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Effect of growth retardants and nutrients on, fruit and quality parameter of mango (*Mangifera indica* L.) Cv. Alphonso

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Abstract
The present investigation, entitled "effect of growth retardants and nutrients on fruit and quality parameter mango (*Mangifera indica* L.) cv. Alphonso" was conducted at the orchard of the Department of Fruit Science, Kittur Rani Channamma College of Horticulture, Arabhavi, Mudalagi Taluk, Belagavi District, during the year 2024-25 to evaluate the effect of growth retardants and nutrients on fruit characteristics and different quality parameters of Alphonso mango. Thirteen-year-old trees planted at 3 m × 3 m spacing were subjected to eight treatments in a Randomized Complete Block Design with three replications, each consisting of three trees. Among the different treatments, T_7 - Paclobutrazol @ 5 ml /m cd + foliar spray of Ca $(NO_3)_2$ @ 2% + KNO_3 @ 2% was most effective in improving the fruit characters such as fruit length (10.98 cm), breadth (9.09 cm), weight (268.00 g), pulp weight (211.50 g), and pulp to peel (7.58) and pulp to stone ratios (7.39), highest TSS (21.49 °B), brix-to-acid ratio (153.50), with lower acidity (0.14%), maximum total sugars (13.05%),

Keywords: Mango, growth retardants, nutrients, quality

Introduction
Mango (*Mangifera indica* L.) is one of the most cherished tropical fruits due to its high nutritional value, delightful taste, appealing aroma and numerous health benefits. Often it was referred to as the king of fruit and the ambassador fruit of India. Over 30 mango varieties are cultivated across India, with Alphonso being the most prized and internationally acclaimed for its superior quality. Alphonso mango is medium-sized, orange-yellow in colour and oval to oblique in shape. The average fruit measures about 11.6 cm in length and 9.3 cm in width with a weight ranging from 250 to 350 g. The skin is thin and smooth, the pulp is bright yellow, soft to firm with low fibre content and has an excellent taste and eating quality. It contains a large mono-embryonic stone and the fruit matures in the early to mid-season. The tree itself is moderately large, vigorous and has a dense, broadly rounded canopy.
Despite being regarded as the king of mangoes, Alphonso suffers from several agronomic limitations such as biennial bearing, poor sex ratio, inadequate pollination, multiple flowering flushes, low fruit set and poor fruit retention. The occurrence of spongy tissue at ripening further reduces its market value. Its strong tendency toward alternate bearing—heavy yield in one year followed by a light or no yield in the next—results in persistently low productivity, averaging only about 4.5 $t \cdot ha^{-1}$ compared with other commercial cultivars (Jangid *et al.*, 2023) [4].
Flowering in mango extends over several months and is influenced by environmental conditions, previous crop load and cultural practices, including the use of growth regulators and nutrients. Pruning also plays an important role in maintaining canopy structure, regulating vegetative growth and improving fruit size and shape (Yeshitela, 2004) [18].
Among plant growth retardants, paclobutrazol (PP333) is widely used to suppress vegetative growth and promote flowering in mango, whereas uniconazole (UCZ), another triazole, acts as a strong gibberellin inhibitor with rapid and broad-spectrum effects. Balanced nutrient management is equally important in regulating growth and inducing early flowering. Potassium

nitrate (KNO_3) enhances nitrate reductase activity and ethylene production, contributing to bud break and floral initiation, while calcium functions as a secondary messenger in processes associated with flower induction.

Beyond influencing flowering and fruit set, growth retardants and nutrients play a crucial role in determining fruit development and quality. Their application affects key fruit characters such as fruit length, breadth, volume and weight, along with pulp percentage and pulp texture. Chemical parameters including total soluble solids (TSS), acidity and the TSS:acid ratio—which collectively define sweetness, flavour and overall consumer acceptability—are also significantly modified by growth regulation and nutrient balance.

In this context, regulating flowering, fruiting and fruit quality in Alphonso mango is essential for improving its productivity and market competitiveness. Therefore, the present investigation was undertaken to evaluate the effects of growth retardants and nutrient treatments on major fruit and it's quality parameters in mango cv. Alphonso.

Materials and Methods

Soil drenching of paclibutrazole and uniconazole was done only once during October. Whereas calcium nitrate and pottasium nitrate applied as a foliar spray during November December january and March.

Observations recorded

Fruit parameters such as fruit length, fruit width, fruit weight, and pulp-to-stone ratio were recorded at harvest. Fruit dimensions were measured using a digital Vernier caliper, while individual fruit weight was determined using an electronic balance. Pulp, stone, and peel weights were obtained by manually separating the fruit components and weighing them individually.

Fruit quality attributes, including total soluble solids (TSS), titratable acidity, brix to acid content were assessed using standard laboratory procedures. TSS was measured using a hand-held digital refractometer, whereas titratable acidity was estimated through titration with phenoptalene as an indicator. All fruit and quality data were subjected to statistical analysis as per the methods outlined by Fisher and Yates (1963) at a significance level of $p = 0.05$ for both the 'F' and 't' tests.

Results and Discussion

Fruit parameters

Significant improvements in fruit length, breadth, volume and weight were recorded under growth retardant and nutrient treatments compared to the control was shown in the table 1, 2, 3.

The maximum fruit length was registered in the treatment T_7 - soil drenching of paclobutrazol at 5 ml per meter canopy diameter and foliar application of $Ca(NO_3)_2$ at 2 per cent with KNO_3 at 2 per cent at (10.98 cm) followed by T_8 (10.96 cm) and maximum breadth was recorded in T_7 (9.09 cm) followed by T_8 (9.08 cm). whereas the minimum fruit length (8.05 cm), breadth (7.02 cm), was registered in control T_1.

The highest value for fruit volume was recorded in T_7 (286.40 cc), followed by T_8 (281.17 cc) lowest fruit volume was recorded in the control T_1 (227.17 cc). The maximum fruit weight was recorded in T_7 (268.00 g), followed by T_8 (266.10 g), minimum fruit weight was registered in control T_1 (219.00 g). The enhancement in fruit weight and volume was noted may be attributed to improved chlorophyll content, leading to greater photosynthetic efficiency and assimilate accumulation in fruit sinks. In the present study these nutrients likely facilitated better nutrient mobilization, regulated the cell division, cell-wall permeability, thereby allowing more water mobility and increased absorption in fruits, resulting in enlargement of fruit size during fruit development. Consequently, increased sink strength enhanced the size of fruit and weight. These results align with previous findings of Sudha *et al.* (2012) [12] in Alphonso, Talang *et al.* (2016) [13] in mango cv. Himsagar, Bibi *et al.* (2019) [2] in mango cv. Summer Bahisht Chausa, Usharani *et al.* (2019) [15] in Alphonso mango.

Here, treatment T_8 - uniconazole at 5g per meter canopy diameter and foliar application of $Ca(NO_3)_2$ at 2 per cent with KNO_3 at 2 per cent followed by T_7 registered the minimum physiological loss in weight (7.28% and 8.16% respectively), indicating better storability, while the highest value was recorded in the control (16.03%). These effects could be attributed to potassium's ability to reduce transpiration and sustain cellular hydration, which limits physiological weight loss and decay. In the present study, chemical-induced changes enhance water retention and alter cell proteins to improve hydrophilicity. Similarly, mango fruits treated with calcium nitrate were Ca^{2+} exhibited a lower respiration rate than the control, indicating delayed senescence and better physiological stability. These results were in accordance with Vidya *et al.* (2014) [16] in mango cv. Mallika, Maloba *et al.* (2014) [7] in mango cvs. Apple and Ngowe. Virendra *et al.* (2017) [17] in Dashehari and Amrapali mango.

Pulp weight, pulp per cent, pulp to peel, pulp to stone ratio and peel weight

The highest pulp weight (211.50 g), pulp percent (78.91%), pulp to peel ratio (7.58), pulp to stone ratio (7.39) and minimum peel weight (27.90 g) was recorded in T_7 on par with T_8, whereas lowest pulp weight (153.66 g), pulp percent (70.16%), pulp to peel ratio (4.69), pulp to stone ratio (4.71) and maximum peel weight (32.75 g) was obtained in control T_1.

The enhancement in fruit pulp, pulp per cent, pulp: peel ratios, pulp: stone ratios may be attributed to potassium and calcium's vital role in leaf-to-fruit translocation of photosynthates, thereby ensuring more efficient utilization of assimilates, promoting cell expansion, water uptake and nutrient transport, all of which promote the development of well-formed, pulpy fruits, which intern decrease the peel and stone weight leading to decreased peel and stone per cent. In contrast, fruits from untreated trees (T_1) recorded the minimum values for all physical parameters, likely due to uncontrolled vegetative growth, poor nutrient availability and competition for assimilates. These results are in agreement with Abo-El-Ez (2002) [1] in Langra, Srilatha *et al.* (2015) [11] in Raspuri mango, Pal *et al.* (2017) [8] in Himsagar mango, Rani *et al.* (2017) [10] in Dashehari mango, Makland *et al.* (2020) in Ewais mango.

Table 1: Effect of growth retardants and nutrients on fruit parameters in mango cv. Alphonso

Treatment	Fruit length (cm)	Fruit breadth (cm)	Fruit volume (cc)	Fruit weight (g)	Physiological loss in weight (%)
T_1 - Control (water spray)	8.05	7.02	227.17	219.00	16.03
T_2 - Paclobutrazol @ (5 ml /m cd)	9.42	7.86	243.07	228.00	12.74
T_3 - Paclobutrazol @ (5 ml /m cd) + foliar spray of KNO_3 @ 2%	10.05	8.29	259.67	240.73	11.24
T_4 - Uniconazole @ (5 g /m cd) + foliar spray of KNO_3 @ 2%	10.31	8.51	259.00	241.20	10.70
T_5 - Paclobutrazol @ (5 ml /m cd) + foliar spray of Ca $(NO_3)_2$ @ 2%	10.51	8.82	270.40	243.80	9.76
T_6 - Uniconazole @ (5 g /m cd) + foliar spray of Ca $(NO_3)_2$ @ 2%	10.69	8.97	273.97	248.00	9.17
T_7 - Paclobutrazol @ (5 ml /m cd) + foliar spray of Ca $(NO_3)_2$ @ 2% + KNO_3 @ 2%	10.98	9.09	286.40	268.00	8.16
T_8 - Uniconazole @ (5 g /m cd) + foliar spray of Ca $(NO_3)_2$ @ 2% + KNO_3 @ 2%	10.96	9.08	281.17	266.10	7.28
S. Em±	0.25	0.17	5.80	4.92	0.34
CD @ 5%	0.76	0.54	17.61	14.95	1.04
CV (%)	7.43	6.34	6.63	6.05	9.70

Note: m cd - meter canopy diameter

Table 2: Effect of growth retardants and nutrients on parameters of pulp and peel in mango cv. Alphonso

Treatment	Pulp weight (g)	Peel weight (g)	Pulp per cent	Peel per cent	Pulp to peel ratio	Pulp to stone ratio
T_1 - Control (water spray)	153.66	32.75	70.16	14.96	4.69	4.71
T_2 - Paclobutrazol @ (5 ml /m cd)	164.69	31.73	72.23	13.92	5.19	5.21
T_3 - Paclobutrazol @ (5 ml /m cd) + foliar spray of KNO_3 @ 2%	179.10	31.70	74.50	13.19	5.64	6.05
T_4 - Uniconazole @ (5 g /m cd) + foliar spray of KNO_3 @ 2%	181.51	30.30	75.25	12.57	5.99	6.17
T_5 - Paclobutrazol @ (5 ml /m cd) + foliar spray of Ca $(NO_3)_2$ @ 2%	184.40	30.10	75.63	12.37	6.12	6.29
T_6 - Uniconazole @ (5 g /m cd) + foliar spray of Ca $(NO_3)_2$ @ 2%	188.99	30.05	76.20	12.13	6.28	6.52
T_7 - Paclobutrazol @ (5 ml /m cd) + foliar spray of Ca $(NO_3)_2$ @ 2% + KNO_3 @ 2%	211.50	27.90	78.91	10.42	7.58	7.39
T_8 - Uniconazole @ (5 g /m cd) + foliar spray of Ca $(NO_3)_2$ @ 2% + KNO_3 @ 2%	207.40	29.90	77.94	11.24	6.93	7.20
S. Em±	3.94	0.51	0.97	0.37	0.22	0.18
CD @ 5%	11.95	1.54	2.95	1.11	0.68	0.54
CV (%)	6.42	5.01	6.01	8.91	11.25	8.75

Fruit quality parameters

The highest TSS value of (21.49 °B), lowest acidity (0.14%), highest brix to acid ratio (153.50), was achieved with the treatment T_7 - soil applied paclobutrazol at (5 ml /m cd) + foliar spray of Ca $(NO_3)_2$ @ 2% + KNO_3 @ 2%. The increase in TSS and the reduction in fruit acidity may be attributed to the rapid hydrolysis of polysaccharides into soluble sugars and higher solute accumulation resulting from enhanced translocation of carbohydrates from source to sink induced by nutrients. Additionally, The enhancement in sugar content was likely because of the activity of cytoplasmic sucrose phosphate synthase, an important enzyme regulating sucrose pool size in leaves- is stimulated by plant growth regulators (PGRs) like paclobutrazol and uniconazole, thereby enhancing phloem loading and assimilate transport. Additionally, foliar spray of potassium promotes the conversion of starch into simple sugars during fruit ripening by activating the sucrose synthase enzyme, enhancing carbohydrate metabolism, protein synthesis and the neutralization of organic acids in mango fruit. Similar findings have been reported by Kishore *et al*. (2019) [5] in Arka Neelachal Kesari, Thiruezhirselvan *et al.* (2024) [14] in Bnganapalli mango and Chouhan *et al*. (2025) [3] in Amrapali mango.

Table 3: Effect of growth retardants and nutrients on total soluble solids, titratable acidity and Brix to acid ratio in mango cv. Alphonso

Treatment	Total soluble solids (°Brix)	Titratable acidity (%)	Brix to acid ratio
T_1 - Control (water spray)	17.96	0.35	51.31
T_2 - Paclobutrazol @ (5 ml /m cd)	18.06	0.31	58.25
T_3 - Paclobutrazol @ (5 ml /m cd) + foliar spray of KNO_3 @ 2%	19.85	0.18	110.27
T_4 - Uniconazole @ (5 g /m cd) + foliar spray of KNO_3 @ 2%	19.66	0.21	93.61
T_5 - Paclobutrazol @ (5 ml /m cd) + foliar spray of Ca $(NO_3)_2$ @ 2%	19.53	0.27	72.33
T_6 - Uniconazole @ (5 g /m cd) + foliar spray of Ca $(NO_3)_2$ @ 2%	19.39	0.28	69.25
T_7 - Paclobutrazol @ (5 ml /m cd) + foliar spray of Ca $(NO_3)_2$ @ 2% + KNO_3 @ 2%	21.49	0.14	153.50
T_8 - Uniconazole @ (5 g /m cd) + foliar spray of Ca $(NO_3)_2$ @ 2% + KNO_3 @ 2%	21.42	0.16	133.87
S. Em±	0.40	0.01	2.86
CD @ 5%	1.23	0.03	8.69
CV (%)	6.20	13.80	9.26

Conclusion

From the results of the present investigation, it can be concluded that the treatment comprising soil drenching of paclobutrazol at 5 ml per meter canopy diameter with foliar application of Ca $(NO_3)_2$ at 2 per cent and KNO_3 at 2 per cent followed by uniconazole at 5 g per meter canopy diameter with foliar application of Ca $(NO_3)_2$ at 2 per cent and KNO_3 at 2 per cent was most effective in enhancing fruit parameters and achieving fruit quality of mango cv. Alphonso.

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