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Yukta J Patel
Department of Fruit Science, College of Horticulture, Junagadh Agricultural University, Junagadh, Gujarat, India

ND Polara
Department of Fruit Science, College of Horticulture, Junagadh Agricultural University, Junagadh, Gujarat, India

Rikshita R Gondaliya
Department of Fruit Science, College of Horticulture, Junagadh Agricultural University, Junagadh, Gujarat, India

Darshana V Patel
Department of Fruit Science, College of Horticulture, Junagadh Agricultural University, Junagadh, Gujarat, India

Shivani Patel
Department of Fruit Science, College of Horticulture, Junagadh Agricultural University, Junagadh, Gujarat, India

Corresponding Author:
Yukta J Patel
Department of Fruit Science, College of Horticulture, Junagadh Agricultural University, Junagadh, Gujarat, India

Effect of different chemicals on yield attributing parameters and yield of ber cv. gola

Yukta J Patel, ND Polara, Rikshita R Gondaliya, Darshana V Patel and Shivani Patel

Abstract
The field experiment took place at the Fruit Research Station in Khengarvav, Junagadh Agricultural University, Junagadh, during the period of 2022 to 2023. The outcome of the experiment indicated that the application of NAA (Naphthalene acetic acid) at a concentration of 40 ppm resulted in various positive effects on the ber fruit. Notably, it led to significant increases in multiple parameters related to fruit quality and yield. Specifically, the use of NAA at 40 ppm resulted in the highest values for various attributes including fruit weight (27.83 g), fruit length (3.53 cm), fruit diameter (3.62 cm), fruit volume (29.31 ml), pulp weight (25.41 g), and the maximum pulp to stone ratio (11.62). Additionally, the application of NAA at this concentration led to a fruit set of 11.65%, a minimal fruit drop of 40.83%, and the highest recorded fruit yield per tree (11.88 kg/tree) as well as yield per hectare (3.29 t/ha). In conclusion, the study demonstrates that the use of NAA at 40 ppm has a positive impact on various parameters related to ber fruit production, including fruit quality and overall yield. The key findings emphasize the potential of NAA to enhance ber cultivation and its yield. This investigation contributes to the understanding of optimizing the growth and yield of ber fruit.

Keywords: Ber, Gola, NAA, borax, yield

1. Introduction
The plant scientifically named *Zizyphus mauritiana* Lamk, commonly referred to as Indian Ber, holds several alternative names such as Chinese date, Indian plum, Indian jujube, or Chinese fig. It belongs to the Rhamnaceae family and falls under the genus *Zizyphus*. This tetraploid species possesses a chromosome count of 2n = 4x = 48. Indian Ber is renowned for its economic viability, cost-effectiveness in cultivation, and its remarkable adaptability to various environmental conditions, especially its resilience to drought. This attribute has earned it the moniker "king of arid fruits." The plant's versatility is evident in its ability to flourish across diverse soil and climatic settings. Notably, it thrives even in harsh conditions where other plants struggle.

Regarding ber cultivation in India, the states prominently engaged in its growth include Rajasthan, Gujarat, Madhya Pradesh, Haryana, Punjab, Bihar, Uttar Pradesh, Andhra Pradesh, Tamil Nadu, West Bengal, and Assam (Bal and Randhawa, 2007) [4]. Notably, India holds the foremost position globally in terms of ber cultivation. The country's overall ber cultivation area spans 53,000 hectares, yielding a total production of 5,80,000 metric tons (Anon., 2020) [1]. In Gujarat alone, the ber cultivation area accounts for 10,680 hectares, contributing to a total production of 1,03,196 metric tons (Anon., 2021) [2].

A significant challenge in ber fruit management is its limited storage life, lasting only about 6 to 7 days under normal ambient conditions. This short shelf life poses a considerable obstacle to successful transportation and marketing efforts. While there has been relatively limited research on extending the shelf life of ber through the application of micronutrients and plant growth regulators (Meena *et al*., 2013) [9], recent developments have focused on utilizing plant growth regulators to enhance quality, prolong storage duration, and consequently extend the shelf life of various fruit crops, ber included.

NAA, classified as a vital growth regulator belonging to the auxin group, serves as an instrumental agent in diminishing fruit drop while concurrently enhancing fruit set and quality, particularly in terms of Total Soluble Solids (TSS). The application of NAA through spraying proves advantageous in bolstering both the yield and overall quality of fruits. The essential nutrient potassium holds a pivotal role in plant meristematic growth and physiological functions.

This encompasses the regulation of pivotal processes such as water and gas exchange, protein synthesis, enzyme activation, photosynthesis, and the translocation of carbohydrates in plants. The element boron occupies a significant position, contributing to the development of ovules, growth of pollen tubes, improvement in fruit set, and the augmentation of fruit quality. The use of foliar-applied plant growth regulators in conjunction with micro-nutrients holds the promise of mitigating the adverse effects of fruit drop, thereby potentially enhancing yield and refining fruit quality characteristics in ber and other fruit-bearing plants. Multi-micronutrient grade-IV formulation incorporates five trace essential micronutrients crucial for crop development. Notably, it consists of zinc (6.0%), iron (4.0%), copper (0.5%), chelated manganese (1.0%), and boron (0.5%). The strategic application of this formulation emerges as a viable approach to elevating both crop quality and productivity by means of enhancing essential nutrient availability.

2. Materials and Methods

Conducted within the timeframe of 2022 to 2023, this experiment took place at the Fruit Research Station situated in Khengarvav, affiliated with Junagadh Agricultural University in Junagadh. Employing a Randomized Block Design, the experiment incorporated a distinctive approach and was replicated three times. The study encompassed nine distinct treatments: T_1 - Control, T_2 - NAA @ 40 ppm, T_3 - NAA @ 60 ppm, T_4 - KNO3 @ 1.5%, T_5 - KNO3 @ 2%, T_6 - Borax @ 0.4%, T_7 - Borax @ 0.6%, T_8 - Multi-micronutrients grade-IV @ 1%, and T_9 - Multi-micronutrients grade-IV @ 2%. Each treatment was replicated three times, following a total of nine experimental units.

The planting layout adhered to a spacing of 6 meters by 6 meters, following a square planting system. The application of these treatments was executed through foliar spraying, carried out on the 15th of October, 2022, during the flowering stage. A subsequent spray occurred 30 days after the first application. Throughout the course of the experiment, meticulous observations were diligently recorded. Consistency was maintained in applying recommended fertilizer doses and other prescribed agricultural practices for ber cultivation across all treatments, including the control group.

3. Result and Discussion

The effect of different chemicals on yield and yield attributing parameters are tabulated in Tables 1 and 2.

3.1 Yield and yield attributing parameters

The experiment conducted during the period 2022-23 at the Fruit Research Station situated in Khengarvav, Junagadh Agricultural University, Junagadh, yielded noteworthy results in terms of the impact of various chemical treatments on yield and yield-associated parameters. These parameters encompass fruit weight, fruit length, fruit diameter, fruit volume, pulp weight, stone weight, and the pulp: Stone Ratio.

Remarkably, the application of NAA at a concentration of 40 ppm (T_2) resulted in the maximum fruit weight (27.83 g), paralleled by the effect of borax at 0.4% (T_6). Similarly, NAA at 40 ppm (T_2) induced the highest fruit length (3.53 cm), coinciding with NAA at 60 ppm (T_3), KNO_3 at 1.5% (T_4), and borax at 0.4% (T_6). Additionally, NAA at 40 ppm (T_2) demonstrated the highest fruit diameter (3.62 cm), aligning with the effect of borax at 0.4% (T_6). This rise in fruit size and weight, particularly noticeable in NAA-treated trees, can be attributed to the stimulation of leaf and flower bud growth. This, in turn, may have contributed to the enlargement of fruit dimensions and weight. A positive correlation emerged between fruit length, fruit weight, and fruit diameter. These findings coincide with earlier studies conducted on ber by Choudhary *et al.* (2020) [6], as well as studies on Aonla by Yadav (2010) [18] and Tripathi and Viveka (2022) [17] and Parsana *et al.* (2023) [11] in Custard apple.

NAA application at 40 ppm (T_2) yielded the maximum fruit volume (29.31 ml), also paralleled by the effect of borax at 0.4% (T_6). This outcome can be attributed to the increased fruit size facilitated by the exogenous supply of plant growth regulators (PGRs), which likely enhanced the transport of nutrients and metabolites to developing fruits, thereby augmenting fruit volume. Similar trends were reported in previous research on Ber (Singh *et al.*, 2001) [16], Lemon (Manju and Rawat, 2015) [8], Custard apple and Aonla (Tripathi and Viveka, 2022) [17].

The same treatment impact in pulp weight can be attributed to the larger size and weight of fruits, coupled with increased diversion of photosynthates towards the fruit as a strong sink. This pattern aligns with studies on mango by Bhowmick and Banik (2011) [5], Ber by Choudhary *et al.* (2020) [6], and Aonla by Tripathi and Viveka (2022) [17].

A similar trend was observed with stone weight, where NAA at 40 ppm (T_2) and borax at 0.4% (T_6) resulted in the minimum stone weight (2.19 g). This reduction in stone weight might be due to increased fruit weight and a shift in photosynthetic resources towards fruit growth. This finding correlates with research on Aonla by Singh *et al.* (2007) and Tripathi and Viveka (2022) [17], Ber by Choudhary *et al.* (2020) [6].

The highest pulp: Stone Ratio (11.62) was associated with the application of NAA at 40 ppm (T_2). This might be attributed to the variations in pulp and stone weights across different treatments. This observation is in line with the findings of Choudhary *et al.* (2020) [6] on Ber and Tripathi and Viveka (2022) [17] on Aonla.

NAA at 40 ppm (T_2) led to the maximum fruit set (11.65%), akin to the effect of borax at 0.4% (T_6) and multi-micronutrient grade-IV at 1% (T_8). Similarly, NAA application at 40 ppm (T_2) yielded the minimum fruit drop (40.83%), also paralleled by the effect of borax at 0.4% (T_6). The reduction in fruit drop could be attributed to the flower-preserving effect of NAA, wherein auxins counteract abscisic acid (ABA) and ethylene, maintaining the fruit's attachment by regulating physiological processes. Similar findings were reported in Kinnow mandarin, Sapota (Sahu *et al.*, 2018) [14], Ber (Choudhary *et al.*, 2020) [6], and Custard apple (Pujari *et al.*, 2021) [13].

Impressively, the highest fruit yield (11.88 kg/tree) and overall yield (3.29 t/ha) were attained through NAA application at 40 ppm (T_2), matching the effect of borax at 0.4% (T_6). The surge in yield could be attributed to the combination of reduced fruit drop and increased fruit weight in these treatments. These outcomes align with research on persimmon by Kassem *et al.* (2010) [7], Acid lime by Patel *et al.* (2013), and Ber by Choudhary *et al.* (2020) [6].

4. Conclusion

Based on the findings of the current study, several conclusions can be deduced. The application of various

chemical treatments exhibited a positive influence on both the yield and yield-related characteristics of ber fruit. Particularly noteworthy was the dual application of NAA at a concentration of 40 ppm, wherein the first spray during the flowering stage followed by a second spray after a 30-day interval led to notable enhancements in yield-related parameters and the overall yield of the ber variety 'Gola'.

Table 1: Effect of different chemicals on yield attributing and yield parameters of ber

Sr. No.	Treatment detail	Fruit weight (g)	Fruit length (cm)	Fruit diameter (cm)	Fruit volume (ml)	Pulp weight (g)	Stone weight (g)	Pulp: Stone ratio
T_1	Control	19.60	3.10	3.21	18.16	17.03	2.57	6.64
T_2	NAA @ 40 ppm	27.83	3.53	3.62	29.31	25.41	2.19	11.62
T_3	NAA @ 60 ppm	22.67	3.31	3.37	22.74	19.55	2.45	7.96
T_4	KNO_3 @ 1.5%	22.07	3.30	3.31	23.16	19.13	2.53	7.55
T_5	KNO_3 @ 2.0%	20.30	3.27	3.25	22.60	17.74	2.52	7.07
T_6	Borax @ 0.4%	24.51	3.44	3.51	27.37	22.02	2.22	9.92
T_7	Borax @ 0.6%	20.31	3.27	3.22	19.65	17.33	2.47	7.00
T_8	Multi-micronutrient grade- IV @ 1%	21.10	3.28	3.25	21.75	18.55	2.51	7.39
T_9	Multi-micronutrient grade- IV @ 2%	20.07	3.16	3.34	19.64	17.28	2.45	7.07
S.Em.±		1.175	0.079	0.080	0.886	1.183	0.081	0.469
C.D. at 5%		3.52	0.23	0.24	2.65	3.54	0.24	1.40
C.V.%		9.24	4.17	4.15	6.76	10.69	5.69	10.14

Table 2: Effect of different chemicals on yield attributing and yield parameters of ber

Sr. No.	Treatment detail	Fruit set (%)	Fruit drop (%)	Yield (kg/tree)	Yield (t/ha)
T_1	Control	9.11	50.03	7.85	2.17
T_2	NAA @ 40 ppm	11.65	40.83	11.88	3.29
T_3	NAA @ 60 ppm	10.05	46.93	9.82	2.72
T_4	KNO_3 @ 1.5%	9.99	48.55	8.57	2.37
T_5	KNO_3 @ 2.0%	9.63	49.88	7.90	2.19
T_6	Borax @ 0.4%	11.19	41.44	10.27	2.84
T_7	Borax @ 0.6%	6.78	45.80	6.43	1.78
T_8	Multi-micronutrient grade- IV @ 1%	10.82	47.77	8.50	2.35
T_9	Multi-micronutrient grade- IV @ 2%	9.67	48.14	8.13	2.25
S.Em.±		0.513	1.295	0.672	0.186
C.D. at 5%		1.54	3.88	2.01	0.55
C.V.%		9.01	4.82	13.22	13.22

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