Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
www.phytojournal.com
JPP 2020; 9(4): 1968-1972
Received: 19-05-2020
Accepted: 21-06-2020

Raj Bala Choudhary
Department of Horticulture, Sri Karan Narendra Agriculture University, Jobner, Jaipur, Rajasthan, India

LN Bairwa
Department of Horticulture, Sri Karan Narendra Agriculture University, Jobner, Jaipur, Rajasthan, India

OP Garhwal
Department of Horticulture, Sri Karan Narendra Agriculture University, Jobner, Jaipur, Rajasthan, India

Priya Negi
Department of Horticulture, Sri Karan Narendra Agriculture University, Jobner, Jaipur, Rajasthan, India

Corresponding Author:
Raj Bala Choudhary
Department of Horticulture, Sri Karan Narendra Agriculture University, Jobner, Jaipur, Rajasthan, India

Effect of plant growth regulators and nutrients on yield attributing characters and yield of ber (*Zizyphus mauritiana* Lamk.) cv. Gola

Raj Bala Choudhary, LN Bairwa, OP Garhwal and Priya Negi

Abstract
The experiment was conducted at S.K.N. College of Agriculture Jobner (Rajasthan) on four years old uniform trees of ber cv. Gola during 2018-19 and 2019-20 to study the effect of plant growth regulators and nutrients. Results revealed that application of NAA @ 50 ppm significantly influenced the fruiting attributes *viz.*, fruit set, fruit drop and fruit retention and physico-chemical attributes of ber plant whereas maximum physical attributes *viz.*, fruit diameter, fruit weight, pulp weight, pulp: stone ratio, fruit yield and leaf area were recorded with application of GA_3 @ 50 ppm. Similarly, among nutrients application of K_2SO_4 @ 2 per cent significantly increased the yield attributing characters and fruit yield of ber. Apportioning the combined spray of GA_3 @ 25 ppm applied with K_2SO_4 @ 2 per cent is worth recommendable for farmers of semi-arid region of Rajasthan as it fetched comparable fruit yield, net returns and benefit:cost ratio from ber crop.

Keywords: Ber, PGRs, nutrients, yield attributes and fruit yield etc.

Introduction
Ber or Indian jujube (*Zizyphus mauritiana* Lamk.) belongs to family Rhamnaceae, is one of the ancient and common fruit of India and China, being cultivated over 4000 years (Mehra, 1967) [19]. It has wide adaptability because of which it is cultivated practically all over India especially in arid and semi-arid regions for its fresh fruits. Therefore, it is also called as 'the apple of arid zone fruits'. The important provinces for ber cultivation in India are Madhya Pradesh, Uttar Pradesh, Andhra Pradesh, Bihar, Assam, Punjab, Haryana, Gujarat and Rajasthan.
Pareek (1983) [20] also reported that cultivation of ber requires the least input, care and management. Growth, yield and quality of any plant are the result of genetic expression but these can be regulated to a some extent by environment and other factors like proper nutrition and effective care and management throughout life span. Fruit trees are considered high value crops and even small modifications in production efficiency, product quality or enhanced appeal have the potential to significantly increase the product value (Sesbian *et al*., 2019) [22]. The beneficial effect of foliar application of PGRs and nutrients is based on the fact that the nutrients reach directly to leaves, buds, petioles and flowers etc which are the sites of metabolism.
Keeping these facts in view, a field experiment of foliar application of plant growth regulators and nutrients carried out to improve the fruiting attributes, physical attributes and fruit yield of 'Gola' ber.

Materials and Methods
The field experiment was conducted at the Horticulture Farm, S.K.N. College of Agriculture, Jobner (Rajasthan) during 2018-19 and 2019-20 on four years old uniform 'Gola, ber trees planted at 6m x 6m in loamy sand soils. The experiment comparising of 25 treatment combinations with five levels of PGRs (control, NAA @ 25 ppm, NAA @ 50 ppm, GA_3 @ 25 ppm and GA_3 @ 50 ppm) and five levels of nutrients (control, KNO_3 @ 1 %, KNO_3 @ 2 %, K_2SO_4 @ 1 % and K_2SO_4 @ 2 %) in Factorial Randomized Block Design with three replications.
Different cultural operations like preparation of basins, weeding & hoeing, manuring and fertilization, irrigation and plant protection measures etc were carried out during both year of experimentation accordance with recommended package of practices. The application of PGRs (NAA and GA_3) and nutrients (KNO_3 and K_2SO_4) as foliar spray on each selected plants during both the years of experimentation in 2018-19 and 2019-20.

The each treatments were applied two times in a year *i.e.* first spray in the last week of August (at commencement of flowering) and second spray at 40 days after first spray in the second week of October until total saturation of foliage of experimental plants. The control trees were sprayed with water. However, response of plants to these may vary depending upon the soil and agro-climatic conditions.

The treatments effect were evaluated in terms of fruit set, fruit drop, fruit retention, specific gravity of fruit, fruit diameter, fruit weight, pulp weight, stone weight, pulp : stone ratio, fruit yield/tree, fruit yield/hectare, net returns and benefit : cost ratio during both the year of experimentation in 2018-19 and 2019-20. The observations were recorded on tagged shoots from all directions of experimental plants of each replication.

The fruit set was estimated by counting the number of fruits at pea size stage and fruit drop and fruit retention at the time of harvesting by counting the number of fruits retained on tagged branches. Fruits were harvested at optimum maturity. Ten fruits per tree were taken at random to determine physical attributes. Specific gravity of fruit calculated through water displacement method. Fruit diameter was measured with the help of vernier calipers. Fruit weight, pulp weight and stone weight were measured with electronic balance and expressed in gram. Pulp: stone ratio was calculated by dividing the pulp weight with stone weight. Ripened fruits were harvested periodically and then weight was recorded with the help of single pan balance to calculate fruit yield per plant. Then the total fruit yield was calculated by summing up the total of fruits at different pickings obtained during harvesting period from each experimental plant.

Statistical analysis

To test the significance of variation in the data obtained from various fruiting attributes, physical attributes, Physico-chemical attributes of plant, fruit yield and economics the technique of statistical analysis of variance was suggested by Fisher (1950) [9] for Factorial Randomized Block Design. Significance of difference in the treatment effect was tested through 'F' tests at 5 per cent level of significance and CD (critical difference) was calculated, wherever the results were significant.

Results and Discussion

Fruiting attributes

A perusal of data regarding to fruit set, fruit drop and fruit retention presented in table-1 significantly affected by foliar application of various PGRs and nutrients.

The highest increase in fruit set (42.34 %), fruit retention (53.34 %) and decrease in fruit drop (46.66 %) were observed under treatment P_2 (NAA @ 50 ppm) which was significantly superior than rest of the treatments except P_1 (NAA @ 25 ppm). The increase in fruit set and fruit retention with application of NAA might be attributed to reduce fruit drop by correcting the deficiency of endogenous auxin and on-going physiological and biochemical process of inhibition of abscission layer possibly through the inhibition of enzymatic activity such as pectinase, cellulose and polygalactauronase (Tomaszewska and Tomaszewska, 1970) [25]. The results obtained in present investigation are also in line with finding of Godara *et al.* (2001) [12], Bhati and yadav (2003) [1], Yadav *et al.* (2004) [27], Gill and Bal (2009) [11] and Majumder *et al*. (2017) [15] in ber.

Table 1: Effect of plant growth regulators and nutrients on fruiting attributes of ber

Treatments	Fruit set (%)	Fruit drop (%)	Fruit retention (%)
PGRs			
P_0 (control)	25.36	67.44	32.56
P_1 (NAA @ 25 ppm)	41.69	47.85	52.15
P_2 (NAA @ 50 ppm)	42.34	46.66	53.34
P_3 (GA_3 @ 25 ppm)	37.97	51.96	48.04
P_4(GA_3 @ 50 ppm)	39.55	51.06	48.94
SEm ±	0.59	0.99	0.86
CD (P = 0.05)	1.64	2.76	2.41
Nutrients			
K_0 (control)	26.13	66.00	34.00
K_1 (KNO_3 @ 1%)	38.21	52.15	47.85
K_2 (KNO_3 @ 2%)	41.12	48.36	51.64
K_3 (K_2SO_4 @ 1%)	39.58	51.17	48.83
K_4 (K_2SO_4 @ 2%)	41.85	47.19	52.81
SEm ±	0.59	0.99	0.86
CD (P = 0.05)	1.64	2.76	2.41

A further reference to data showed in table-1 application of treatment K_4 (K_2SO_4 @ 2 %) recorded maximum fruit set (41.85 %) and fruit retention (52.81 %), whereas, minimum fruit drop (47.19 %). Treatment K_4 found significantly highest as compared to control, K_1 and K_2. The reason for reduction in fruit drop and increment in fruit retention might be due to application of potassium sulphate which might be increase the endogenous level of potassium and sulphur. The synthesis of macro and micro nutrients and their translocation to growing fruit bud (Sharma *et al*., 2011) [23]. The above results are in accordance with the finding of Singh and Bal (2006) [24] in 'Umran' ber.

Physical attributes

It is evident from data (Table-2) that application of plant growth regulators and nutrients had significant effect on physical attributes.

Table 2: Effect of plant growth regulators and nutrients on physical attributes of ber

Treatments	Specific gravity of fruit	Average fruit diameter (cm)	Average fruit weight (g)	Pulp weight (g)	Stone weight (g)	Pulp:stone ratio
PGRs						
P_0 (control)	1.040	2.56	13.44	12.327	1.113	11.09
P_1 (NAA @ 25 ppm)	1.023	3.68	18.51	17.407	1.098	15.88
P_2 (NAA @ 50 ppm)	1.016	3.75	19.03	17.936	1.094	16.42
P_3 (GA_3 @ 25 ppm)	1.005	4.19	20.40	19.323	1.077	17.97
P_4(GA_3 @ 50 ppm)	1.002	4.27	20.80	19.742	1.060	18.66
SEm ±	0.024	0.04	0.20	0.219	0.024	0.25
CD (P = 0.05)	NS	0.13	0.57	0.612	NS	0.71
Nutrients						
K_0 (control)	1.040	2.35	13.60	12.496	1.106	11.32
K_1 (KNO_3 @ 1%)	1.024	3.83	18.84	17.739	1.098	16.19
K_2 (KNO_3 @ 2%)	1.004	4.18	19.94	18.859	1.077	17.55
K_3 (K_2SO_4 @ 1%)	1.015	3.85	19.32	18.234	1.088	16.80
K_4 (K_2SO_4 @ 2%)	1.003	4.23	20.48	19.409	1.071	18.17
SEm ±	0.024	0.04	0.20	0.219	0.024	0.25
CD (P = 0.05)	NS	0.13	0.57	0.612	NS	0.71

The maximum average fruit diameter (4.27 cm), average fruit weight (20.80 g), pulp weight (19.742 g) and pulp : stone ratio (18.66) were recorded with application of treatment P_4 (GA_3 @ 50 ppm) which was found statistically at par with treatment P_3 (GA_3 @ 25 ppm). These finding clearly indicated that plant growth regulators (GA_3) played a significant role for enhancing physical attributes of fruit might be due to the better utilization of the sources in plants. The direct effect of gibberellic acid on stimulating cell division and cell enlargement, ultimately increase fruit size reported by Davies (1995) [5]. This might have lead to more length and diameter of fruit and also larger weight of individual fruit. These results were enclosed close conformity with the finding of Maslkar and Wahval (1991) [18], Kale *et al*. (2000) [14] and Vishwakarma *et al*. (2015) [26] in ber.

Among nutrients, application of K_2SO_4 @ 2 per cent (K_4) registered significantly highest average fruit diameter (4.23 cm), average fruit weight (20.48 g), pulp weight (19.409 g) and pulp: stone ratio (18.17) as compared to control and other treatments except treatment K_2 (KNO_3 @ 2 %) which remained statistically at par. The increased fruit size might be due to the role of potassium in cell wall construction (Boman and Hebb, 1998) [3]. Increase in fruit weight with potassium application might be due to the enhanced photosynthesis which leads to supply of more carbohydrates revealed by Harold and George (1966) [13]. Similar findings were also observed by Pathak *et al*. (2008) [21] and Yadav *et al.* (2014) [28].

The data presented in table-2 further indicates that foliar application of plant growth regulators and nutrients brought about non-perceptible variation in specific gravity and stone weight of fruit.

Fruit yield

The data pertaining to the effect of plant growth regulators and nutrients *viz.*, fruit yield (kg/plant) and fruit yield (q/ha) of ber are summarized in table-3. Yield is a complex character which depends on yield contributing characters.

Application of PGRs significantly increase the fruit yield per plant as well as per hectare. Fruit yield (21.01 kg/plant and 58.42 q/ha) was significantly highest under treatment P_4 (GA_3 @ 50 ppm) as compared to control, P_1 and P_2. However, this treatment was found statistically at par with treatment P_3 (GA_3 @ 25 ppm).

There was a positive and significant correlation among the diameter of fruit with the weight of fruit which ultimately increase fruit yield. The increase yield under this growth regulators treatment (GA_3) was associated with increased fruit size and fruit weight. These findings also revealed by Gill and Bal (2013) [10], Bhosale and Singh (2017) [2], Majumder *et al*. (2017) [16] and Devi *et al.* (2019) [6] in ber.

It is amply clear from the data (Table-4) that application of various nutrients had favourable and significant effect on fruit yield. The maximum fruit yield per plant (20.11 kg) and per hectare (55.89 q) were observed under treatment K_4 (K_2SO_4 @ 2 %) followed by application of KNO_3 at the rate of 2 per cent (K_2).

It is possibly due to their directly or indirectly involvement in growth and development of fruits. These activities enhance fruit size and fruit weight, thus increased the total yield of the fruits. Number of earlier reports is available to confirm the present finding that foliar application of potassium sulphate is helpful in increasing yield in fruit crops. These results are closely similar with the findings of El-Sherif *et al*. (2000) [8], Dutta (2004) [7], Manivannan *et al*. (2015) [17] and Dalal *et al*. (2017) [4].

Table 3: Effect of plant growth regulators and nutrients on fruit yield and economics of ber

Treatments	Fruit yeld (kg/plant)	Fruit yield (q/ha)	Net returns (Rs/ha)	Benefit: Cost ratio
PGRs				
P_0 (control)	13.83	38.43	105497	2.18
P_1 (NAA @ 25 ppm)	17.05	47.39	141015	2.89
P_2 (NAA @ 50 ppm)	17.63	49.01	147190	3.00
P_3 (GA_3 @ 25 ppm)	20.83	57.91	177510	3.26
P_4(GA_3 @ 50 ppm)	21.01	58.42	173629	2.88
SEm ±	0.19	0.52	1895	0.03
CD (P = 0.05)	0.52	1.45	5303	0.08
Nutrients				
K_0 (control)	13.11	36.44	99719	2.16

K_1 (KNO_3 @ 1%)	18.53	51.52	154070	2.96
K_2 (KNO_3 @ 2%)	19.74	54.88	161498	2.77
K_3 (K_2SO_4 @ 1%)	18.86	52.42	159777	3.18
K_4 (K_2SO_4 @ 2%)	20.11	55.89	169776	3.14
SEm ±	0.19	0.52	1895	0.03
CD (P = 0.05)	0.52	1.45	5303	0.08

Economics

Data presented in table-3 further explain that net returns and B:C ratio significantly influenced with the application of various plant growth regulators and nutrients.

The application of GA_3 @ 25 ppm (P_3) fetched highest and significantly more net returns (177510 Rs/ha) and B:C ratio (3.26) over rest of the treatments but statistically at par with treatment P_4 (GA_3 @ 50 ppm).

Similarly, maximum and significantly higher net returns (169776 Rs/ha) was recorded in treatment K_4 (K_2SO_4 @ 2 %) over rest of the treatments. Whereas, application of K_2SO_4 @ 1 % (K_3) exhibited maximum B:C ratio (3.18) which was statistically at par with treatment K_4 (K_2SO_4 @ 2 %).

Conclusion

On the basis of the results emerged out from the experiment conducted, it can be concluded that combined spray of GA_3 @ 25 ppm applied with K_2SO_4 @ 2 per cent is worth recommendable for farmers of semi-arid region of Rajasthan to get maximum fruit yield, ultimately net returns and B:C ratio in ber.

References

1. Bhati BS, Yadav PK. Effect of foliar application of urea and NAA on quality of ber cv. Gola. Haryana Journal of Horticultural Science. 2003; 32(1-2):32-33.
2. Bhosale GH, Singh V. Effect of plant growth regulators on growth, yield and quality of ber (*Zizyphus mauritiana* Lamk.) cv. Mehrun under Saurashtra region, 2017. *krishikosh.egranth.ac.in/handle/1/5810023628.*
3. Boman BJ, Hebb JW. Post bloom and summer foliar K effects on grapefruit size. Proceedings of the Florida State Horticultural Society. 1998; 111:128-135.
4. Dalal RPS, Vijay, Beniwal BS. Influence of foliar sprays of different potassium fertilizers on quality and leaf mineral composition of sweet orange (*Citrus sinensis*) cv. Jaffa. International Journal Pure & Applied Biosciences. 2017; 5(5):587-594.
5. Davies PJ. (Ed.), Plant Hormones: Physiology, Biochemistry and Molecular Biology, IInd ed. Kluwer Academic Publishers, Netherland, 1995.
6. Devi Poornima, Gautam RKS, Singh J, Maurya SK, Chaudhary A. Effect of foliar application of NAA, GA_3 and Zinc Sulphate on fruit drop, growth and yield of ber (*Zizyphus mauritiana* Lamk.) cv. Banarasi Karaka. International Journal of Current Microbiology & Applied Sciences. 2019; 8(1):1679-1683.
7. Dutta P. Foliar potassium spray in improving the quality of 'Sardar' guava (*Psidium guajava* L.). Orissa Journal of Horticulture. 2004; 32(1):103-104.
8. El-Sherif AA, Saeed WT, Nouman VF. Effect of foliar application of potassium and zinc on behaviour of Montakhab El-Kanater guava trees. Bulletin of Faculty of Agriculture, University of Cairo. 2000; 51(1):73-84.
9. Fisher RA. Statistical Methods for Research Worker. Oliver and Boyd. Edinburgh, 1950.
10. Gill KS, Bal JS. Impact of application of growth regulators on Indian jujube. Acta Horticulture. 2013; 993:119-124.
11. Gill PPS, Bal JS. Effect of growth regulator and nutrients spray on control of fruit drop, fruit size and quality of ber under sub-montane zone of Punjab. Journal of Horticultural Science. 2009; 4(2):161-163.
12. Godara NR, Singh R, Dahiya SS. Response of foliar application of growth regulators and nutrients in ber (*Z. mauritiana* Lamk.) cv. Umran. Haryana Journal of Horticultural Science. 2001; 30(3/4):161-163.
13. Harold JE, George JS. Role of mineral elements with emphasis on the univalent cations. Annals of Plant Physiology. 1996; 11:47-76.
14. Kale VS, Dod VN, Adpawar RN, Bharad SG. Effect of PGR on fruit characters and quality of ber. Crop Research (Hisar). 2000; 20(2):327-333.
15. Majumder I, Sau S, Ghosh B, Kundu S, Roy D, Sarkar S. Response of growth regulators and micronutrients on yield and physico-chemical quality of Ber (*Zizyphus mauritiana* Lamk) cv. BAU Kul-1. Journal of Applied and Natural Science. 2017; 9(4):2404-2409.
16. Majumder I, Sau S, Ghosh B, Kundu S, Roy D, Sarkar S. Response of growth regulators and micronutrients on yield and physico-chemical quality of Ber (*Zizyphus mauritiana* Lamk) cv. BAU Kul-1. Journal of Applied and Natural Science. 2017; 9(4):2404-2409.
17. Manivannan MI, Irulandi S, Thingalmaniyan KS. Studies on the effect of pre-harvest application of plant growth regulators and chemicals on yield and quality of guava (*Psidium guajava* L.) cv. L-49. International Journal of Agricultural Sciences. 2015; 11(1):138-140.
18. Masalkar SD, Wavhal KN. Effect of various growth regulators on physico-chemical properties of ber cv. Umran. Maharashtra Journal of Horticulture. 1991; 5(2):37-40.
19. Mehra KL. History of the jujube in acient. Indian Journal of Horticulture. 1967; 24:37-47.
20. Pareek OP. The jujube, Indian Council of Agricultural Research, New Delhi, 1983, 71.
21. Pathak AP, Pal RKK, Singh T. Effect of foliar application of nutrients on yield and quality of guava (*Psidium guajava* L.) fruits cv. Sardar. Progressive Research. 2008; 3(1):89-90.
22. Sebastian K, Arya MS, Reshma UR, Anaswara SJ, Thampi Syama SS. Impact of plant growth regulators on fruit production. International Journal of Current Microbiology and Applied Sciences. 2019; 8(02):800-814.
23. Sharma J, Sharma SK, Panwar RD, Gupta RS. Fruit retention, yield and leaf nutrient content of ber as influence by foliar application of nutrient and growth regulators. Environment and Ecology. 2011; 29:627-631.
24. Singh C, Bal JS. Effect of nutrients and growth regulators on fruit drop, size and yield of ber (*Zizyphus mauritiana* Lamk.) International Journal of agriculture Sciences. 2006; 2(2):358-360.

25. Tomaszewska E, Tomaszewska M. Endogenous growth regulators in fruit and leaf abscission. *Zeszyty Nauk Biology*, Copernicus University. 1970; 23:45-53.
26. Vishwakarma SK, Ram RB, Kumar A. Effect of pre-harvest application of GA_3 and Ca $(NO_3)_2$ on fruit quality of Ber (*Zizyphus mauritiana* Lamk.) cv. Banarasi Karaka. Research in Environment and Life Sciences. 2015; 8(1):31-32.
27. Yadav B, Rana GS, Bhatia SK. Response of naphthalene acetic acid, urea and zinc sulphate on fruit drop in ber (*Zizyphus mauritiana* Lamk.). Haryana Journal of Horticultural Science. 2004; 33(3/4):181-182.
28. Yadav D, Singh SP, Singh S. Effect of foliar application of potassium compounds on yield and quality of ber (*Zizyphus mauritiana* Lamk.) cv. Banarasi Karaka. International Journal of Research in Applied, Natural and Social Sciences. 2014; 2(2):89-92.