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Review Article

Advancement and efficacy of plant growth regulators in Ber (*Ziziphus mauritiana* Lamk) - A review

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Abstract
Ber (*Ziziphus maurtiana*) is an important minor fruit crop of India. Over the years the crop is now widely domesticated and commercial orchards of Ber are now available. With wide commercialization, many physiological problems, i.e. flowers and fruit drop, embryo abortion, poor flowering and fruit setting, abnormal and small size fruits etc. were observed which cause huge loss to the growers. In order to minimize these problems, over the years many experiments and advancement have been done, and among them, usage of plant growth regulators is one of the most adopted methods and is utilized to improve flowering fruiting and yield with improved fruit quality. The current review discusses the role of different plant growth regulators and how they influence each fruit character. This information could be useful to the researchers in planning further advance research in this aspect and for the commercial growers to decide the proper treatments to mitigate the problems.

Keywords: Ber, Fruit drop, Fruit retention, GA3, IAA, NAA, Plant growth regulators

INTRODUCTION

Ber *(Ziziphus mauritiana* Lamk.) is an important arid fruit crop that belongs to the family Rhamnaceae. The crop is originated in India but one of its related species *Z. jujube* is widely cultivated in the hills of Himalayas. It is well known for its specificity on hardiness and adaptive capacity in the adverse soil and climatic condition. It is one of the fruit crops which can give good returns even under rainfed conditions and can be grown in a variety of soils and climatic conditions (Krishna *et al*. 2014). This fruit crop is commonly grown in India and also in other countries *i.e.*, China, Afghanistan, Iran, Russia, Syria, Myanmar, Australia and USA. In India, ber is cultivated in various part of the country particularly in arid and semi-arid regions comprising of 50000 ha area producing 5.13 lakh MT of fruits (Anonymous, 2018). The major growing regions are Rajasthan, Madhya Pradesh, Uttar Pradesh, Haryana, Punjab, Gujarat, Bihar, Maharashtra, Andhra Pradesh and Tamil Nadu.
Ber is a nutritious and delicious table fruit. The fruit is a rich source of ascorbic acid, vitamin B- complex and minerals and the root, stem bark, flower and seed are used in Ayurveda to treat indigestion, headache, cough etc. The leaves are good fodder for animals, especially goats and ships. The ber is a hardy plant and shows summer-deciduous nature and can grow under low-inputs which makes the plant sustain salinity and drought and becomes a popular fruit crop of arid and semi-arid regions. In spite of having vast potential, the ber fruit has limited cultivation, unlike the other fruit crops as for commercial production. It needs proper care and adequate plant management. Generally, ber growers faced various problems like low and inferior quality yield, flower and fruit drops and poor fruit setting. These problems occur due to various factors, *i.e.* improper nutrition management, inadequate cultivation practices and changes in environment variables. Plant nutrition's help in the production of raw materials that require the plant to sustained normal growth. However, the hormones help in translocation of raw materials and regulate the normal physiological process in plants. Imbalance of hormones in the plant altered normal physiological processes (Singh *et al.,* 1991; Singh and Bal 2006; Karole and Tiwari 2016) that directly affects on the reproductive response of the plants.

Application of plant growth regulators is an integral part of modern crop production practice for increasing production of quality fruits (Kumari *et al*., 2018). Plant growth regulators like NAA, IAA, IBA, 2,4-D, 2,4,5-T; GA, TIBA and Ethephon are widely used for improving the flowering, fruit set, size and quality of fruit as well as yield. Plant growth regulators play a great role in the regulation of physiological phenomena, growth, yield and quality of various fruit crops (Suman *et al.,* 2017). In ber, the PGRs are widely used for increasing fruit set, controlling fruit drop, enhancing the quality and uniform maturity (Sahoo, *et al*., 2019; Kumar *et al.,* 2017). During last two decades considerable research has been done on use of various plant growth regulator, time and amount of application (Lawes, and Woolley 2001; Petracek *et al.,* 2003; Ram *et al.,* 2005; Singh and Randhawa 2001; Singh and Bal 2008; Ghosh *et al*., 2009; Gill and Bal 2013; Arora and Singh 2014; Karole and Tiwari 2016; Majumder *et al.,* 2017); Kumar *et al*., 2018; Sheoran *et al*., 2019; Devi *et al.,* 2019). The main objective of this article was to summarize the recent advances in the use of various plant growth regulators in increasing production efficacy of ber (*Ziziphus maurtiana*) fruit.

Plant growth regulators: Plant growth regulators are the non-naturally occurring synthetic compounds (Su *et al*., 2017) requires in minute quantity to promote or inhibit the plant physiological process (Rademacher 2015). PGRs regulate the growth and development of plants by regulating the internal processes (Bons *et al*., 2015). An exogenous application of these substances modifies the growth responses. Auxins were the first group of growth regulators discovered during 19th to early 20th century (Masuda and Kamisaka 2000). Subsequently, during the middle of the 20th century, the other growth regulators i.e. abscisic acid, cytokinins, gibberellins and ethylene were also identified as synthetic plant hormones (Kende and Zeevaart, 1997; Ferguson and Lessenger 2006). Since then marked experiments has done to identify their efficacy in the regulation of plant physiological process (Sara *et al.* 2014; Su, 2017). Discovery of plant hormones and identification of their efficacy in the improvement of yield and qualitative parameters had a great impact on the fruit production (Bisht *et al*., 2018). Between various groups of growth regulators, auxin and gibberellins are widely used to control the fruit drop and to improve the quality of fruit (Suman *et al*., 2017). However, gibberellins and cytokinins had shown marked improvement in fruit characteristics, i.e. size, colour, shape and enhancement of shelf life (Lawes, and Woolley 2001). In ber, plant growth regulators are widely used to regulate various physiological phenomena viz. flowering, fruit seating, size and quality improvement (Kumar *et al*., 2017).

Effect of growth regulators on propagation: The ber is propagated sexually by seed as well vegetatively using the budding technique. The germination responses of ber seed are not adequate due to its stony endocarp present in the fruit that makes the seed impermeable to water and air and normally takes about 3 -4 weeks for germination (Sinohrot *et al.,* 1970). Among the many cultural practices, Bhambhota and Singh (1971) reported higher seed germination (76%) by sowing the kernels as compared to that by sowing the whole seed (54%). Whereas Yazdanpanah *et al.,* (2013) showed the high percentage of germination (65%) were obtained with the treatment of scarification with sandpaper and the treatment of sulphuric acid for 10 min (46%). However, among the growth regulators, gibberellic acid and benzyladenine widely used to break dormancy in ber (Murthy and Reddy, 1990; Sheoran *et al*., 2019). Hore and Sen (1994) treated the ber seed with GA_3 at 200 ppm and found maximum germination 98.76% and further extended seed longevity. They also reported the combination of gibberellic acid with nutrient (composed of 1% Microshakti and 1000 ppm K_2HPO_4) caused maximum seedling growth. However, seeds treated with gibberellic acid at 400 ppm combined with 1000 ppm chlormequat increased the polyembryony (Sheoran *et al.,* 2019). Among the various scarification treatments under nursery condition, gibberellic acid-soaked with 250 ppm for 24 hours was best It resulted into highest plant height (97.1cm), seedling diameter (4.77mm), inter-nodal length (31.3mm), number of leaves/plant (116.3), leaf area (6.29 cm^2) at 120 days after sowing or at the time of budding followed by gibberellic acid @ 500 ppm for 24 hours.

Response of growth regulators with pruning intensities: Pruning is an important operation for better flowering and fruiting in ber fruit. In India flowering period of ber varies from early June to late November in different varieties and under different agroclimatic conditions (Neeraja *et al.,* 1995, Josan *et al.,* 1980). Flowering can, however, be regulated to some extent by timing the pruning operation. In India, after the fruit harvesting, the branches of the ber tree are heavily pruned just keeping the main stem which also coincides with the summer at many places when the plant naturally shed their leaves and enter into dormancy. The flower buds in ber are borne on both mature as well as current season's growth, and the inflorescence is an axillary cyme (Pareek *et al.,* 2007). The newly emerged healthy shoots produce better flowers and fruits. The intensities of pruning affect the flowering and fruiting in ber. Application of growth regulators after pruning improves shoots health resulting in better yield and quality of fruit (Singh *et al.,* 2017). The highest number of sprouted shoots per branch and shoot length have been obtained by 75% pruning + GA_3

10ppm. Significantly maximum number of fruit set (60.14%), fruit retention (43.80%) were recorded with 50% pruning + GA_3 10 ppm followed by 50% pruning + NAA 10 ppm. Singh *et al.*(2019) experimented four different pruning intensity of previous season growth, *i.e.* no pruning, 25 % pruning, 50 % pruning, 75 % pruning and sprayed plant growth regulators *viz.,* GA_3 @ 10 ppm and NAA @10 ppm. He found significantly higher fruit weight (23.69 g) with 75% pruning intensity + NAA 10 ppm followed by 75% pruning intensity + GA□ 10 ppm and least being in control. However, maximum fruit yield (110.54 kg/plant) has been achieved by employing 50% severity of pruning with NAA 10ppm, which found significantly superior over 25% pruning intensity+ NAA 10ppm and control.

Effect of PGRs on flowering and fruit set: The flowering and fruiting process is the most important and periodic phenomenon of the plants (Kebede and Isotalo, 2016). Duration of flowering in ber is prolonged and the time of blossoming largely depends on climatic conditions (Pareek *et al.,* 2007). However, flowering and fruiting is a complex network where more than one plant hormone is involved in controlling various aspects of fruit development (Kumar *et al*., 2014). Flower formation and development are known to be influenced by hormones, especially by cytokinin, gibberellins, and auxins (Chandler, 2010). Endogenous hormones level of the plant plays a great role in flowering and fruit set. Alternation or disturbance of these substances reduces metabolic activities and affects the normal physiology of the plant. According to Bons and Kaur (2019) application of plant growth regulators improves the internal physiology of developing fruits that induce fruit seating and also reduce fruit drop. Growth regulators play a great role in flowering induction and fruit set in ber. Various researches have demonstrated the use of different growth regulators at various concentrations, also at various stages that have a significant influence on flowering and fruit set in ber. Sandhu and Thind (1988) achieved maximum fruit set with the application of NAA 5 and 10 ppm in ber cv. Umran. Application of paclobutrazol 60 ppm sprayed at fruit set stage and at active growth phase improved in fruit setting (Rattan and Bal, 2008). However, Angamuthu *et al.,* (2004) observed that the fruit set was increased with the application of IAA (indole acetic acid) 100 ppm but decreased with IAA 200 ppm in ber cv. Tikdi. Bhosale (2012) recorded maximum fruit set (26.67%) with GA_3 20 ppm on Mehrun cultivar of ber. Results of Majumder *et al.,* (2017) investigation revealed that the application of 2, 4-D @ 10 $mgL^{-1}$was better for inducing the highest fruit set 48.80 %. Kumar *et al*. (2018) studied the effect of NAA, GA_3 and 2,4,5-T on fruit set in ber and they found highest initial fruit set (162) with 2,4,5-T 20 ppm followed by 2,4,5-T 25 ppm and GA_3 25 ppm, while the lowest (159) was registered in NAA 10 ppm.

Effect of PGRs on fruit retention: In ber fruit retention varies with varieties. There is a significant relationship between fruit retention and fruit set (Adhikary *et al*., 2019). Higher fruit setting does not lead to maximum fruit retention. Sharma *et al*. (1990) recorded higher fruit seating in the cv. Sanur-2 but fruit retention was not up to the mark. Ghosh *et al*., (2009) examined the effect of NAA at 25, 50 and 100 mgL^{-1} and GA_3 at 10, 20 and 40 mgL^{-1} in ber cv. Banarasi Karka. They were thoroughly sprayed three times just after fruit set at 21 days interval. Results revealed that the NAA at 25 mgL^{-1} gave significantly highest fruit retention (75%) which resulted in the highest fruit yield of 120.5 quintals as against 64.7 quintals ha^{-1} in control. However, GA_3 did not show any significant effect on fruit retention. Whereas, Pandey (1999) revealed that the NAA 20 ppm and $GA_3$15 ppm influence the fruit retention in cv. Banarasi. Bankar and Prasad (1990) reported the effect of GA_3 and NAA at 10, 20 or 30 ppm alone or in combination at flowering and after 15 days of the first spray-on eight-year old ber cv. Gola (Gill and Bal, 2009). Results indicated that NAA at 30 ppm spray was better for fruit retention. Majumder *et al.,* (2017) obtained maximum fruit retention (42.83%) and total no. of fruits/tree (514) with the application of NAA @ 20 mgL^{-1}. However, Bhosale (2012) observed fruit retention percentage 48 per cent with GA_3 20 ppm on cv. Mehrun. Karole and Tiwari (2016) reported better fruit retention 49.28% from foliar application of NAA 60 ppm+ GA_3 30 ppm + 2.0% urea.

Effect of growth regulators on flower and fruit drop: Dropping of immature flower and fruit from the mature tree is a natural tendency of the ber crop. It is a major constraint in ber production. Normally in ber, the number of fruit set is very high, but the extent of fruit retention varies according to the cultivar type and on the level of production of endogenous plant hormones (Azam-Ali *et al.,* 2006). According to Adhikary *et al.,*(2019), there was a highly negative correlation between fruit drop and fruit set and in fruit drop and fruit retention in ber. The problem can be minimized to some extent by the use of plant growth regulators (Suman *et al.,* 2017). Generally, fruit drop occurs due to imbalance of auxin in the plants. If auxin level reduces and the concentration of abscisic acid increases that results in the formation of the abscission layer and dropping of the fruits. Exogenous applications of plant growth regulator can effectively control the fruit drop in ber (Kumar *et al.,* 2018). According to Teotia and Chauhan (1964) maximum fruit drop during early fruit development stage in ber. They recorded the highest fruit drop in cv. Banarasi pewandi as compared to Thornless and Banarasi Karaka. Similarly, Yamdagini *et al.* (1968) observed only 8-9 per cent fruit of the total fruit set was retained at maturity. Singh and Singh (1976) reported that 30 ppm 2, 4, 5-T reduced the fruit drop by 14.19 per cent over control. However, in their study NAA, 2,4-D, and methyl ester of naphthalene acetic acid could not reduce the fruit drop. Bal *et al.* (1981) proved 2, 4, 5-T 25 ppm to be the most effective treatment for reducing the fruit drop up to 11.07 per cent in ber cv. Sanaur-2. However, in ber cvs. Sanaur-2 and 5, NAA at 10 ppm and 2, 4, 5-T at 25 ppm were the most effective treatments in reducing the fruit drop (Bal *et al.,* 1982). Singh (2000) observed that the paclobutrazol at 200 ppm was effective in minimizing fruit drop and also for the fruit cracking. Singh and Randhawa (2001) Observed that GA_3 at 60 ppm accounted for the lowest fruit drop and highest fruit set while Yadav and Chaturvedi (2005) reported that the GA_3at 30 ppm showed minimized fruit drop (80.28%) and increased fruit retention (19.72%) in ber cv. Banarsi Karaka. Ram *et al.* (2005) revealed the effect of GA_3at 15 and 25 ppm on fruit drop and increasing the fruit retention in ber cv. Banarasi Karaka. Gill and Bal (2008) studied the efficacy of NAA (20, 30 and 40 ppm) by spraying them during the last week of October and again in the last week of November. Minimum fruit drop and maximum fruit retention were recorded with NAA 30 ppm. Devemani *et al.,* (2009) tested GA @ 40 ppm and sprayed twice on 20th October and another on 20th November in ber cv. Banarasi Karka and decreased fruit drop (74.25 %) was observed. Gill and Bal (2013) found the lowest fruit drop 58.52% with 30 ppm NAA. They also observed that the fruit drop mainly occurred up to in between fruit set during October till 31st January 60 %but, thereafter the fruit drop per cent decreased up to 17.66 till harvest in the Umran cultivar of ber. However, Karole and Tiwari (2016) reported minimum fruit drop 51.72 % recorded with NAA 60 ppm+ GA3 30 ppm+ 2.0 % urea. While Kumar *et al*. (2018) suggested 2, 4, 5-T 20 ppm as most effective growth regulator to control the fruit drop in ber.

Effect of growth regulators on physical fruit traits and quality: Physical fruit characters of ber like fruit size, weight, volume, specific gravity, colour, surface, palatability rating are the qualitative characters. Quality is an important parameter of the fruit that determines its market value. Market acceptability of ber fruit can be improved with the application of growth regulators. Arora and Singh (2014) found a significant increase in fruit size traits, *i.e.* fruit length, breadth, weight and volume was recorded with the application of NAA at 30 ppm. While, the palatability rating of fruits in terms of taste, colour and texture of fruit was recorded maximum with the application of GA_3 at 50 ppm. Meena *et al.,* (2013) in their experiment revealed that the application of 100 ppm NAA combination with 0.4% FeSO4 during the fruit development stage (pea size) was effective in increasing the fruit weight (18.35 & 22.95%), fruit length (23.11 & 27.95%) and fruit width (20.15 & 17.9%) receptively over the control in ber cv. Gola. According to Gill and Bal (2013), GA_3 at20 ppm, 40 ppm and NAA at 30 ppm was effective in increasing size and weight of ber fruit. Similarly, Devi *et al.*(2019) also reported better results on fruit length (4.71 cm), fruit width (2.76 cm), fruit volume (15.64 cc), fruit weight (15.68 g) and weight of fruit pulp (14.64 g) from GA_3at 20 ppm. However Karole and Tiwari (2016) achieved better fruit length(3.58 cm), fruit diameter (3.31 cm), fruit volume (24.46 ml), pulp thickness (1.21 cm), fruit weight (20.08 g) from pre-harvest foliar application of NAA 60 ppm + GA_3 30 ppm + 2.0% urea. Whereas in Case of Verma *et al.*(2016) GA_3 at 150 ppm was proved to be an effective plant growth regulator to enhance the yield and physical character of ber fruits. Gami *et al.*(2019) reported that maximum fruit length (3.17 cm), fruit diameter (3.00 cm), fruit volume (23.50 ml), fruit weight (22.87 g), stone weight (1.70 g), pulp weight (20.67 g), specific gravity (0.97) with NAA 60 ppm + KNO_3 1.5% + $ZnSO_4$ 0.5%.

Effect of growth regulators on fruit yield: The yield is a major and foremost important parameter for any crop which determines its commercial value. In general potentiality of yield in ber, depends on cultivars / varieties and also on the crop management practices. But sometimes the plant physiological process also affects the yielding capacity of the crop. The use of growth regulator to balance the physiological process is practised for many years. The effect of plant growth regulators like GA_3 and NAA on the determination of ber yield has been tested by various researches. Pandey (1999) reported that GA_3at 15 ppm followed by NAA at 20 ppm resulted in the highest fruit yield in ber cv. Banarasi Karaka. Singh (2000) reported that a higher dose of paclobutrazol (200 ppm) increased the fruit yield in Gola, Seb and Umran cultivars of ber. Singh and Randhawa (2001) recorded the highest fruit yield in Umran cultivar of ber with NAA 60 ppm. Bhati and Yadav (2003) found that fruit yield was higher with the application of NAA at 20 ppm followed by 2 per cent urea in ber cv. Gola. Kumar and Reddy (2004) obtained the highest fruit yield with a foliar spray of 3 per cent thiourea, followed by 3 per cent potassium nitrate in ber cv. Umran. Singh and Bal (2008) applied foliar sprays of various chemicals *viz*., potassium sulphate(0.5, 1.0 and 1.5%), potassium nitrate (0.5, 1.0 and 1.5%), paclobutrazol (100, 200, 300 ppm) and naphthalene acetic acid (20, 40 and 60 ppm) along with control at active growth phase of the fruit on nineteen years old trees of bercv. Umran. Maximum fruit yield (81.30 kg/tree) was recorded with an application of 60 ppm NAA. Ghosh *et al.,* (2009) applied seven treatments contained growth regulators *viz.,* NAA at 25, 50 and 100 ppm and $GA_3$10, 20 and 40 ppm and control (water spray) on 6 years old Banarasi Karaka cultivar of ber. These chemicals were thoroughly sprayed three times just after fruit set at 21 days interval. Results of two years of investigation revealed that application of NAA at 25 ppm gave significantly highest fruit yield of 120.5 quintals as against 64.7 quintals per hectare in control. No beneficial effect of GA_3 on improving fruit yield was observed. In the experiments of Wangbin *et al.,* (2008) with jujube "Dongzao" (*Z. Jujube* Mill.) the application of Mo 50 ppm + girdling + $GA_3$15 ppm and Mo 100 ppm + girdling + $GA_3$15 ppm during the flowering period increased the fruit yield per tree by 7.11 kg and 5.95 kg, respectively. Gill and Bal (2013) the highest fruit yield was recorded in trees sprayed with 30 ppm GA_3. Kumar *et al.,* (2017) studied the effect of growth regulators on the yield of ber cv. Banarasi Karaka. They found the highest concentrations of all the growth regulators, i.e. 30, 35, and 25 ppm caused a greater effect in boosting the yield over its lower and medium doses. Maximum fruit yield was recorded with 2, 4, 5-T at 25 and 20 ppm(43.58 and 45.06 kg) succeeded by NAA at 30 and 20 ppm (34.66 and 36.05 kg) and GA_3 25 ppm (28.51 and 29.60 kg) during both year of the experiment. Further, they have noticed that increasing concentrations of all the growth regulators caused a significant increment in the yields. Majumder *et al.,* (2017) obtained the maximum no of fruits/tree (514) with the application of NAA @ 20 mg L^{-1}. Application of GA3 @ 20 mg L^{-1} recorded significantly higher yield (30.67 kg/tree) in ber cv. BAU-Kul-1.

Effect of PGRs on biochemical parameters: The bio-chemical character (TSS, Acidity, TSS: acid ratio, Total sugar, and ascorbic acid) is an important criterion that have been used to evaluate the quality of fruits. Ber fruits ideally enriched with bio-chemicals composition, i.e. total soluble solids 12 to 23%, the acidity of fruit should be less than 0.13 to 1.42 per cent, total sugars 1.4 to 9.7 per cent, and ascorbic acid content in different ber cultivars ranged from 39-166 mg/100 g of pulp (Ghosh and Mathew (2002); Obeed, *et al*., (2008). The biochemical properties vary from the variety. These properties are also influenced by the status of nutrient and level of hormones in the plant. Application of growth regulators improved physicochemical attributes of ber (Majumder *et al.,* 2017). If plant imbalances or deficit important nutrient or hormones, that directly affects on biochemical properties of fruits. Application of plant growth regulators at the right time with the right concentration shown significant benefit in biochemical properties of ber fruit. Sandhu *et al.* (1990) reported that NAA when sprayed during lag phase, increased total sugars in ber cv. Umran. However, Bal *et al.,* (1993) applied ethephon at 0, 100, 200, 300, 400 or 500 ppm to 13-year-old Umran ber trees as a foliar spray when fruits were just changing colour and found that treatment with 400 or 500 ppm ethephon produced fruits with the highest sugar contents. Kale (2000) found better results in improving fruit quality with 20 ppm GA_3 applied at full bloom and 15 days after flowering in ber. Singh (2000) found the best result with a spray of 150 ppm paclobutrazol in increasing the TSS contents in Gola, Seb and Umran cultivars of ber. Yadav and Chaturvedi (2005) found that the GA_3 30 ppm increased total soluble solids content 18.93° Brix in Banarsi Karaka cultivar of ber. Highest total soluble solids content (10.83%) was recorded with 100 ppm paclobutrazol treatment sprayed at the active growth phase of the fruit on nineteen years old trees of Indian jujube cv. Umran (Singh and Bal, 2008). Whereas, Gill and Bal (2008) found maximum vitamin C content with the application of NAA at 30 ppm, applied at last week of October and again in the last week of November. Whereas, Singh and Bal (2008) achieved higher vitamin C (98.77 mg/100 g pulp) with the spray of 200 ppm paclobutrazol in Umran cultivar of ber. Karole and Tiwari (2016) found that pre-harvest foliar application of NAA 60 ppm + GA_3 30 ppm + 2.0% urea increases the total soluble solids (19.68° Brix), reducing sugar (5.42%), non reducing sugar (4.57%) and chlorophyll content (71.0 S pad Value) in cultivar Gola. Gami *et al.,* (2019) found maximum TSS (15.93° Brix), minimum acidity (0.26 %), ascorbic acid (49.47 mg/100g of pulp), reducing sugar (6.11 %), total sugars (11.87 %), non-reducing sugar (5.76 %) from NAA 60 ppm + KNO_3 1.5% + $ZnSO_4$ 0.5%.

Conclusion

The present study concluded that being as a hardy crop, ber (*Z. maurtiana* Lamk.) requires minimal management, and it can give handsome economic returns if managed properly. Due to biotic and abiotic stresses and improper management practices, the declining trend has been noticed in productivity and quality. The major problems of growers were faced, i.e. heavy fruit drop, less fruiting, and poor-quality fruits. The results reported from various researchers on the application of plant growth regulators have shown marked improvement in the management of elucidated problems. In recent time the use of plant growth regulators is given prime importance in horticulture crop production system. The remarkable experiment has been done on the use of PGRs for improving fruit set, decreasing fruit drop, improving physical characteristics and biochemical composition. However, there is a need to have more advancements in the use of PGRs in canopy management, fruit quality improvement and increasing shelf life of ber fruit.

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