

Influence of Plant Growth Regulators and Zinc Sulphate on Yield and Physical Traits of Ber (*Ziziphus mauritiana* L.)

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Abstract

Ber is an important arid fruit crop. Mature ber fruit offers rich nutrition, with abundant calcium, vitamin C, vitamin B, and vitamin A. Fruit drop poses a significant hurdle for ber cultivation in Punjab, and its status as a minor crop has led to limited research. Zinc sulphate ($ZnSO_4$) and plant growth regulators (PGRs) effects on ber fruit drop, yield, and other physical characteristics. So, this study “The effect of PGRs and $ZnSO_4$ on fruit drop, yield and other physical traits of ber”. In the second week of December, plants were sprayed with $ZnSO_4$ (0.5%), Salicylic acid (SA) (300 ppm), Gibberellic acid (GA_3) (30 and 40 ppm), Naphthalene acetic acid (NAA) (20 and 30 ppm), sole as well as combination and one control repeated three times. This investigation revealed that all treatments led to reduced fruit drop compared to the control. Treatment T_2 NAA (40 ppm) resulted in the lowest fruit drop, whereas the control showed the highest fruit drop. Yield and yield efficiency were highest in the same treatment that is T_2 (NAA 30 ppm) whereas lowest was in control. The treatment T_{10} GA_3 + $ZnSO_4$ + SA (40 ppm + 0.5% + 300 ppm) given the best result for Chlorophyll index, fruit weight, length, diameter, volume, and firmness whereas they were all at their lowest levels in control plants.

Keywords

Ber, Physical traits, Yield, Plant growth regulators, Zinc sulphate, Salicylic acid

Introduction

The Rhamnaceae family includes the important arid fruit crop known as ber (*Ziziphus mauritiana* Lamk.). The crop was first grown in India. *Z. mauritiana* has been found to have $2n = 48$ chromosomes. Ber is also known as ‘Chinese date’ and ‘Chinese fig’ and commonly considered as poor man’s fruit. It is popularly known as “King of arid fruits”. It is one of the fruit crops that can be cultivated in a range of soils and climatic conditions and yet yield acceptable results when fed by rain [1].

This fruit crop is frequently grown outside of India in nations including China, Afghanistan, Iran, Russia, Syria, Myanmar, Australia, and the United States. India is the main producer of ber. Rajasthan, Madhya Pradesh, Uttar Pradesh, Haryana, Punjab, Gujarat, Bihar, Maharashtra, and Tamil Nadu are the principal developing states. Ber is grown throughout India but is most found in dry and semi-arid areas. Data from agricultural statistics briefly for 2020–2021 show that 51000 hectares will produce 551000 MT of fruits in 2021 [2].

The nutritional content of ber is quite high and a relatively inexpensive market price, which makes it quite popular with consumers. It has greater protein, beta-carotene, and vitamin C than apples, ber fruit is regarded as being more

nutritious [3]. Its fruit is typically consumed fresh as well as in dry form, is tasty and delicious, and contains high levels of vital minerals including iron and calcium as well as vitamins A, B, and C [4].

Heavy fruit drops are a significant barrier to this region's ber industry's growth. Most fruit drops happen in the second week of December, early in the fruit's development. Numerous factors, including hormonal instability, embryonic miscarriage, and unfavorable weather, have been implicated in the fall of immature fruits in ber [5].

By using NAA and $ZnSO_4$ alone or together, fruit drop in ber cv. Umran was significantly reduced [6]. Grapes, berries, citrus, cherries, and apples are just a few of the crops that benefit economically from the usage of gibberellin to enhance fruit quality. It is largely used for influencing physiological processes. It has an impact on floral thinning, rachis cell lengthening, and the development of grape berries. Citrus has also benefited from the impact of GA_3 ability to delay fruit senescence, and more recent research has shown that GA_3 may even encourage apple blossoming. The results of studies [7, 8]. GA_3 causes fruit set increasing while fruit loss is down in ber. With a greater ability to withstand oxidative damage, pre-harvest SA spray directly or indirectly alters the oxidative metabolism and retains the nutritional value of fruit throughout storage. It has been demonstrated in the past that SA applied prior to harvesting reduces disease and pathogen assault in cherry and pear. Many fruits are thought to require zinc for proper expansion and development. It contributes to photosynthetic activity since it is one of the elements required to produce chlorophyll. Zinc is a component of several enzymes and is also involved in plants' manufacture of indole acetic acid. The current study was carried out considering the findings to ascertain the efficiency of foliar sprays of NAA, GA_3 , SA, and $ZnSO_4$ in lowering fruit drop and improving ber quality.

Material and Methods

Experiment site

This current study has conducted at Department of Horticulture at Lovely Professional University, Punjab, India, during 2022-23 on 10 years old plant which were pruned and maintained properly.

Experiment design

In the experiment, a randomized block design was used, comprising three replications, with each replication consisting of three plants of the ber. The study involved eleven different treatments.

Experiment treatments

There were eleven treatments with NAA (20 and 30 ppm), GA_3 (30 and 40 ppm), SA (300 ppm) $ZnSO_4$ (0.5%) alone and with their combinations NAA + $ZnSO_4$ + SA (20 ppm + 0.5% + 300 ppm, 30 ppm + 0.5% + 300 ppm), GA_3 + $ZnSO_4$ + SA (30 ppm + 0.5% + 300 ppm, 40 ppm + 0.5% + 300 ppm) with one control and the control trees were sprayed with water.

Parameters of study

Fruit drop (%): The following equation was used to get the fruit drop percentage:

$$\text{Fruit drop (\%)} = \frac{\text{Total no. of fruit set} - \text{Total no. of fruit at harvest time}}{\text{Total no. of fruit set}} \times 100$$

Yield (Kg/tree): Fruit yield/tree was measured and reported as the yield per treatment in kg.

Yield efficiency: Kg/cm² was used to indicate the yield efficiency.

$$\text{Yield efficiency} = \frac{\text{Yield}}{\text{Branch cross sectional area}} \times 100$$

$$\text{Branch cross sectional area} = \frac{\text{Girth}^2}{4\pi}$$

Fruit weight (gm): The weight of some randomly selected fruit from each treatment and replication was measured on an electric balance, and the mean value was expressed in grammes.

$$\text{Average fruit weight} = \frac{\text{Total weight}}{\text{Number of fruits}}$$

Fruit length (cm): At harvest, Vernier callipers were used to measure the length of the fruits from stem end to calyx end in cm.

Fruit width (cm): The fruit was measured as it expanded horizontally at its widest point using Vernier callipers. The average value was given in cm.

Fruit volume (cc): The fruit's volume was determined and represented in cubic centimetres (cc) using a measuring cylinder and the water displacement method.

Fruit firmness: Using a penetrometer, the fruits' hardness was evaluated. The unit of firmness is lbs.

Chlorophyll index: Using a leaves chlorophyll index (SPADE) - 502 metre, the leaf chlorophyll index was calculated when the plants approached their maximum vegetative development, and the chlorophyll index unit was expressed as SPADE.

Result and Discussion

Numerous morphological traits were observed, including initial fruit set, fruit drop, fruit retention, fruit volume, fruit length, fruit breadth, fruit weight, yield, and yield efficiency. The physical properties of fruit reflect a plant's vegetative activity, and $ZnSO_4$ and other PGRs have both had a major impact on this activity.

Fruit drop, yield, and yield efficiency

Based on the findings in table 1, applying $ZnSO_4$ and plant bio-regulators in varying doses to the soil significantly reduced the fruit drop percentage. The treatment of T_2 (NAA 30 ppm) had the lowest fruit decrease, 68.18%, followed by T_1 (NAA 20 ppm) which was 69.19%. The minimum fruit drop under T_0 management, however, was 81.77% (Figure 1). Previous workers have also observed that NAA sprays reduce the fruit drops of ber of [2].

Yield was measured in kg per tree. Table 1 in the exper-

Table 1: Influence of different levels of PGRs and ZnSO₄ alone and in combination on yield and physical traits of ber.

S. No	Treatments	Fruit drop (%)	Yield (kg/tree)	Yield efficiency (kg/cm ²)	Fruit weight (gm)	Fruit length (cm)	Fruit diameter (cm)	Fruit volume (cc)	Fruit firmness (lbs)	Leaves chlorophyll index (SPADE)
1	T ₀ control (water spray)	81.77	18.55	0.4	21.2	3.34	2.31	21.72	4.8	46.02
2	T ₁ (NAA 20 ppm)	69.19	27.72	1.23	25.8	4.52	2.6	26.32	5.6	55.45
3	T ₂ (NAA 30 ppm)	68.18	29.86	1.84	27.66	4.6	2.65	28.01	5.64	56.23
4	T ₃ (GA ₃ 30 ppm)	75.89	21.19	0.62	29.35	4.75	2.67	29.7	5.69	55.61
5	T ₄ (GA ₃ 40 ppm)	79.37	22.85	0.75	30.27	4.79	2.84	30.47	5.76	55.98
6	T ₅ (SA 300 ppm)	78.33	21.37	0.59	25.3	4.62	2.53	25.62	5.51	53.47
7	T ₆ (ZnSO ₄ 0.5%)	75.55	25.03	0.77	26.57	4.68	2.75	27.3	5.66	56.32
8	T ₇ (20 ppm NAA + 0.5% ZnSO ₄ + 300 ppm SA)	71.91	27.3	0.91	26.64	4.55	2.66	26.94	5.67	56.76
9	T ₈ (30 ppm NAA + 0.5% ZnSO ₄ + 300 ppm SA)	73.77	27.12	0.64	28.26	4.62	2.71	28.67	5.71	56.94
10	T ₉ (30 ppm GA ₃ + 0.5% ZnSO ₄ + 300 ppm SA)	75.02	26.69	0.67	30.54	4.81	2.79	30.89	5.78	58.95
11	T ₁₀ (40 ppm GA ₃ + 0.5% ZnSO ₄ + 300 ppm SA)	78.31	26.47	0.97	32.65	4.87	2.82	33.08	5.82	59.78
12	SE (m)	0.86	0.37	0.01	0.40	0.07	0.03	0.46	0.07	0.83
13	SE (d)	1.22	0.53	0.02	0.57	0.11	0.05	0.66	0.09	1.18
14	C.D. at 5% level	2.58	1.12	0.04	1.20	0.23	0.11	1.39	0.20	2.48

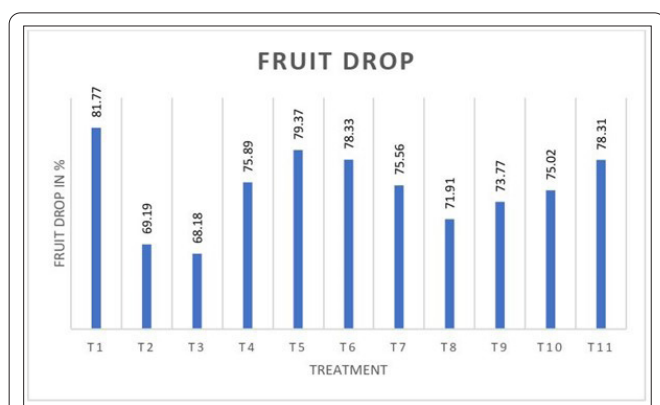


Figure 1: Graphical illustration of PGRs and ZnSO₄ on fruit drop of ber.

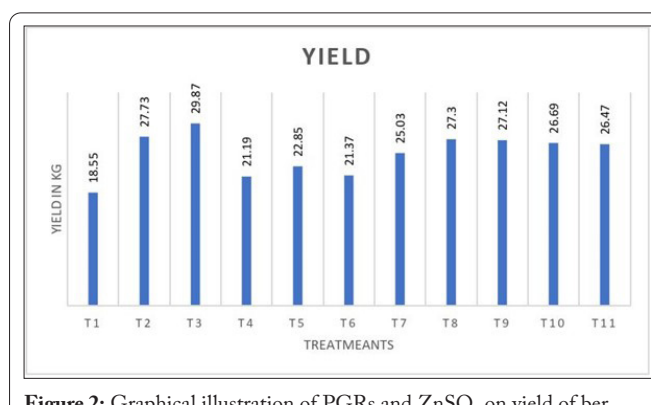


Figure 2: Graphical illustration of PGRs and ZnSO₄ on yield of ber.

iment clearly shows that T₂ (NAA 30 ppm) produced the maximum production (29.86 kg/tree), followed by T₁ (NAA 20 ppm), which recorded a fruit yield of (27.72 kg/tree). The lowest yield (18.55 kg/tree) was noted in control T₀ (Figure 2).

While conducting an experiment, it is clear from the table 1 that the highest yield efficiency 1.84 kg/cm² was seen in T₂ (NAA 30 ppm) followed by T₁ (NAA 20 ppm) which registered fruit yield efficiency of 1.23 kg/cm². The minimum yield was observed in control T₀ 0.40 kg/cm² (Figure 3). The faster and better nutrient transfer from the roots to the apical parts of the plant may be the cause of the improved fruit production after NAA treatment. The quantity of fruits per plant increased because of the increase in concentration. These outcomes are consistent with [5, 9, 10].

Fruit weight, length and width, volume, firmness

Spraying plant bio-regulators and ZnSO₄ together or separately significantly increased fruit weight table 1. The best treatment in the current investigation, T₁₀, which consisted of GA₃ + ZnSO₄ + SA (40 ppm + 0.5% + 300 ppm), produced fruits with the highest weight (32.65 gm), ahead of T₉ acid

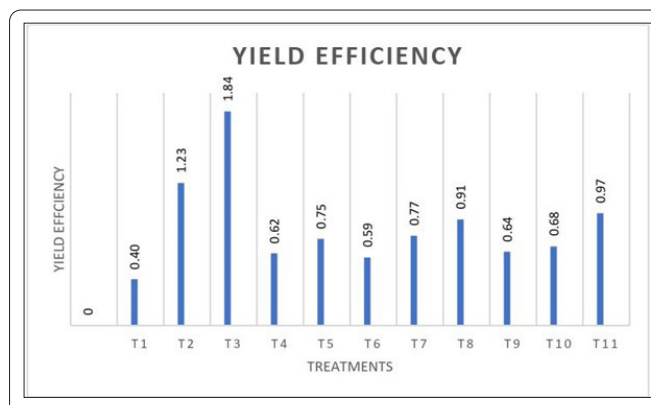


Figure 3: Graphical illustration of PGRs and ZnSO₄ on yield efficiency of ber.

(30 ppm + 0.5% + 300 ppm), which was responsible for (30.54 gm). However, under T₀ management, fruits with the smallest fruit weight (21.20 gm) were produced (Figure 4). This chemical and plant bio-regulators have enhanced the synthesis of additional photosynthates and their translocation to the fruits, which might be what caused the increased fruit weight in the current study. This result was in line with references of [2, 5].

ZnSO₄ and plant bio-regulators were shown to increase

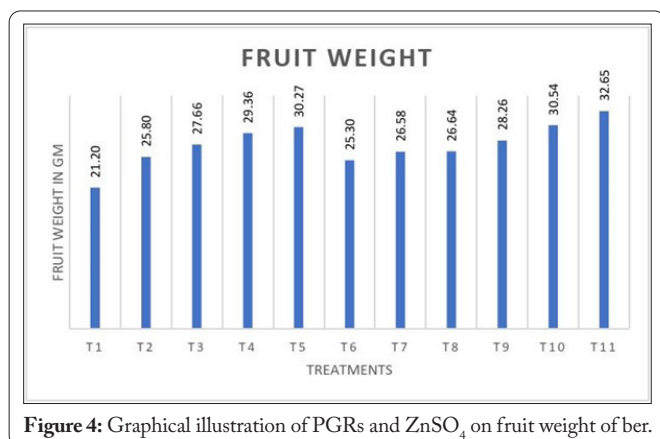


Figure 4: Graphical illustration of PGRs and ZnSO₄ on fruit weight of ber.

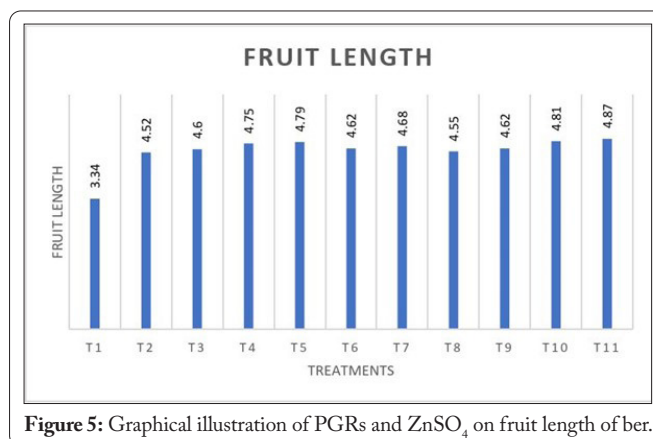


Figure 5: Graphical illustration of PGRs and ZnSO₄ on fruit length of ber.

average fruit length and width. Which seen in table 1. The combined spray T₁₀ GA₃ + ZnSO₄ + SA (40 ppm + 0.5% + 300 ppm) produced the longest fruit length (4.87 cm), followed by the treatment T₉ GA₃ + ZnSO₄ + SA (30 ppm + 0.5% + 300 ppm), which produced the longest fruit length (4.81 cm) (Figure 5). While under monitoring, the shortest fruit length (3.34 cm) was noted.

By spraying the plant bio-regulators and ZnSO₄ in combination of GA₃ + ZnSO₄ + SA (40 ppm + 0.5% + 300 ppm) produced the highest fruit width of (2.82 cm), followed by treatment T₉ GA₃ + ZnSO₄ + SA, 30 ppm + 0.5% + 300 ppm with the narrowest fruit width of (2.79 cm). While in control T₀ found the lowest fruit width of (2.31 cm) found in table 1 (Figure 6). The accelerated cell division, elongation, and development of cells caused by GA₃, SA, and ZnSO₄ in hormone metabolism may contribute to the possible increase in fruit size. These results are in accordance with references of [7, 8].

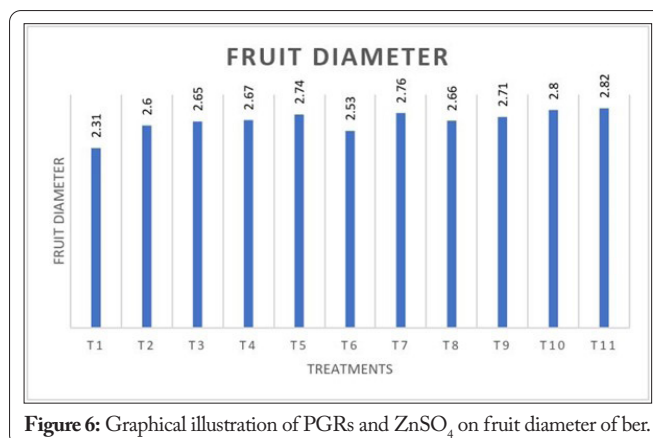


Figure 6: Graphical illustration of PGRs and ZnSO₄ on fruit diameter of ber.

As can be seen from table 1, the application of T₁₀ GA₃ + ZnSO₄ + SA (40 ppm + 0.5% + 300 ppm) produced the highest volume (33.08 cc), followed by T₉ GA₃ + ZnSO₄ + SA (30 ppm + 0.5% + 300 ppm), which was (30.89 cc), and the lowest volume (21.71 cc), (Figure 7) which was obtained in the T₀ control GA₃ modifies the cell wall's semi-permeability to mobilise more water into the fruits, which ultimately leads to the maximum fruit volume. The findings corroborate the accounts of [1, 10-12].

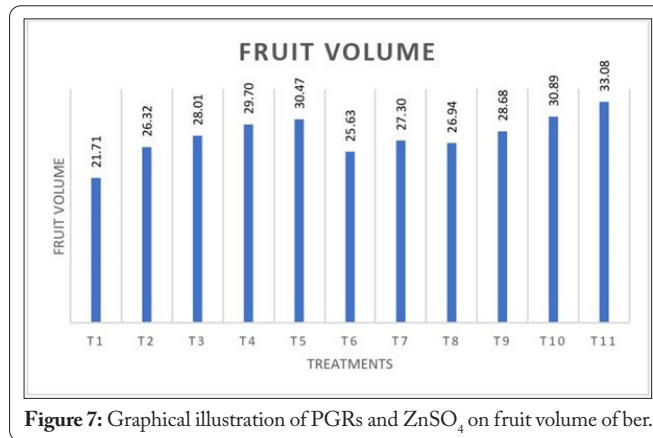


Figure 7: Graphical illustration of PGRs and ZnSO₄ on fruit volume of ber.

Following the application of GA₃ + ZnSO₄ + SA (40 ppm + 0.5% + 300 ppm), the maximum firmness (5.82 lbs) was recorded, followed by GA₃ + ZnSO₄ + SA (30 ppm + 0.5% + 300 ppm) (5.78 lbs), while T₀ control had the lowest firmness (4.80 lbs) (Figure 8). Fruit will become more solid because GA₃ causes the ripening process to take longer.

Chlorophyll content

Treatments with ZnSO₄ and plant bio-regulators were shown to increase average chlorophyll content. Table 1 shown that T₁₀ combined spray of GA₃ + ZnSO₄ + SA (40 ppm + 0.5% + 300 ppm) had the highest chlorophyll content (59.78 SPADE), followed by T₉ spray of GA₃ + ZnSO₄ + SA (30 ppm + 0.5% + 300 ppm), which had the lowest chlorophyll content (58.95 SPADE). While under T₀ control, the lowest amount of chlorophyll (46.02 SPADE) was found (Figure 9). As GA₃ helps in cell division and elongation with the result

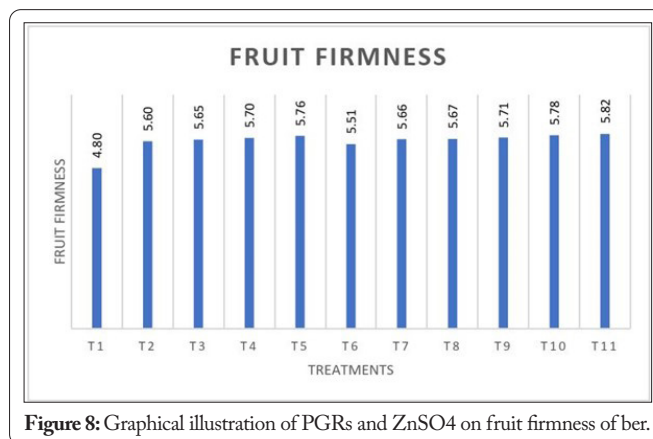


Figure 8: Graphical illustration of PGRs and ZnSO₄ on fruit firmness of ber.

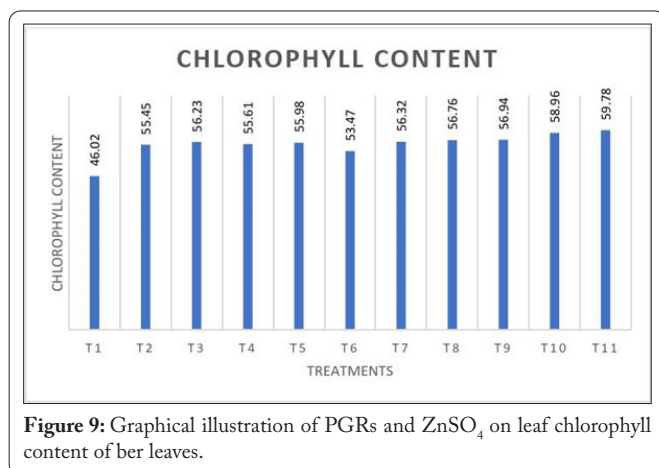


Figure 9: Graphical illustration of PGRs and ZnSO₄ on leaf chlorophyll content of ber leaves.

there is an increase in leaf area, ZnSO₄ as the co-factor for tryptophan, which is the precursor of auxin that helps in cell division, protein synthesis which helps in formation of more chlorophyll content.

Conclusion

According to the results of the experiment, NAA 30 ppm treatment T₂ at the fruit setting stage was considerably beneficial in reducing fruit drop, and it also increased yield and yield efficiency. The fruit weight, length, width, volume, firmness, and chlorophyll content of leaves were all increased by the treatment T₁₀ GA₃ + ZnSO₄ + SA (40 ppm + 0.5% + 300 ppm). This findings from the current inquiry are original and extremely helpful for researchers, orchard owners, and farmers. From this study it was concluded that spraying growth regulators like NAA, GA₃, SA, and micronutrients like ZnSO₄ is highly helpful for reducing fruit drop and increasing ber fruit quality and output for the farmers in Punjab area.

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Conflict of Interest

None.

References

1. Krishna H, Parashar A, Awasthi OP, Singh K. 2014. Tropical and Sub Tropical Fruit Crops: Crop Improvement and Varietal Wealth Part-I. Jaya Publishing House, Delhi.
2. Bal JS, Singh SN, Randhawa JS, Jawandha JS. 1984. Effect of growth regulators on fruit drop, size and quality of ber (*Zizyphus mauritiana* Lamk). *Indian J Hort* 41(3-4): 182-185.
3. Rai M, Gupta PN. 1994. Genetic Diversity in Fruits of Ber. Indian Horticulture ICAR, New Delhi.
4. Pareek S, Frageria MS, Dhaka RS. 2002. Performance of ber genotypes under arid condition. *Curr Agric* 26: 63-65.
5. Singh Z, Dhillon BS, Sandhu AS. 1991. Relationship of embryo degeneration with fruit drop and its pattern in different cultivars of ber. *Indian J Hort* 48(4): 277-281.
6. Bal JS, Singh SN, Randhawa JS, Jawandha JS. 1984. Effect of growth regulators on fruit drop, size and quality of ber (*Zizyphus mauritiana* Lamk). *Indian J Hort* 41: 182-185.
7. Banker GJ, Prasad RM. 1990. Effect of gibberellic acid and NAA on fruit set and quality of fruit in ber cv. Gola. *Prog Hort* 22(1-4): 60-62.
8. Kale VS, Kale PB, Adpawar RW. 1999. Effect of plant growth regulators on fruit yield and quality of ber cv. Umran (*Zizyphus mauritiana* Lamk.). *Annals Plant Physiol* 13(1): 69-72.
9. Yadav DN, Chaturvedi OP. 2004. Influence of GA3 and trace elements on fruit drop, growth and quality of ber (*Zizyphus mauritiana* Lamk.) cv. Banarsi Karaka. *Farm Sci J* 14(1): 27-28.
10. Pandita ML, Aroma SK, Singh K. 1978. Effect of plant regulators on the chemical composition of tomato (*Lycopersicon esculentum* Mill.) var. HS-101. *Haryana J Horticult Sci* 5: 65-72.
11. Gupta RK, Brahmachari VS. 2004. Effect of foliar application of urea, potassium nitrate and NAA on fruit retention, yield and quality of mango cv. Bombai. *Orissa J Horticult* 32: 7-9.
12. Bhowmick N, Banik BC. 2011. Influence of pre-harvest application of growth regulators and micronutrients on mango cv. Himsagar. *Indian J Hort* 68(1): 103-107.