 73.33 cm).

In this study, the total number of branches is directly proportional to the number of primary and secondary branches plant $^{-1}$. The NPK soil and foliar combination worked well in enhancing the branches of plants among different treatments and the data found are significantly different from each other. Similar findings were recorded by Al-Mansour *et al.* (2018) [3].

Table 4: Effect of different NPK levels and application methods on the total no. of branches (cm) of *Ocimum basilicum* cv. Cim-Saumya at 45 DAP and at harvest 60 (DAP), SA=Soil Application; FA=Foliar Application

Treatments		45 DAP	60 DAP (At harvest)
T_1	NPK (100%SA)	66.37	87.73
T_2	NPK (80%SA)	64.57	84.57
T_3	NPK (80%SA + 1%FA)	68.13	89.17
T_4	NPK (80%SA + 2%FA)	70.13	92.27
T_5	NPK (60%SA)	58.40	79.13
T_6	NPK (60%SA + 1%FA)	60.43	80.13
T_7	NPK (60%SA + 2%FA)	62.60	80.83
T_8	NPK (50%SA)	53.87	75.80
T_9	NPK (50%SA + 1%FA)	55.07	77.47
T_{10}	NPK (50%SA + 2%FA)	56.80	78.00
T_{11}	Control	53.67	73.33
	Mean	60.90	81.68
	S.Em±	1.78	2.02
	CD at 5%	5.20	5.90

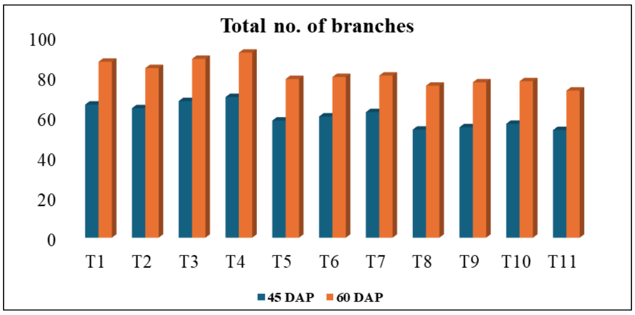

Fig 3: Plant spread (cm) as influenced by different NPK levels and application methods.

4. Conclusion

The present investigation clearly demonstrated that the combined application of NPK through soil and foliar methods significantly influenced the growth characteristics of sweet basil (*Ocimum basilicum* cv. Cim-Saumya). Among the 11 treatment combinations, T4 (80% soil application + 2% foliar spray) consistently recorded superior performance in terms of plant height, spread and branching at both 45 and 60 days after transplanting. These results highlight the potential to reduce the soil-applied RDF by 20% without compromising plant vigour, thereby enhancing nutrient use efficiency and promoting sustainable fertilizer management. The findings suggest that integrating foliar nutrition with reduced basal application can be a viable strategy for optimizing growth in sweet basil, with broader implications for resource-efficient horticultural practices.

The study underscores the agronomic advantage of integrating foliar nutrition with reduced soil-applied NPK in sweet basil cultivation. Treatment T4 (80% RDF via soil + 2% foliar spray) emerged as the most effective, promoting enhanced vegetative growth while conserving input resources. This approach not only improves nutrient uptake dynamics but also aligns with sustainable horticultural practices by minimizing fertilizer wastage and environmental impact.

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