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A Study on Foliar Feeding of GA_3 and NAA on Fruit Drop, Retention, Yield and Quality of Ber Fruit (*Ziziphus mauritiana* Lamk.) cv. "Banarasi Karaka"

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ABSTRACT: A study on foliar feeding of GA_3 and NAA on fruit drop, retention, yield and quality of ber fruit (*Ziziphus mauritiana* Lamk.) cv. "Banarasi Karaka". The investigation was conducted at Horticulture Garden CSA University of Agriculture and Technology, Kanpur during the year 2020-21 on ber fruit. Results revealed that the sprays of 30 ppm significantly maximized (161.75) fruit set against control N_0 (159.50). 30 ppm GA_3 significantly maximized (163.50) fruit set against control G_0 (157.25). The minimum 90.09 % fruit drop was shown under 40 ppm NAA over control N_0 (91.95 %) 30 ppm GA_3 significantly minimized 89.75% fruit drop against control G_0 (92.97%). Interactive treatment N_2G_2 significantly produced lesser (89.19 %) fruit drop against control N_0G_0 (95.02 %). NAA 40 ppm revealed maximum of 15.97 % fruit retention over control N_0 (12.87 %). GA_3 30 ppm maximized 16.76% fruit retention over control G_0 (10.93%) interactive treatment N_2G_2 significantly maximized (17.84 %) fruit retention over control N_0G_0 (7.77 %). NAA 30 ppm significantly maximized (34.16 kg/tree) fruit yield over control N_0 (27.60 kg/tree). GA_3 40 ppm treatment revealed significantly maximum of 37.63 kg fruit yield per tree against control (26.31 kg/tree). Interactive treatment of N_2G_3 revealed the maximum of 42.48 kg/tree fruit yield over control N_0G_0 (25.54 kg). NAA 40 ppm revealed significantly maximum of 14.18°Brix TSS over control N_0 (12.82°Brix). GA_3 20 ppm induced significantly maximum (14.03°Brix) TSS content over control (13.13°Brix). Interactive treatment N_3G_1 recorded significantly maximum (15.14°Brix) over control N_0G_0 (12.82°Brix). NAA 20 ppm produced significantly maximum ascorbic acid (107.78 mg/100g pulp) against control N_0G_0 (86.26 mg/100 pulp). GA_3 40 ppm significantly enhanced ascorbic acid (107.50 mg/100 pulp) over control G_0 (75.71 mg/100 pulp). Interactive treatment N_1G_3 significantly increased ascorbic acid (128.56 mg/100g pulp) over control N_0G_0 (75.29 mg/100g pulp). Significantly maximum (9.56 %) total sugar was observed under NAA 30 ppm against control N_0 (8.83%). GA_3 20 ppm recorded significantly maximum of (9.93%) total sugar against control G_0 (8.83%). Interactive treatment of N_2G_1 significantly maximized 10.59% total sugar content against control N_0G_0 (8.76%).

Keywords: Ber, NAA, GA_3, yield, TSS, Ascorbic acid and Total sugar.

INTRODUCTION

Ber (*Ziziphus mauritiana* Lamk.) is a tropical and subtropical fruit native to the northern hemisphere (Lyrene, 1979). It is also known as 'Chinese date' or 'Chinese fig' and commonly consider as poor man's fruit. Ber is wide popular use to high economic returns, low cost of cultivation and wide adoptability and ability to stand drought. It is popularly known as 'king of arid fruit'. The fruit is dried and is used as a dessert fruit. It can also be preserved as a candid fruit. It is an important indigenous fruit of India and belongs to the family Rhamnaceae having in about 50 species in which 18-20 are native of India. It is found growing wild as well as in cultivated forms throughout the warmer regions up to an altitude of 1500 meters above mean sea level. Ber fruits are highly nutritious, rich in ascorbic acid and contain fairly good amount of vitamin A and B, minerals like calcium, phosphorus and iron (Yamadagni, 1985; Shoba and Bharathi 2007). Caffeic acid, *p* hydroxybenzoic acid, ferulic acid and *p*-coumaric acid are predominant phenolics reported in ber (Tanmay *et al.*, 2011; Ayaz *et al.*, 2012) which account for its significant antioxidant activity, reducing power activity and scavenging of free radical activity (Krishna and Parashar, 2012). Indian Ber contain good source of ascorbic acid and total phenolics ranging from 19.54 to 99.49 mg/100g and 172 to 328.6 mg GAE/100g respectively (Koley *et al.*, 2011) and average antioxidant activities were 1.6–6.33 and 1.22 – 5.49 µ mol TE/g as the CUPRAC and FRAP assays, respectively (Krishna and Parashar, 2012). Punjab, Uttar Pradesh, Haryana, Rajasthan, Madhya Pradesh, Bihar, Maharashtra, Assam, Andhra Pradesh, Tamil Nadu and West Bengal are the growing states of India. There are various aspects which are used during the last 50 years considerably, research work has been done in the country on variety propagation, irrigation, training and pruning etc. The experiment was planned to getting improved quality fruit. It would be there for worthwhile

to improve the yield and quality of fruit crop by foliar application of plant growth regulators. Among plant growth regulators GA_3 and NAA are prominent due to these abilities are taken for improving the quality yield of different fruit. It also improves fruit retention and reduced fruit drop in fruits as well as in ber. Thus, in present investigation this hormone being very useful for improving quality yield of ber fruit and obtaining good returns to the orchardist and farmers.

MATERIALS AND METHODS

The experiment was conducted at Garden, Department of Fruit Science, Collage of Horticulture, CSA University of Agriculture and Technology, Kanpur. The title of experiment was "Effect of foliar application of GA_3 and NAA on fruit drop, retention, yield and quality of ber (*Ziziphus mauritiana* Lamk.) cv. 'Banarasi Karaka' which was conducted in the year of 2020-21 on 48 years old ber plants. The plants were prune and maintained properly. All the manures and irrigation, culture practices as well as plant protection measures were adapted accordingly to norms. There were 4 levels each of NAA and GA_3 *i.e.* 0, 20, 30 and 40 ppm. Thus, 16 treatments *i.e.* N_0 G_0,
N_0 G_1, N_0 G_2, N_0 G_3, N_1 G_0, N_1 G_1, N_1 G_2, N_1 G_3, N_2 G_0, N_2 G_1, N_2 G_2, N_2 G_3, N_3 G_0, N_3 G_1, N_3 G_2 and N_3 G_3 were taken for testing the efficacy of treatments along with three controls *i.e.* N_0, G_0 and N_0 G_0 replicated thrice in Factorial Completely Randomized Design. There were 16 plants of ber were taken and on each plant similar three branches were selected in each direction possibly which were used as planting material. Each branch was allotted for one treatment by using randomization. Spraying of treatments were done on 11th November 2020 at fruit setting stage. Observation on fruit drop percentage fruit retention percentages were calculated by counting of initial fruit set before spraying. Yield of the fruit was determining to the weighing of fruit with electronic balance in each harvesting and finally each harvested weight fruit are added and the yield was obtained. The TSS content of the fruits was recorded with help of Erma Refractometer. Whereas ascorbic acid and total sugar were determining as the methods A.O.A.C. (1980). Observations to be recorded Fruit set, Fruit retention, Fruit drop, Yield, Total soluble solids, Ascorbic acid, and Total sugar respectively.

The set per panicles was recorded after spraying, by counting the total number of fruit set under tagged panicles of each treatment and average number of fruits per panicles were derived. The number of initial fruit set form each treatment per replication was recorded and after fruit shedding, remaining fruits were counted in each treatment. The fruit drop was calculated on the basis of initial fruit set. Recorded T.S.S. sample fruits of each plant were crushed to form a homogenized sample and then the juice was extracted through muslin cloth. The extract was used for determination of T.S.S. in °Brix by hand refractometer. A few drops of juice were placed on the surface of prism. The hinged part was placed back. The refractometer was then placed against the sun, and then reading was noted by revolving the eyepiece at room temperature. The ascorbic acid was determined by the procedure detailed in A.O.A.C. (1984). Ascorbic acid was extracted from the pulp by macerating 5mg of sample with 3% Metaphosphoric Acid solution. The extract was filtered and volume made of 25 ml in volumetric flask. 2 ml of the aliquot was taken and titrated against standardized blue dye till the light pink colour appeared which was taken as the end point Observations to be recorded respectively.

RESULTS AND DISCUSSION

(i) Fruit set: It is clear from Table 1 that treatment of NAA 30 ppm significantly maximized 161.75 fruit set closely followed by NAA 40 ppm (161.25) against control (159.50). The improvement of fruit set was increased by 1.41 and 1.10% due to sprays of NAA 30 ppm and NAA 40 ppm treatments respectively over control. The effect of NAA on plant growth is greatly dependent on the time of admission and concentration. NAA has been shown greatly increased in the plant by exogenous application. Due to these causes fruit setting was enhanced. These findings are in accordance with the reports of Chaurasiya *et al.*, (2019); Choudhary *et al.,* (2020) in ber. GA_3 30 ppm recorded significantly maximum (163.50) fruit set closely followed by its 40 ppm dose recorded 162.00 fruit set against control G_0 (157.25). The increasement in fruit set was increased by 3.97 and 3.02% due to GA_3 30 ppm and 40 ppm sprays over control (G_0). It is probably might be due to providing of right concentration of GA_3 during investigation causing enhancement of vegetative growth which accelerated the production of more photosynthetes towards fruit bearing area that's contributed to increase fruit set. These findings are in line with the reports of Bankar and Prasad *et al.,* (1990); Chaurasiya *et al.,* (2019) in ber and Phaungchik, (1994) in mango.

Table 1: Effect of foliar application of GA_3 and NAA on fruit set in ber.

Treatment NAA\GA_3	G_0 (Control)	G_1(GA_3 20 ppm)	G_2 (GA_3 30 ppm)	G_3 (GA_3 40 ppm)	Mean	Sources	S.E.D.	C.D.
N_0 (Control)	156	159	162	161	159.50	NAA, GA_3, NAA × GA_3	0.612, 0.612, 1.225	1.25, 1.25, N.S.
N_1 (NAA 20ppm)	158	161	163	162	161.00			
N_2 (NAA 30ppm)	157	162	165	163	161.75			
N_3 (NAA 40ppm)	158	161	164	162	161.25			
Mean	157.25	160.75	163.50	162.00				

(ii) Fruit retention (%): NAA 40 ppm exhibited maximum of 15.97% fruit retention (Table 2) followed by NAA 30 ppm (15.67%) against control N_0 (12.87%). Enhancement on fruit retention increased by 24.08 and 21.76 % due to positive effect of NAA 40 ppm and 30 ppm concentration over control. It is well documented that auxin content in fruit when become low, fruit drop occurs due to formation of abscission layer and

retention of fruits are decreased as a result of exhaustion of auxin Anand *et al.,* (2003) in mango. In present investigation exogenous application of NAA might have act to prevention of abscission layer and thus, retention of fruit is increased. These findings are in accordance with the reports of Bankar and Prasad (1990); Ghosh *et al.,* (2008) in ber. GA_3 30 ppm dose significantly enhance (16.76%) fruit retention followed by its 40 ppm concentration (16.23%) over control G_0 (10.93%). The enhancement on fruit retention was increased by 53.09 and 48.49 % due to sprays of GA_3 40 ppm and 30 ppm treatments respectively. The increase in fruit retention might be due to effectiveness of GA_3 on metabolic activities of the plants and improved source- sink relationship with favorable influenced the metabolic status resulting in better check of fruit drop and enhancing retention of more number of fruit on plants. The findings are in agreement with the reports of Bankar and Prasad (1990); Yadav and Chaudhary (2005); Chaurasiya *et al.,* (2019) in ber. Interactive effect of NAA × GA_3 induced significant variation on fruit retention and N_2 G_2 treatment significantly maximized (17.84%) over control N_0 G_0 (7.77%). These findings are closely supports with the reports of Chaurasiya *et al.,* (2019) in ber.

Table 2: Effect of foliar application of GA_3 and NAA on fruit retention in ber fruits (%).

Treatment NAA\GA_3	G_0 (Control)	G_1 (GA_3 20 ppm)	G_2 (GA_3 30 ppm)	G_3 (GA_3 40 ppm)	Mean	Sources	S.E.D.	C.D.
N_0 (Control)	7.77	13.15	15.37	15.20	12.87	NAA, GA_3, NAA × GA_3	0.322, 0.322, 0.643	0.65, 0.65, 1.310
N_1 (NAA 20ppm)	11.49	12.30	16.27	16.48	14.16			
N_2 (NAA 30ppm)	12.09	16.25	17.84	16.49	15.67			
N_3 (NAA 40ppm)	12.38	17.28	17.58	16.65	15.97			
Mean	10.93	14.74	16.76	16.23				

(iii) Fruit drop (%): Table 3 indicated that minimum fruit drop 90.09% was exhibited under NAA 40 ppm closely followed by NAA 30 ppm (90.33%) against control (91.95 %) reduction on fruit drop were ascertained due to above treatments and increased by 2.08 and 0.83% over control (N_0). When auxin content of the fruit become low, fruit drop occurs due to formation of abscission layer and retention of fruit are ultimately decrease and fruit drop enhance in present investigation, the exogenous application of NAA might have increase the concentration of auxin in plants which possibly induced to reduction of fruit drop. These findings are in line with the reports of Naseem *et al.,* (2016); Choudhary *et al.,* (2020) in ber. GA_3 30 ppm dose significantly reduced (89.75%) fruit drop followed by GA_3 40 ppm (90.15%) against control G_0 (92.97%). GA_3 sprays possibly increased auxin synthesis which may cause to prevent fruit drop in present investigation. These findings are collaborated with the reports of Yadav and Chaudhary (2005); Chaurasiya *et al.,* (2019) in ber. Interactive effect of NAA × GA_3 found to be significant and combined treatment N_2G_2 recorded significantly minimum of 89.19% fruit drop closely followed by N_3G_1 (89.20%) against control N_0G_0 (95.02%).

Table 3: Effect of foliar application of GA_3 and NAA on fruit drop in ber fruits (%)

Treatment NAA\GA_3	G_0 (Control)	G_1(GA3 20 ppm)	G_2(GA_3 30 ppm)	G_3(GA_3 40 ppm)	Mean	Sources	S.E.D.	C.D.
N_0 (Control)	95.02	91.73	90.51	90.56	91.95	NAA, GA_3, NAA × GA_3	0.305, 0.305, 0.610	0.62, 0.62, 1.24
N_1 (NAA 20 ppm)	92.42	91.90	90.02	90.44	91.19			
N_2 (NAA 30 ppm)	92.30	89.97	89.19	89.88	90.33			
N_3 (NAA 40 ppm)	92.16	89.20	89.28	89.72	90.09			
Mean	92.97	90.70	89.75	90.15				

(iv) Yield: Table exhibited that of NAA 30 ppm revealed significantly maximum 14.16 kg/tree yield followed by NAA 40 ppm (33.36 kg) over control N_0 (27.60 kg) these results in conformity with those of Singh *et al.,* (2001) in ber and Haidry *et al.,* (1997); Singh *et al.,* (2005) in mango. GA_3 40 ppm significantly induced highest yield (37.63 kg/tree) followed by GA_3 30 ppm (32.96 kg) over control G_0 (26.31 kg/tree). The findings are gets support to the reports of Bankar and Prasad (1990) in ber and Rokaya *et al.,* (2016) in mandarin. Interactive treatment N_2 G_3 significantly maximized (42.48 kg/tree) followed by N_3 G_3 (41.20 kg) against control N_0 G_0 (25.54 kg/tree). These findings are in line with the reports of Kale *et al.,* (2000); Masalkar and Wavhal (1991) in ber.

Table 4: Effect of foliar application of GA_3 and NAA on fruit yield of ber (kg/tree).

Treatment NAA\GA_3	G_0 (Control)	G_1 (GA_3 20 ppm)	G_2 (GA_3 30 ppm)	G_3 (GA_3 40 ppm)	Mean	Sources	S.E.D.	C.D.
N_0 (Control)	25.54	26.03	28.72	30.11	27.60	NAA, GA_3, NAA × GA_3	0.510, 0.510, 1.021	1.04, 1.04, 2.08
N_1 (NAA 20 ppm)	26.26	29.88	32.30	36.75	31.30			
N_2 (NAA 30 ppm)	26.81	31.67	35.70	42.48	34.16			
N_3 (NAA 40 ppm)	26.64	30.46	35.14	41.20	33.36			
Mean	26.31	29.51	32.96	37.63				

(v) Total soluble solids: NAA 40 ppm significantly maximized (14.18°Brix) TSS content followed by NAA 30 ppm (13.99°Brix) over control N_0 (12.82°Brix). NAA might have caused diversion of more solids metabolites towards developing fruits and increasing amylase activity and thus, there was conversion of starch into simple sugar thereby enhancing TSS content. These findings are similar with accordance of

Haidry *et al.,* (1997); Gupta and Brahamchari (2004) in mango. 14.03% TSS content was significantly maximized with GA_3 20 ppm (Table 5) followed by GA_3 30 ppm (13.56°Brix) over control G_0 (13.13%). These findings are in line with the reports of Kale *et al.,* (2000) in ber and Rokaya *et al.,* (2016) in mandarin. Interactive treatment N_3 G_1 significantly increased 15.14°Brix TSS followed by N_2 G_1 (14.62°Brix) over control N_0 G_0 (12.82°Brix). These findings are in line with the reports of Banker and Prasad (1990); Ram *et al.,* (2005); Gill and Bal (2013) in ber.

Table 5: Effect of foliar application of GA_3 and NAA on Total soluble solids in ber fruits (°Brix).

Treatment NAA \GA_3	G_0 (Control)	G_1 (GA_3 20 ppm)	G_2 (GA_3 30 ppm)	G_3 (GA_3 40 ppm)	Mean	Sources	S.E.D.	C.D.
N_0(Control)	12.82	12.94	12.80	12.74	12.82	NAA, GA_3 NAA × GA_3	0.112, 0.112, 0.225	0.23, 0.23, 0.46
N_1 (NAA20 ppm)	12.96	13.42	13.21	13.14	13.18			
N_2 (NAA30 ppm)	13.25	14.62	14.05	14.06	13.99			
N_3 (NAA40 ppm)	13.48	15.14	14.18	13.92	14.18			
Mean	13.13	14.03	13.56	13.46				

(vi) Ascorbic acid: Table 6 indicated that NAA 20 ppm significantly enhanced (107.78 mg ascorbic acid/100g pulp) followed by its 30 ppm dose (95.55 mg) over control N_0 (86.26 mg) these findings are collaborated with reports of Bal *et al.,* (1986) and Singh *et al.,* (2001) in ber. 40 ppm GA_3 significantly maximized (107.50 mg) followed by GA_3 30 ppm (102.02 mg) over control G_0 (75.71 mg). The increase in ascorbic acid content may have resulted owing to enhanced synthesis of ascorbic acid due to favorable metabolic activity involving certain enzyme and metabolic ions possibly under the influence of GA_3. These findings are in line with the reports of Masalkar and Wavhal (1991) in ber. Significantly maximum of 128.56 mg ascorbic acid/100 g pulp was elaborated under combined treatment of N_1 G_3 (114.37 mg) over control N_0 G_0 (75.29 mg). These findings are conformity with the reports of Pandey (1999) in ber Singh and Singh (2015) in aonla.

Table 6: Effect of foliar application of GA_3 and NAA on Ascorbic acid in ber fruit (mg/100g pulp).

Treatment NAA\GA_3	G_0 (Control)	G_1 (GA_3 20 ppm)	G_2 (GA_3 30 ppm)	G_3 (GA_3 40 ppm)	Mean	Sources	S.E.D.	C.D.
N_0 (Control)	75.29	85.21	91.10	93.45	86.26	NAA, GA_3 NAA × GA_3	0.559, 0.559, 1.118	1.14, 1.14, 2.28
N_1 (NAA 20ppm)	76.03	114.37	112.18	128.56	107.78			
N_2 (NAA 30ppm)	75.74	100.08	107.46	106.94	97.55			
N_3 (NAA 40ppm)	75.79	98.72	97.36	101.05	93.23			
Mean	75.71	99.59	102.02	107.50				

(vii) Total sugar: Treatment of NAA 30 ppm significantly revealed maximum of 9.56 % total sugar (Table 7) followed by NAA 40 ppm (9.51%) over control N_0 (8.83%). Increase in total sugar may attributed due to NAA which may accelerated the conversion of starch and other polysaccharide in soluble from of sugar which promoted sugar content. These findings are similar with accordance of Kale *et al.,* (1999) in ber and Yadav *et al.,* (2010) in aonla. Significantly maximum of 9.93% total sugar was recorded with GA_3 20 ppm followed by GA_3 30 ppm (9.29%) over control N_0 G_0 (8.87%). Probably GA_3 increasing fruit sweetness might be due to photosynthetic activity and formation of more carbohydrates content and its transportation are maximised within the fruit. Under the influences of growth regulator GA_3 sugar are quickly converted in to their derivatives by reaction involving of glycolytic pathway. These results are in line with the reports of Kale *et al.,* (1999); Yadav and Chaturvedi (2005) in ber. Significantly maximum of 10.59% total sugar was recorded under interactive treatment N_2 G_1 followed by N_3 G_1 (10.26%) against control N_0 G_0 (8.76%).

Table 7: Effect of foliar application of GA_3 and NAA on Total sugars in ber fruit (%).

Treatment NAA\GA_3	G_0 (Control)	G_1 (GA_3 20 ppm)	G_2 (GA_3 30 ppm)	G_3 (GA_3 40 ppm)	Mean	Sources	S.E.D.	C.D.
N_0 (Control)	8.76	8.91	8.86	8.78	8.83	NAA, GA_3, NAA × GA_3	0.078, 0.078, 0.155	0.16, 0.16, 0.32
N_1 (NAA 20 ppm)	8.88	9.96	9.18	9.05	9.27			
N_2 (NAA 30 ppm)	8.91	10.59	9.43	9.30	9.56			
N_3 (NAA 40 ppm)	8.95	10.26	9.68	9.16	9.51			
Mean	8.87	9.93	9.29	9.07				

CONCLUSION

On the basis of results, plant growth regulators NAA and GA_3 used as a tool in improving the performance of ber cv. 'Banarsi karaka' fruits with respect to fruiting parameter, yield and quality attributes in the present investigation. The results concluded that NAA 30 ppm maximized fruit set, yield and total sugar and it was exhibited prominent as second effective treatment in fruit retention, TSS and ascorbic acid content. NAA 20 ppm and 40 ppm maximized less parameter in comparison of NAA 30 ppm considerably. Similarly, GA_3 40 ppm promoted significantly maximum yield and ascorbic acid and also enhanced fruit set, fruit retention and yield while lesser fruit drop was seen. The effectiveness of GA_3 20 and 30 ppm exhibited positive but did not expressed superimpose to GA_3 40 ppm treatment. So, on the conclusion of present

investigation it is advice to the concerning peoples, orchardist and farmers of central U.P. for spraying of NAA 30 ppm and GA_3 40 ppm at the time of pre blooming stage and pea stage of fruits to getting maximum quality yield of ber.

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Conflict of Interest. None.

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