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Effect of Nutrients and Growth Regulators on Fruit Set, Fruit Retention and Yield of Ber CV. Banarasi

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Short Research Article

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ABSTRACT

Fruit quality is found best under hot sunny and dry conditions but there should be a support to the growth and flowering leaving enough soil moisture to carry the fruit to maturity. The experiment was conducted at Regional Research Station, Tamil Nadu Agricultural University, Aruppukottai and laid in a Randomized Block design with four replications. This study was undertaken to determine the effect of micronutrients and plant growth regulators on morpho-physiological and yield and yield parameters of ber under rainfed vertisol and to fix up suitable method of application of micronutrients and plant growth regulators combination for high yield and quality of ber under

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rainfed vertisol conditions. The plots had five treatments viz., T_1 - Nutrient mixture, T_2 - Nutrient mixture + NAA 50ppm, T_3 - Nutrient mixture + Salicylic acid 50ppm, T_4 - Nutrient mixture + NAA 50ppm+ Salicylic acid 50ppm, T_5 - Control. The variety Banarasi was used as experimental material with all normal cultural practices followed for ber cultivation. The foliar applications of a nutrient mixture with hormones were sprayed at full foliage stage and the peak flowering stage. Three trees were selected from each treatment and replication for recording morphological observations on Tree height (m), Girth (cm), Number of primary branches per tree, No of secondary branches per Tree and Tree spread East – West and North – South (m). Physiological parameters viz., Ascorbic acid (mg/100g), soluble protein (mg /g), total chlorophyll (mg/g), specific leaf weight (mg/cm2), relative water content (%) and chlorophyll stability index (%) were recorded. The yield and quality characters like., number of fruits per tree, pulp weight (g), stone weight (g), pulp stone ratio and total soluble solids (brix) were recorded during the harvest stage. Comparing the five treatments, foliar application of Nutrient mixture + Salicylic acid 50ppm (T_3) recorded the highest value in morphological characters. While the treatment T_4 (Nutrient mixture + NAA 50ppm+ Salicylic acid 50ppm) registered the highest value in physiological, quality and yield characters in ber. The increase in the fruit yield with the foliar application of nutrients may be attributed to increased fruit size, fruit weight and minimum fruit drop. In addition, more cell division, cell elongation and translocation of photosynthates and metabolites from leaves to the developing fruit resulted in higher fruit yield.

Keywords: Nutrients; PGRs; morphology; physiological; ber; metabolites.

1. INTRODUCTION

Ber or Indian jujube (*Ziziphus mauritiana Lamk*.) belong to family Rhamenaceae, is one of the most ancient and common fruit of Indian subcontinents and South Western China. Ber is grown under rain -fed condition in arid and semi-arid region of India and has been identified as highly drought and heat tolerant fruit crop (Hussain et al., 2021). It is cultivated widely for its resistance to grow in drought and other diversified soil and climatic conditions. It is a hardy tree that copes with extremes temperature and thrives well under dry conditions. Fruit quality is found best under hot sunny and dry conditions but there should be a support to the growth and flowering leaving enough soil moisture to carry the fruit to maturity (Patel et al., 2023). The ber plant is quick growing, early bearing and spreading tree. The area under ber in India is about 50 million hectare and production consists of 513 million tons. The area under ber in Tamilnadu is about 46.2 ha and production consists of 425.1 mt. The ber fruit is very well-liked among consumers due to its high nutritional value but somewhat lower market price. Its fruit is delicious and is usually eaten fresh. Also fruit of the ber is considered more nutritious than apple for its higher protein, Beta-carotene and vitamin-C (70-165 mg/100g fruit pulp), (Ram *et al*., 2005). The berries are the richest source of amino acids. Among the amino acids, asparagine, arginine, glutamic acid, aspartic acid, glycine, serine, alfa serine and threonine are found in ber pulp (Bal, 1981). For getting getting best quality ber, it can be achieved with the foliar application of plant growth regulators and nutrients. Micronutrients play a specific role in improving the growth, yield and quality of ber plant, even though these elements are needed in small quantities. Zinc element is essentially required for growth, development and also involved in a diverse range of enzyme systems in ber. The functional role of zinc includes auxin metabolism, influence on activating enzyme synthesis and stability of ribosomal fractions (Kaur, 2017).

Therefore, this study was undertaken to (i) study the effect of micronutrients and plant growth regulators on morpho-physiological and yield and yield parameters of ber under rainfed vertisol and (ii) to fix up a suitable method of application of micronutrients and plant growth regulators combination for high yield and quality of ber under rainfed vertisol conditions.

2. MATERIALS METHODS

The field experiment was conducted at the Regional research Station, Tamil Nadu Agricultural University, Aruppukottai, under Indian Council of Agricultural Research - All India Coordinated Research project on Arid Zone Fruit Crops. The experiment was laid in a Randomized Block design with four replications. The plots had five treatments and the details were presented in Table 1.

Table 1. Treatment Details

Treatments		Details
T_1	:	Nutrient Mixture
T_2	:	Nutrient Mixture + NAA 50ppm
T_3	:	Nutrient Mixture + Salicylic acid 50ppm
T_4	:	Nutrient Mixture + NAA 50ppm+ Salicylic acid 50ppm
T_5	:	Control

The concentration of nutrients in Nutrient Mixture details were presented in Table 2.

Table 2. Concentration of nutrients in Nutrient Mixture

S.No	Nutrients		Concentration
1.	Potassium	:	0.15% (1.5g / lit)
2.	Thio Urea	:	0.1% (1g / lit of water)
3.	$ZnSO_4$	:	0.1% (1g / lit of water)
4.	Boric acid	:	0.1% (1g / lit of water)
5.	$MgSO_4$	:	0.1% (1g / lit of water)
6.	$FeSO_4$	:	0.1% (1g / lit of water)
7.	$CuSO_4$	:	0.1% (1g / lit of water)
8.	$MnSO_4$		0.1% (1g / lit of water)
9.	Citric acid		0.05% (0.5g / lit of water)
10.	Sodium Molybdate		0.025% (0.25g / lit of water)

The variety Banarasi was used as experimental material with all normal cultural practices followed for ber cultivation. Three trees were selected from each treatment and replication for recording observations on Tree height (m), Girth (cm), Number of primary branches per Tree, No of secondary branches per Tree and Tree spread East – West and North – South (m). Tree height was measured from base to apex using a measuring tape attached with pole. The tree girth also measured at 30 cm above ground using tape. The tree spread was measured canopy diameter East–West and North–South with tape. The physiological parameters like., Ascorbic acid (mg/100g), soluble protein (mg /g), total chlorophyll (mg/g), specific leaf weight (mg/cm2), relative water content (%) and chlorophyll stability index (%) were recorded fifteen days after foliar applications of nutrients and plant growth regulators. The yield and quality characters like., number of fruits per tree, pulp weight (g), stone weight (g), pulp stone ratio and total soluble solids (brix) were recorded during the harvest stage.

3. RESULTS AND DISCUSSION

3.1 Morphological Parameters (Table 3)

3.1.1 Tree height

The result on tree height revealed that, treatment T_3 recorded the tallest tree in terms of height than the other treatments. Among the five treatments, T_3 (Nutrient mixture + Salicylic acid 50ppm (T_3) registered higher values in Tree height (3.48 m) (Table 3), which was followed by treatment T_1 (Nutrient Mixture) had the tree height of 3.40m. Whereas the control recorded the lowest values in tree height (3.01 m).

3.1.2 Tree girth

The data on tree girth reported that treatment T_8 recorded the highest tree girth than the other treatments. Among the five treatments, T_3 (Nutrient mixture + Salicylic acid 50ppm (T_3) registered higher values in Tree height (3.48 m) (Table 3), which was followed by treatment T_1 (Nutrient Mixture) had the tree height of 3.40m. Whereas, the control recorded the lowest values in tree height (3.01 m).

3.1.3 Number of primary branches

The report on Number of Primary branches stated that, among the five treatments, T_3 (Nutrient mixture + Salicylic acid 50ppm (T_3) registered higher values in Number of Primary branches (2.63) (Table 3), Which was followed by treatment T_1 (Nutrient Mixture) had the Number of Primary branches of 2.50. Whereas, the control recorded the lowest values in Number of Primary branches (2.13).

3.1.4 Number of Secondary branches

The outcome on the Number of Secondary branches stated that treatment T_3 recorded the largest Number of Secondary branches among the other treatments. Among the five treatments, T_3 (Nutrient mixture + Salicylic acid 50ppm (T_3) registered the higher values in Number of Secondary branches (9.0) (Table 3), which was followed by treatment T_1 (Nutrient Mixture) had the Number of Secondary branches 8.50. Whereas, the control recorded lowest values in Number of Secondary branches (7.25).

3.1.5 Tree spread

Among the nine treatments, T_3 (Nutrient mixture + Salicylic acid 50ppm (T_3) registered higher values in tree spread (3.22 EW, 3.06 NS) (Table 2), which was followed by treatment T_1 (Nutrient mixture) had the tree spread (3.09 EW, 2.98 NS) than the other treatments. Whereas, the control recorded lowest values in tree spread (2.85 EW, 2.63 NS) in among the treatments.

3.2 Physiological Parameters (Table 4)

Comparing the five treatments, foliar application of Nutrient Mixture + NAA 50ppm+ Salicylic acid 50ppm (T_4) recorded the highest value in ascorbic acid content (93.52 mg/100g), soluble protein content (49.40 mg g^{-1}), total chlorophyll content (2.54 mg g^{-1}), and specific leaf weight (4.90 mg/cm^2) (Table 4). The least value was observed in control treatments (T_1). The treatment T_4 (Nutrient Mixture + NAA 50ppm+ Salicylic acid 50ppm) maintained its superiority in relative water content and chlorophyll stability index of about 82.80% and 64.39% to the other treatments. An increase in ascorbic acid content might be due to perpetual synthesis of glucose-6-phosphate throughout the growth and development of fruit which is thought to be the precursor of vitamin-C Bhati and Yadav (2003).

3.3 Fruit Quality and Yield Parameters (Table 5)

The yield and quality characters like., number of fruits per tree, pulp weight (g), stone weight (g), pulp stone ratio and total soluble solids (brix) were recorded during the harvest stage and data were presented in Table 5. Comparing the five treatments, foliar application of Nutrient Mixture + NAA 50ppm+ Salicylic acid 50ppm (T_4) recorded the highest value in Number of Fruits/tree (250.90), Pulp weight (9.94g), least Stone weight (0.86g) Pulp : Stone ratio (11.30), TSS (13.46 Brix). The least value was observed in control treatments (T_1). The treatment T_4 (Nutrient Mixture + NAA 50ppm+ Salicylic acid 50ppm) maintained its superiority in yield of about 3.84 kg $tree^{-1}$ than the other treatments.

Table 3. Effect of nutrients and PGRs on morphological parameters in ber

Treatments	Tree height (m)	Girth (cm)	No of branches /Tree		Tree spread (m)	
			Primary	Secondary	EW	NS
T_1	3.40	58.60	2.50	8.50	3.09	2.98
T_2	3.38	55.00	2.25	7.87	2.63	2.79
T_3	3.48	64.88	2.63	9.00	3.22	3.06
T_4	3.33	47.52	2.13	7.38	2.96	2.89
T_5	3.01	53.45	2.13	7.25	2.85	2.63
Mean	**3.32**	**55.89**	**2.33**	**8.00**	**2.95**	**2.87**
SEd	0.52	2.24	0.31	0.86	0.52	0.46
CD(P=0.05)	0.98	4.49	0.62	1.64	1.06	0.89

Table 4. Effect of nutrients and PGRs on physiological parameters in ber

Treatments	Ascorbic acid (mg / 100g)	Soluble protein (mg / g)	Total chlorophyll (mg / g)	Specific Leaf Weight (mg / cm^2)	RWC (%)	CSI (%)
T_1	89.91	43.10	1.98	4.81	81.20	62.45
T_2	90.51	43.90	2.24	4.79	82.80	64.60
T_3	92.51	46.20	2.21	4.81	82.20	64.00
T_4	93.52	49.40	2.54	4.90	82.80	64.39
T_5	90.35	40.40	1.78	4.74	80.10	62.00
Mean	**91.36**	**44.60**	**2.15**	**4.81**	**81.82**	**63.49**
SEd	2.61	1.89	0.29	0.54	2.41	2.07
CD(P=0.05)	5.23	3.61	0.58	1.07	4.67	4.13

Table 5. Effect of nutrients and PGRs on fruit quality and yield parameters in ber

Treatments	No. of Fruits / tree	Pulp weight (g)	Stone weight (g)	Pulp: Stone ratio	TSS (^{0}Brix)	Yield (Kg / tree)
T_1	219.20	9.01	0.88	10.27	12.40	2.17
T_2	225.90	9.50	0.87	10.94	12.04	2.34
T_3	229.60	9.80	0.90	10.89	13.16	2.55
T_4	250.90	9.94	0.86	11.30	13.46	3.84
T_5	186.10	8.98	0.90	9.98	12.00	1.84
Mean	**222.34**	**9.45**	**0.88**	**10.68**	**12.61**	**2.55**
SEd	4.31	0.94	0.05	0.98	0.99	0.07
CD(P=0.05)	8.97	2.04	0.10	1.94	1.98	0.12

These results were in agreement with the report of Samant *et al*. (2008) who stated that, the increase in yield per plant is obviously due to the increase in volume and weight of the fruit with the combined application of GA_3 NAA and KNO_3. According to Bal *et al*. (1984) recorded that the application of NAA increased the percentage of TSS significantly in ber. The increase the values of total soluble solid, sugar and protein in ber might be because growth regulators and nutrients helps in transformations of polysaccharides and pectin into soluble compounds and translocation of sugars from leaves to the developing fruits through cellular membranes by formation of an ionizable sugar borate complex and also improvements in root biomass of plant to uptake nutrients from soil (Prakash *et al*., 2014).

According to Kale *et al.* (2000) who stated that, the possible reasons for enhancement in fruit pulp weight, pulp: stone ratio and specific gravity with GA_3, NAA and KNO_3 might be due to the fact that higher synthesis of metabolites and enhanced mobilization of food and minerals from other parts of the plants towards the developing fruits as it is a well fact that the fruit acts as extremely active metabolic sink. These results are in close proximity with the findings of Kale *et al*. (2000), Singh and Randhawa (2001) in ber. Increased fruit physical parameter in ber with exogenous foliar application of GA_3, NAA and KNO_3 has also been recorded by Arora and Singh (2014) and Samant *et al*. (2008) in ber.

The highest fruit yield recorded by foliar spray of NAA 30ppm+GA_3+KNO_3, may be attributed to better uptake and mobilization of nutrients to sink leading to better fruit development. These findings are also supported by the results of Prakash *et al.* (2014), who applied NAA 30ppm + KNO_3 (2%) in pomegranate.

4. CONCLUSION

The foliar application of Nutrient Mixture + NAA 50ppm+ Salicylic acid 50ppm (T_4) can be recommended for the enhancement of the fruit set, fruit retension and yield characters in ber. The increase in the fruit yield with the foliar application of nutrients may be attributed to increased fruit size, fruit weight and minimum fruit drop. In addition, more cell division, cell elongation and translocation of photosynthates and metabolites from leaves to the developing fruit resulted in higher fruit yield.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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