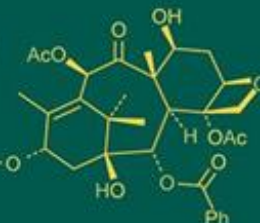
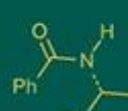
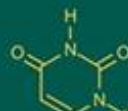
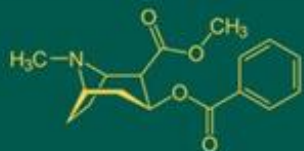


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Priyanka KS

Division of Horticulture,
RCSM Government College of
Agriculture, Kolhapur,
Maharashtra, India

Darshan S Kadam

Regional Wheat Rust
Research Station,
Mahabaleshwar, Satara,
Maharashtra, India

Ganesh Ramesh Belagaonkar

Division of Horticulture,
RCSM Government College of
Agriculture, Kolhapur,
Maharashtra, India

Vijay N Nale

Division of Soil Science, RCSM
Government College of
Agriculture, Kolhapur,
Maharashtra, India

Uday S Shinde

Division of Horticulture,
RCSM Government College of
Agriculture, Kolhapur,
Maharashtra, India

Manish A Sushir

Regional Wheat Rust Research
Station, Mahabaleshwar,
Satara, Maharashtra, India

Vikrant M Sali

Regional Wheat Rust Research
Station, Mahabaleshwar,
Satara, Maharashtra, India

Corresponding Author:

Priyanka K S

Division of Horticulture,
RCSM Govt. College of
Agriculture, Kolhapur,
Maharashtra, India

Effect of foliar application of nutrients on growth and yield of Zucchini (*Cucurbita pepo* L.)

Priyanka KS, Darshan S Kadam, Ganesh Ramesh Belagaonkar, Vijay N Nale, Uday S Shinde, Manish A Sushir and Vikrant M Sali

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Abstract

The present investigation was conducted during the 2024-2025 growing season at The Regional Wheat Rust Research Station, Mahabaleshwar, to evaluate the effect of foliar application of nutrients on The growth, yield and quality of zucchini (*Cucurbita pepo* L.). The experiment was laid out in a Randomized Block Design (RBD) with seven treatments and three replications. The treatments consisted of water spray (control), Phule Micrograde II, calcium nitrate, magnesium sulphate, zinc sulphate, NPK 19:19:19 and 12:61:00. Observations were recorded on growth characters, flowering behaviour, yield and yield attributing characters. Foliar application of nutrients significantly influenced plant height at 60 DAS, plant spread at 60 and 90 DAS and at last harvest, petiole length, days from female flower opening to harvesting, days to first and last harvest, harvesting duration, number of pickings, number of fruits per plant, fruit length, fruit diameter, fruit weight, fruit yield per plant, yield per plot and yield per hectare. However, plant height at 30 and 90 DAS and at the last harvest, plant spread (East-West and North-South) at 30 DAS, and days to initiation of the first male and female flowers were not significantly influenced by foliar nutrient application. Among The treatments, foliar application of NPK 19:19:19 recorded The highest plant height at 60 DAS (25.90 cm), plant spread at harvest (56.40 cm East-West and 59.09 cm North-South), petiole length (28.28 cm), number of days required from opening of female flower to harvesting (6.14), days to first harvest (48.06), days to last harvest (103.67), harvesting duration (55.26), number of picking (5.67), number of fruits/plant (9.33), fruit length (24.40 cm), fruit diameter (3.60 cm), fruit weight (215 g), fruit yield per plant (2.00 kg), yield per plot (72.13 kg), and yield per hectare (55.65 t ha⁻¹), and was statistically at par with calcium nitrate for several yield attributes. The study demonstrated that foliar application of balanced nutrients, particularly NPK 19:19:19, is an effective nutrient management practice for improving growth and yield of zucchini under the agro-climatic conditions of Mahabaleshwar.

Keywords: *Cucurbita pepo* L., foliar nutrition, NPK 19:19:19, calcium nitrate, growth, yield, quality

Introduction

Zucchini (*Cucurbita pepo* L.), commonly known as summer squash, is an important vegetable crop belonging to the family Cucurbitaceae and is native to tropical America. It is a fast-growing, early-yielding crop valued for its high nutritional and economic importance. The fruits are low in calories and fat but are rich in vitamins, minerals, dietary fiber, phenolic compounds, flavonoids, and antioxidants, making them beneficial for human health (Tamer *et al.*, 2010) [1]. Zucchini grows best under cool and humid climatic conditions with an optimum temperature range of 16-27 °C. The crop is widely cultivated in several parts of India, including Punjab, Uttar Pradesh, Haryana, Himachal Pradesh, Jammu and Kashmir and West Bengal (Thamburaj and Singh, 2001; Dhaliwal, 2012; Pandey *et al.*, 2018) [2, 3, 4]. The productivity and quality of zucchini are greatly influenced by balanced nutrient management. Foliar fertilization has become an effective method of supplying nutrients directly to plant foliage, ensuring rapid absorption and efficient utilization compared with soil application. The effectiveness of foliar nutrient application depends on several factors, including The nutrient solution, environmental conditions, and plant characteristics (Shahid *et al.* 2017; Kah *et al.* 2019) [5, 6]. Foliar application is particularly beneficial under conditions where soil nutrient availability is restricted and has been reported to improve plant growth, flowering, fruiting, and yield in many vegetable crops (Begum and Fry, 2022; Narimani *et al.* 2010; El-Fouly *et al.* 2011; Abdoli, 2020) [7, 8, 9, 10, 11]. Previous studies have demonstrated that fertilization significantly influences nutrient uptake, vegetative growth, and yield in zucchini (Martinetti and Paganini, 2006) [12]. Nitrogen fertilization, either alone or combined with foliar nutrient application, has been reported to enhance vegetative biomass and productivity

(Doikova *et al.*, 1996)^[13]. Although foliar nutrition has shown promising results in several vegetable crops (Panayotov, 2005; Panayotov and Stoeva, 2005; Fernandez *et al.* 2013)^[14], limited information is available regarding the comparative performance of different foliar nutrient sources in zucchini. Therefore, the present investigation was undertaken to evaluate The effect of foliar application of nutrients on The growth and yield of zucchini (*Cucurbita pepo* L.).

Materials and Methods

The present investigation entitled “Effect of Foliar Application of Nutrients on Growth and Yield of Zucchini (*Cucurbita pepo* L.)” was conducted during The Rabi season (January-May 2025) at The Regional Wheat Rust Research Station, Mahabaleshwar, Satara, Maharashtra, India (17° 93'N latitude and 73° 61' E longitude), situated at an altitude of 1270 m above mean sea level. The experimental site falls under a high rainfall zone with red soil susceptible to leaching. The soil had a pH of 6.7, EC of 0.2 dS m⁻¹, available nitrogen of 192 kg ha⁻¹, available phosphorus⁻ (P₂O₅) of 61.82 kg ha⁻¹, available potassium (K₂O) of 121 kg ha⁻¹, and adequate micronutrient status. The experiment was laid out in a Randomized Block Design (RBD) with seven treatments and three replications as represented in Table 1. The field was prepared by ploughing followed by cross cultivation and levelling to obtain a fine tilth. The crop was sown on ridges and furrows at a spacing of 60×60 cm with a plot size of 3.6×3.6m². A recommended fertilizer dose of 125:62.5:62.5 kg N: P₂O₅: K₂O ha⁻¹ was uniformly applied to all treatments, and standard agronomic practices were followed throughout The crop growth period. Foliar application of different nutrient sources was carried out at 0.5% concentration at 30 days after sowing (DAS) and 1.0% concentration at 60 DAS. Observations on growth, flowering and yield parameters were recorded following standard procedures. The experimental data were statistically analysed by The analysis of variance (ANOVA) for Randomized Block Design as described by Panse and Sukhatme (1985)^[15].

Table 1: Treatment details

Treatment	Details
T ₁	Control (Water spray)
T ₂	Phule Micrograde II
T ₃	Calcium Nitrate
T ₄	Magnesium sulphate
T ₅	Zinc sulphate
T ₆	19: 19: 19
T ₇	12: 61: 00

(Foliar spray @ 30 and 60 DAS)

Result and Discussion

Growth parameters

Plant height (cm)

The data pertaining to plant height at 30, 60, 90 DAS and at last harvest as influenced by foliar application of nutrients are presented in Table 2 and illustrated in Fig. (a). Plant height did not differ significantly among the treatments at 30 DAS with values ranging from (5.07 to 7.11 cm). However, significant differences were observed at 60 DAS. Among The treatments, T₆ (19:19:19) recorded the highest plant height (25.90 cm), which was statistically at par with T₂ (Phule Micrograde-II) (24.89 cm) and T₃ (Calcium nitrate) (24.67 cm). The lowest plant height was recorded in T₁ (Control) (19.02 cm). At 90

DAS and at the last harvest, the differences among treatments were non-significant. The increase in plant height under T₆ (19:19:19) may be attributed to the balanced supply of nitrogen, phosphorus and potassium, which enhanced nutrient uptake, chlorophyll formation, photosyn Thesis and cell elongation, thereby promoting vigorous vegetative growth. Similar findings were reported by Maurya *et al.* (2024)^[16], Nongmai Them *et al.* (2023)^[17] who observed significant improvement in plant height following foliar application of balanced nutrients in cucurbit crops.

Plant spread EW (cm)

The data pertaining to East-West plant spread at 30, 60, 90 DAS and at last harvest are presented in Table 2. Plant spread did not vary significantly at 30 DAS. However, significant differences were observed at 60 DAS, 90 DAS and at The last harvest. T₆ (19: 19: 19) recorded The maximum plant spread (43.73, 55.40 and 56.40 cm, respectively), followed by T₂ (Phule Micrograde-II) recorded (43.28, 53.28 and 53.95, respectively) and T₃ (Calcium nitrate) recorded (42.56, 52.56 and 53.22, respectively) while The minimum plant spread was recorded in T₁ (Control).The increase in plant spread under balanced foliar nutrition may be due to improved nutrient availability, enhanced chlorophyll synthesis, greater photosynthetic efficiency and increased cell division and enlargement, resulting in vigorous canopy development. Similar findings were reported by Maurya *et al.* (2024)^[16] and Nongmaithem *et al.* (2023)^[17] in zucchini and cucumber

Plant spread NS (cm)

The data pertaining to North-South plant spread at 30, 60, 90 DAS and at last harvest are presented in Table 3. The observations on North-South plant spread revealed non-significant differences at 30 DAS. However, significant variation among treatments was recorded at 60 DAS, 90 DAS and at The last harvest. The highest plant spread was recorded in T₆ (19:19:19) (55.93, 58.36 and 59.09 cm, respectively), which was statistically at par with T₃ (Calcium nitrate) recorded (52.47, 54.15 and 55.05 respectively and T₂ (Phule Micrograde-II) recorded (49.62, 54.13 and 54.48 respectively). The lowest values were observed in T₁ (Control). The increased North-South plant spread may be attributed to balanced nutrient supply, improved photo syn Thesis activity, enhanced carbohydrate syn Thesis and efficient translocation of assimilates, resulting in better vegetative growth and canopy expansion. Similar observations were reported by Nongmaithem *et al.* (2023)^[17] in zucchini.

Petiole length (cm)

The data regarding petiole length are presented in Table 3. Foliar application of nutrients significantly influenced petiole length. The maximum petiole length (28.28 cm) was recorded in T₆ (19:19:19), which was statistically at par with T₂ (Phule Micrograde-II) (26.73 cm), T₃ (Calcium nitrate) (25.48 cm) and T₇ (12:61:00) (25.21 cm). The minimum petiole length (18.70 cm) was observed in T₁ (Control). The increase in petiole length may be attributed to The role of macro- and micronutrients in cell division, protein syn Thesis, chloroplast development, auxin syn Thesis, vascular tissue differentiation and photosynthesis, which collectively promoted vigorous vegetative growth. Similar results were reported by Monika *et al.* (2023)^[18] in *Cucurbita pepo* var. styriaca.

Table 2: Effect of Foliar application of nutrients on Plant height, Plant spread EW of Zucchini

	Treatments	Plant height (cm)				Plant spread EW			
		30 DAS	60 DAS	90 DAS	At last harvest	30 DAS	60 DAS	90 DAS	At last Harvest
T ₁	Control (Water spray)	5.07	19.02	21.32	21.82	14.46	27.17	34.51	35.51
T ₂	Phule Micrograde II	6.28	24.89	26.13	26.90	15.67	43.28	53.28	53.95
T ₃	Calcium nitrate	6.80	24.67	25.80	26.20	14.33	42.56	52.56	53.22
T ₄	Magnesium Sulphate	6.23	19.81	21.25	22.67	14.90	33.30	44.30	45.97
T ₅	Zinc sulphate	6.63	19.88	22.02	22.69	15.33	33.27	42.61	44.27
T ₆	19: 19: 19	7.11	25.90	26.83	27.70	15.54	43.73	55.40	56.40
T ₇	12: 61: 00	6.17	19.03	21.55	22.27	14.84	36.63	37.86	38.28
	Mean	6.33	21.89	23.56	24.32	15.01	37.13	45.79	46.80
	SE(m) ±	0.38	1.42	1.61	1.70	0.54	1.30	1.62	1.58
	CD @ 5%	NS	4.39	NS	NS	NS	4.02	5.00	4.86

Table 3: Effect of Foliar application of nutrients on Plant spread NS and Petiole length of Zucchini

	Treatments	Plant spread NS (cm)				Petiole length (cm)
		30 DAS	60 DAS	90 DAS	At last harvest	
T ₁	Control (Water spray)	19.14	37.68	38.99	39.88	18.70
T ₂	Phule Micrograde II	17.67	49.62	54.13	54.48	26.73
T ₃	Calcium nitrate	13.33	52.47	54.15	55.05	25.48
T ₄	Magnesium Sulphate	12.93	42.80	44.15	45.01	24.70
T ₅	Zinc sulphate	15.50	40.59	42.36	42.63	22.62
T ₆	19: 19: 19	17.77	55.93	58.36	59.09	28.28
T ₇	12: 61: 00	18.20	45.37	46.76	47.80	25.21
	Mean	16.36	46.35	48.41	49.14	24.53
	SE(m) ±	1.52	2.42	2.00	1.89	0.98
	CD @ 5%	NS	7.46	6.17	5.82	3.00

Flower observations

Days for initiation of first male flower

The data pertaining to the number of days required for initiation of the first male flower as influenced by foliar application of nutrients are presented in Table 4. The results revealed that the treatments did not differ significantly with respect to the initiation of the first male flower. The number of days required for first male flower initiation ranged from 22.40 to 23.20 days. The nonsignificant variation among treatments may be attributed to the fact that foliar nutrient sprays were applied at 30 DAS, whereas initiation of the first male flower had already occurred before The application of treatments. Therefore, this character was mainly governed by the genetic makeup of the cultivar and prevailing environmental conditions rather than nutrient application. Similar observations were reported by [Whitaker and Davis. \(1962\)](#) ^[19]; [Robinson and Decker-Walters. \(1997\)](#) ^[20] in cucurbit crops.

Days for initiation of first female flower

The data regarding the number of days required for initiation of the first female flower are presented in Table 4. Foliar application of nutrients did not exert a significant influence on this character. The initiation of the first female flower varied from 41.53 to 43.53 days after sowing. The absence of significant differences among treatments indicates that

flowering behaviour and sex expression in zucchini are largely controlled by genetic and environmental factors. Although foliar nutrient application improved vegetative growth, it did not substantially influence The initiation of The first female flower. Similar findings were reported by [Whitaker and Davis \(1962\)](#) ^[19]; [Robinson and Decker-Walters. \(1997\)](#) ^[20] in cucurbitaceous vegetables

Number of days required from opening of female flower to harvesting of Zucchini

The data pertaining to The number of days required from opening of The female flower to harvesting are presented in Table 4. Foliar application of nutrients significantly influenced this parameter. The minimum number of days (6.14 days) was recorded in T₆ (19:19:19), which was statistically at par with T₇ (12:61:00) (6.39 days), T₃ (Calcium nitrate) (6.40 days) and T₂ (Phule Micrograde-II) (6.53 days). The maximum duration (8.67 days) was recorded under T₁ (Control). The reduction in the duration from flower opening to harvesting under foliar nutrient treatments may be attributed to enhanced nutrient uptake, increased photosynthetic efficiency, improved translocation of photosynthates and accelerated fruit growth. Balanced nutrition through NPK 19:19:19 promoted rapid physiological and biochemical processes, resulting in early fruit maturity. Similar findings were reported by [Patil et al. \(1996\)](#) ^[21] in bottle gourd and [Maurya et al. \(2024\)](#) ^[16] in zucchini.

Table 4: Effect of Foliar application of nutrients on Flower observations of Zucchini

	Treatments	Days for initiation of first male flower	Days for initiation of first female flower	Number of days required from opening of female flower to harvesting of Zucchini
T ₁	Control (Water spray)	22.60	42.60	8.67
T ₂	Phule Micrograde II	22.73	41.80	6.53
T ₃	Calcium nitrate	22.53	41.53	6.40
T ₄	Magnesium Sulphate	22.80	43.53	7.33
T ₅	Zinc sulphate	23.20	43.20	7.01
T ₆	19: 19: 19	22.40	42.27	6.14
T ₇	12: 61: 00	22.67	41.67	6.39
	Mean	22.70	42.37	6.93
	SE(m)±	0.22	0.51	0.28
	CD @ 5%	NS	NS	0.86

Yield and yield attributing parameters

Days to first harvest

The data pertaining to days to first harvest as influenced by foliar application of nutrients are presented in Table 5. The results revealed significant differences among the treatments. The earliest (12:61:00) (48.06 days), T₂ (Phule Micrograde-II) (48.33 days) and T₆ (19:19:19) (48.41 days). The maximum number of days to first harvest (51.27 days) was observed in T₁ (Control). The earliness in harvesting under foliar nutrient treatments may be attributed to enhanced photosynthetic activity, improved nutrient availability and increased metabolic activity, which accelerated fruit growth and maturity. Similar findings were reported by *Hatwar et al. (2003)* [22], *Hazra et al. (1987)* [23], *Monika et al. (2023)* [18] and *Sidhu et al. (2020)* [24].

Days last harvest

The data regarding days to last harvest are presented in Table 5. Foliar application of nutrients significantly influenced crop duration. The maximum number of days to last harvest (103.67 days) was recorded in T₆ (19:19:19), followed by T₃ (Calcium nitrate) (99.67 days) and T₂ (Phule Micrograde-II) (97.67 days). The minimum crop duration (90.33 days) was recorded in T₁ (Control). The prolonged harvesting period under balanced nutrient application may be due to sustained vegetative growth, continuous flowering and fruit development resulting from improved nutrient availability. Similar findings were reported by *Singh et al. (2023)* [25], *Yadav et al. (2020)* [26] and *Narayanamma et al. (2009)* [27].

Harvesting duration (days)

The data pertaining to harvesting duration are presented in Table 5. Significant variation among treatments was observed. The maximum harvesting duration (55.26 days) was recorded in T₆ (19:19:19), which was statistically at par with T₃ (Calcium nitrate) (51.73 days). This was followed by T₂ (Phule Micrograde-II) (49.33 days). The shortest harvesting duration (39.06 days) was observed in T₁ (Control). The longer

harvesting duration under foliar nutrient application may be attributed to improved photosynthetic efficiency, enhanced nutrient uptake and continuous production of flowers and fruits, thereby extending the productive life of the crop. Similar observations were reported by *Sidhu et al. (2020)* [24], *Yadav et al. (2020)* [26] and *Narayanamma et al. (2009)* [27].

Number of pickings

The data pertaining to the number of pickings are presented in Table 5. Foliar nutrient application significantly affected the number of harvests. The highest number of pickings (5.67) was recorded in T₃ (Calcium nitrate) and T₆ (19:19:19), both of which were statistically at par with T₂ (Phule Micrograde-II) (5.00). The lowest number of pickings (4.00) was recorded in T₅ (Zinc sulphate), while the control recorded 4.33 pickings. The higher number of pickings obtained under calcium nitrate and NPK 19:19:19 treatments may be due to enhanced vegetative growth, increased flowering, better fruit set and continuous fruit development resulting from balanced nutrient availability. Similar findings were reported by *Maurya et al. (2024)* [16] and *Patil et al. (1996)* [21].

Number of fruits per plant

The data pertaining to the number of fruits per plant are presented in Table 5. Significant differences were observed among the treatments. The maximum number of fruits per plant (9.33) was recorded in T₆ (19:19:19), which was statistically at par with T₃ (Calcium nitrate) (9.27). This was followed by T₂ (Phule Micrograde-II) (8.53). The minimum number of fruits per plant (7.60) was recorded in T₁ (Control). The increase in fruit number under NPK 19:19:19 may be attributed to balanced nutrition, improved photosynthetic activity, enhanced flower retention, efficient carbohydrate translocation and better fruit set. Similar findings were reported by *Maurya et al. (2024)* [16], *Nongmaithem et al. (2023)* [17], *Sidhu et al. (2020)* [24], *Singh et al. (2023)* [25] and *Monika et al. (2023)* [18].

Table 5: Effect of Foliar application of nutrients on yield and yield attributing characters of Zucchini

Tr. No	Treatments	Days to first harvest	Days to last harvest	Harvesting duration	Number of pickings	Number of fruits per plant
T ₁	Control (Water spray)	51.27	90.33	39.06	4.33	7.60
T ₂	Phule Micrograde II	48.33	97.67	49.33	5.00	8.53
T ₃	Calcium nitrate	47.93	99.67	51.73	5.67	9.27
T ₄	Magnesium Sulphate	50.87	92.00	41.13	4.33	7.80
T ₅	Zinc sulphate	50.21	91.33	41.12	4.00	7.73
T ₆	19: 19: 19	48.41	103.67	55.26	5.67	9.33
T ₇	12: 61: 00	48.06	91.00	42.94	4.33	7.73
	Mean	49.30	95.10	45.80	4.76	8.29
	SE(m) ±	0.64	2.98	2.95	0.36	0.10
	CD @ 5%	1.99	9.17	9.08	1.11	0.31

Fruit length (cm)

The data pertaining to fruit length as influenced by foliar application of nutrients are presented in Table 6. The results revealed significant differences among the treatments. The maximum fruit length (24.40 cm) was recorded in T₆ (19:19:19), which was significantly superior to all other treatments. It was followed by T₄ (Magnesium sulphate) (22.70 cm), T₂ (*Phule Micrograde-II*) (22.48 cm), T₇ (12:61:00) (22.47 cm) and T₃ (Calcium nitrate) (22.27 cm). The minimum fruit length (20.71 cm) was recorded in T₁ (*Control*). The increase in fruit length under NPK 19:19:19 may be attributed to The balanced supply of essential nutrients, enhanced nutrient uptake, increased photosynthetic activity and better carbohydrate accumulation, which promoted cell elongation and fruit development. Similar findings were reported by Maurya *et al.* (2024) [16], Kumar *et al.* (2020) [28], Yadav *et al.* (2020) [26], Salama *et al.* (2019) [29] and Singh *et al.* (2023) [25].

Fruit diameter (cm)

The data pertaining to fruit diameter are presented in Table 6. Foliar application of nutrients significantly influenced fruit diameter. The maximum fruit diameter (3.60 cm) was recorded in T₆ (19:19:19), followed by T₂ (*Phule Micrograde-II*) (3.17 cm), T₃ (Calcium nitrate) (3.13 cm) and T₄ (Magnesium sulphate) (3.13 cm), which were statistically comparable. The minimum fruit diameter (2.90 cm) was recorded under T₁ (*Control*). The increased fruit diameter under balanced foliar nutrition may be due to improved nutrient absorption, enhanced photosynthetic efficiency and efficient translocation of assimilates to developing fruits. These processes promoted vigorous fruit growth and increased fruit girth. Similar findings were reported by Maurya *et al.* (2024) [16], Dominy (2010) [30], Marschner *et al.* (1990) [31] and El-Shoura (2020) [11].

Fruit weight (g)

The data regarding average fruit weight are presented in Table 6 and illustrated in Fig(b). Significant differences among The treatments were observed. The highest fruit weight (215 g) was recorded in T₆ (19:19:19), which was statistically at par with T₃ (Calcium nitrate) (214 g), T₂ (*Phule Micrograde-II*) (212 g) and T₅ (Zinc sulphate) (207 g). The lowest fruit weight (156 g) was recorded in T₁ (*Control*). The increase in fruit weight under balanced nutrient application may be attributed to enhanced photosynthesis, improved carbohydrate accumulation, better nutrient translocation and vigorous vegetative growth, resulting in improved fruit development. Similar findings were reported by El-Shoura (2020) [11], Salama *et al.* (2019) [29], Sidhu *et al.* (2020) [24], Singh *et al.* (2023) [25] and Monika *et al.* (2023) [18].

Fruit yield per plant (kg)

The data pertaining to fruit yield per plant are presented in Table 6 and illustrated in Fig.(c). Foliar application of nutrients significantly increased fruit yield per plant. The maximum fruit yield (2.00 kg plant⁻¹) was recorded in T₆ (19:19:19), which was statistically at par with T₃ (Calcium nitrate) (1.99 kg plant⁻¹). This was followed by T₂ (*Phule Micrograde - II*) (1.81 kg plant⁻¹) and T₅ (Zinc sulphate) (1.60 kg plant⁻¹). The minimum fruit yield (1.19 kg plant⁻¹) was recorded in T₁ (*Control*). The higher fruit yield obtained under NPK 19:19:19 may be attributed to rapid nutrient absorption through foliage, balanced nutrient availability, improved plant vigour, enhanced flowering, better fruit set and efficient translocation of assimilates towards developing fruits. Similar findings were reported by Maurya *et al.* (2024) [16], Singh *et al.* (2023) [25], Salama *et al.* (2019) [29], Nongmaithem *et al.* (2023) [17] and Sidhu *et al.* (2020) [24].

Yield per plot (kg)

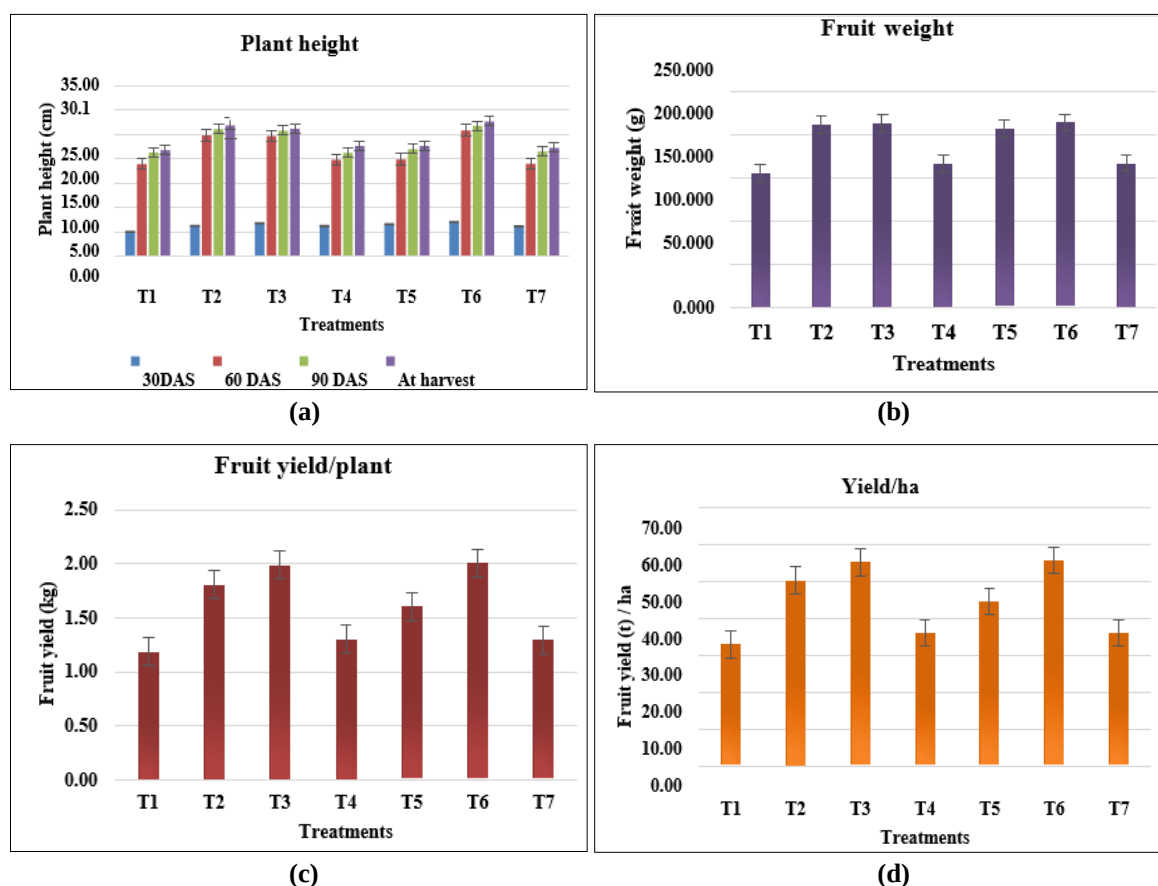
The data regarding yield per plot are presented in Table 6. Significant differences among the treatments were observed. The highest yield per plot (72.13 kg) was recorded in T₆ (19:19:19), which was statistically at par with T₃ (Calcium nitrate) (71.51 kg). It was followed by T₂ (*Phule Micrograde-II*) (65.13 kg) and T₅ (Zinc sulphate) (57.73 kg). The minimum yield per plot (42.67 kg) was recorded in T₁ (*Control*). The increased yield per plot under balanced foliar nutrition may be due to enhanced nutrient uptake, improved photosynthetic efficiency, vigorous vegetative growth and increased fruit production. Similar findings were reported by Maurya *et al.* (2024) [16], Salama *et al.* (2019) [29], Monika *et al.* (2023) [18] and Shafique *et al.* (2022) [32].

Yield per hectare (t)

The data pertaining to yield per hectare are presented in Table 6 and illustrated in Fig.(d). Foliar application of nutrients significantly influenced marketable yield. The maximum yield (55.65 t ha⁻¹) was recorded in T₆ (19:19:19), which was statistically comparable with T₃ (Calcium nitrate) (55.18 t ha⁻¹). This was followed by T₂ (*Phule Micrograde-II*) (50.26 t ha⁻¹) and T₅ (Zinc sulphate) (44.54 t ha⁻¹). The lowest yield (32.93 t ha⁻¹) was recorded under T₁ (*Control*). The highest yield per hectare obtained with NPK 19:19:19 may be attributed to its balanced nutrient composition, rapid foliar absorption and improved physiological efficiency, which enhanced plant growth, fruit development and overall productivity. The improvement in yield was associated with increased photosynthetic activity, greater carbohydrate accumulation and better flower and fruit retention. These findings are in agreement with the observations reported by Maurya *et al.* (2024) [16].

Table 6: Effect of Foliar application of nutrients on Yield and yield attributing characters of Zucchini

Tr.No	Treatments	Fruit length (cm)	Fruit diameter (cm)	Fruit weight(g)	Fruit yield/plant (Kg)	Yield/plot (Kg)	Yield/ha (t)
T ₁	Control (Water spray)	20.71	2.90	156	1.19	42.67	32.93
T ₂	Phule Micrograde II	22.48	3.17	212	1.81	65.13	50.26
T ₃	Calcium nitrate	22.27	3.13	214	1.99	71.51	55.18
T ₄	Magnesium Sulphate	22.70	3.13	167	1.30	46.80	36.11
T ₅	Zinc sulphate	21.43	3.01	207	1.60	57.73	44.54
T ₆	19: 19: 19	24.40	3.60	215	2.00	72.13	55.65
T ₇	12: 61: 00	22.47	2.95	168	1.30	46.68	36.02
	Mean	22.35	3.13	191.24	1.60	57.52	44.38
	SE(m) ±	0.48	0.12	2.62	0.03	1.03	0.80
	CD @ 5%	1.47	0.37	8.07	0.09	3.19	2.46



(T1: Control (Water spray), T2: Phule Micrograde II, T3: Calcium nitrate, T4: Magnesium sulphate, T5: Zinc sulphate, T6: 19:19:19 and T7: 12:61:00)

Fig 1: (a). Effect of foliar application of different nutrients on Plant height (cm) of Zucchini, **(b).** Effect of foliar application of different nutrients on Fruit weight per plant (g) of Zucchini, **(c).** Effect of foliar application of different nutrients on Fruit yield per hectare (t) of Zucchini, **(d).** Effect of foliar application of different nutrients on Fruit weight (g) of Zucchini.

Conclusion

The study concluded that foliar application of nutrients significantly improved the growth, yield, fruit quality, and nutrient status of zucchini. NPK 19:19:19 proved to be the most effective treatment, producing superior vegetative growth, higher yield, and better fruit quality. Calcium nitrate and Phule Micrograde-II also showed beneficial effects but were less effective than NPK 19:19:19. Therefore, foliar application of NPK 19:19:19 is recommended for enhancing zucchini productivity under Mahabaleshwar agro-climatic conditions.

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