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Effect of plant growth regulators on yield and quality of ber (*Zizyphus mauritiana* Lamk.) in semi-arid conditions

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Abstract

The present *investigation* carried out to know the response of plant growth regulators on different cultivars of ber in semi-arid condition as prevailing high temperature and low humidity climatic situations in such regions are major hindrance of good yield. Experiment was conducted with 21 treatments and each treatment was replicated three times under Randomized Block Design. The *experiment comprised three cultivars of ber viz., Gola, Kaithli and Umran and three plant growth regulators (NAA, 2,4-D and GA$_3$) with two concentration of each viz., 15 and 30 ppm and one control (water spray).* The result *showed* that among PGRs spray of 2,4-D @ 30 ppm and among cultivars, cv. *Umran* exhibited significant *influence on most of yield and quality parameters with maximum net return and B: C ratio except fruit weight, fruit diameter, TSS and sugars of ber fruits.*

Key words: PGRs, 2,4-D, GA$_3$, NAA, ber, quality, semi-arid condition, *etc.*

Introduction

Indian jujube or ber (*Zizyphus mauritiana* Lamk.) is one of the most ancient and common fruit which is indigenous to India, South-Western China and Malaya. It belongs to family Rhamnaceae and is tetraploid (2n = 48) in nature. In India, ber is being cultivated on an area of about 87674 hectare with the production of 8,94,848 metric tonnes (Raturi, 2001), is an important fruit crop of semi-arid conditions of Madhya Pradesh, Bihar, Punjab, Haryana, Gujarat and *Rajasthan states.* Ber is popularly known as king of fruits of these regions and "poor man's fruit". It being a hardy crop can be grown on marginal lands with less water where other crops do not grow economically. The fruits of ber are generally consumed fresh as well as in dried and preserved form as candy, jam, jelly and marmalade. It is highly nutritious which contains ascorbic acid 90 -280 mg 100 g^{-1}, vitamin 'A' 55 mg 100 g^{-1}, thiamine 0.13 mg g^{-1}, riboflavin 0.19 mg 100 g^{-1}, total soluble solids 17-20 %, acidity 0.21 %, â carotene 81 µg 100 g^{-1}, protein 0.8 g 100 g^{-1}, fat 0.3 g 100 g^{-1}, carbohydrates 17 g 100 g^{-1}, calcium 4 mg 100 g^{-1}, phosphorus 9 mg 100 g^{-1} and iron 1.8 mg 100 g^{-1}. Plant growth regulators act as metabolic sink for the diversion of metabolites from one part to other parts of the plant leading regulation of flowering, thinning of flower and fruit, improvement of fruit set and size and prevention of pre-harvest fruit drop (Singh, 1990).

Materials and methods

The present *study* was carried out at Asalpur Horticulture Research Farm, S.K.N. College of Agriculture, Jobner during year 2006-07. The trees of uniform size, vigorous, bearing stage and of approximately 20 years age were selected. A single tree was kept as a unit for each treatment having three replications. The experiment comprised of 21 treatments consisting of three cultivars viz., Gola, Kaithli and Umran and seven of PGRs (NAA, 2,4-D and GA$_3$ with two concentration of each viz., 15 and 30 ppm and one control i.e. water spray). Two sprays of plant growth regulators and water were made on all three cultivars of ber at 50 per cent of the flower opened stage and one month later.

One kg fresh and mature golden yellow coloured fruits from each tree of ber were brought to the PHT Laboratory, *department of Horticulture, Jobner* to record the observations like fruit weight, fruit diameter, yield, pulp : stone ratio and quality parameters like TSS (determined by Zeiss^{Tm} hand refractometer on percentage basis at 20C), ascorbic acid content of fruits by using metaphosphoric acid and 2,6 dichlorophenol-indophenol dye solution (A.O.A.C., 1990) and total sugars was determined by using Anthrone reagent method (Dubois *et al.*, 1951). The data recorded for physical and chemical parameters were analysed *statistically* using analysis of variance techniques (Cochran and Cox, 1950).

Results and discussion

Experimental findings exhibited that *application* of NAA, 2, 4-D and GA$_3$ had great and significant impact on fruit set percentage, fruit retention and yield (Table 1 & 2). Spray of 2, 4-D @ 30 ppm recorded significantly more fruit set, fruit retention and finally yield per plant as well as yield per hectare in comparison to control and rest of the treatments. The favourable influence of applied growth regulators on these characters may be ascribed to their physiological effect on metabolic processes of the plant. Application of auxins like, NAA and 2, 4-D might be improved the auxin level of the ovary which have a positive

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effect on fruit set in ber. These findings are in accordance with that of Bankar and Prasad (1990) and Singh *et al.* (2001) in ber. Spray of GA_3, NAA and 2, 4-D (30 ppm of each) significantly reduced the fruit drop (Table 1). The minimum and significant reduction in fruit drop (56.54 %) was observed under 2, 4-D applied @ 30 ppm followed by GA_3 applied @ 30 ppm (57.03 %) and NAA @ 30 ppm (57.21 %) over control (67.58 %). The reduction in dropping of fruit might be due to supply of sufficient auxin or auxin like precursor for developing fruits as reported in navel orange (Lima and Davies, 1984). The results obtained in present investigation are also in line with findings of Singh *et al.* (2001) and Yadav (2002) in ber.

Significant effect of different levels of plant growth regulators was observed on weight, diameter and pulp stone ratio of ber fruits (Tables 1 & 2). The application of GA_3 @ 30 ppm resulted in production of highest and significantly more weight, diameter and pulp stone ratio of fruits, whereas, application of GA_3 (15 ppm), NAA (15 and 30 ppm) and 2,4-D (15 and 30 ppm) were found statistically at par to it (Table-1). The increase in fruit weight and diameter may be due to enhancement in either flesh or stone or both (Grewal *et al.*, 1993). These results are in concurrence with that of Singh and Chohan (1984) in citrus.

Table 3 indicates that total soluble solids and total sugars were significantly altered by different levels of plant growth regulators. Application of GA_3 @ 30 ppm resulted in production of highest and significantly more TSS and total sugars, which was *statistically* at par to 2,4-D (30 ppm), NAA (30 ppm) and GA_3 (15 ppm). The *increase in TSS and total sugars of treated fruit juice might be due to the increase in mobilization of carbohydrates from the source to the sink (fruits) by auxin and gibberellin treatments.* These results are in agreement with the findings of Bhati and Yadav (2003) in ber. *Among different plant growth regulators, maximum ascorbic acid content (137.40 mg / 100 g pulp) was recorded under treatment 2,4-D (30 ppm) followed by NAA (30 ppm), where ascorbic acid content was 133.27 mg / 100 g pulp.* This could be attributed to the possible catalystic influence growth regulators on biosynthesis of ascorbic acid from sugars or inhibition of oxidative enzymes or both. Similar results were propounded by Bhati and Yadav (2003) in ber.

The results further *revealed* that cv. Umran in comparison to *Kaithli* and Gola, responded significantly better for the parameters of yield *viz.*, per cent fruit set, per cent fruit drop, per cent fruit retention, fruit weight, fruit diameter, pulp: stone ratio and fruit yield *per plant* and per hectare and *quality viz., total soluble solids (TSS), ascorbic acid and total sugar reducing and non-reducing sugars* (Table 1 to 3). These *improvements* manifested due to higher biomass production in cultivar Umran over *Kaithli* and Gola. The significant *increase in biomass production under cultivar Umran could be ascribed to its higher genetic potential, which might have facilitated larger canopy development, more fruit set, fruit retension and finally higher yield with minimum fruit drop. Such results were* also observed by Sharma *et al.* (1990).

Being at par with Umran, cv Gola recorded higher values of TSS, ascorbic acid and total sugars over cv. Kaithli. The variation in these parameters might be due to genetic characteristics of cultivar and prevailed environmental conditions. The variation in quality parameters in different cultivars were also observed by Pandey *et al.* (1990).

Application of 2, 4-D @ 30 ppm registered highest and significantly more net return (Rs 104484/-) and B: C ratio (3.54:1) over rest of the treatments (Table 3). Net return and B: C also altered significantly with different cultivars. Maximum net return (Rs 126244/-) and benefit: cost ratio (4.07:1) was obtained in cultivar Umran followed by cultivar Gola, while, minimum cv. Kaithli.

Table 1. Effect of plant growth regulators fruit set, fruit drop, fruit retention and fruit diameter of different ber cultivars

Treatments	Fruit set (%)	Fruit retention (%)	Fruit drop (%)	Fruit diameter (cm)
Plant growth regulators				
P_0 (control)	10.76	32.42	67.58	2.92
P_1 (NAA 15 ppm)	17.48	40.52	59.48	3.19
P_2 (NAA 30 ppm)	18.02	42.79	57.21	3.29
P_3 (2, 4-D 15 ppm)	17.76	40.85	59.15	3.23
P_4 (2, 4-D 30 ppm)	18.30	43.46	56.54	3.31
P_5 (GA_3 15 ppm)	16.29	40.19	59.81	3.32
P_6 (GA_3 30 ppm)	17.63	42.97	57.03	3.46
SEm ±	0.27	0.60	0.88	0.05
CD (P=0.05)	0.78	1.72	2.51	0.16
Cultivars				
C_1 (Gola)	15.68	37.52	62.57	3.34
C_2 (Kaithli)	15.73	39.21	60.97	2.93
C_3 (Umran)	19.00	44.92	55.08	3.47
SEm ±	0.42	0.92	1.34	0.08
CD (P=0.05)	1.20	2.63	3.83	0.24

C = Cultivars P = Plant growth regulators

Table 2. Effect of plant growth regulators on fruit weight, pulp stone ratio, fruit yield per plant and fruit yield per ha of different ber cultivars

Treatments	Fruit weight (g)	Pulp : stone ratio	Fruit yield per plant (kg)	Fruit yield ha^{-1} (tonne)
Plant growth regulators				
P_0 (control)	12.29	12.78	82.93	12.94
P_1 (NAA 15 ppm)	13.15	14.38	90.74	14.16
P_2 (NAA 30 ppm)	13.35	14.37	93.13	14.53
P_3 (2, 4-D 15 ppm)	13.39	14.29	91.11	14.21
P_4 (2, 4-D 30 ppm)	13.52	14.29	95.81	14.95
P_5 (GA_3 15 ppm)	13.44	14.45	91.03	14.20
P_6 (GA_3 30 ppm)	13.59	14.54	94.62	14.76
SEm +	0.19	0.26	1.46	0.23
CD (P=0.05)	0.54	0.74	4.16	0.65
Cultivars				
C_1 (Gola)	13.43	14.60	76.24	11.89
C_2 (Kaithli)	11.27	13.16	85.56	13.35
C_3 (Umran)	15.04	14.72	112.22	17.51
SEm ±	0.29	0.40	2.23	0.35
CD (P=0.05)	0.82	1.13	6.36	0.99

C = Cultivars P = Plant growth regulators

Table 3. Effect of plant growth regulators on TSS, ascorbic acid, total sugars and net return and B: C ratio of different ber cultivars.

Treatments	TSS (%)	Ascorbic acid (mg/ 100g pulp)	Total sugar (%)	Net return	B: C ratio
Plant growth regulators					
P_0 (control)	17.89	111.99	10.46	86884	2.98
P_1 (NAA 15 ppm)	19.33	129.44	12.40	97575	3.33
P_2 (NAA 30 ppm)	20.06	133.27	12.71	100708	3.41
P_3 (2, 4-D 15 ppm)	19.40	128.80	12.37	98115	3.34
P_4 (2, 4-D 30 ppm)	20.23	137.40	12.81	104484	3.54
P_5 (GA_3 15 ppm)	20.02	124.10	12.89	93509	2.77
P_6 (GA_3 30 ppm)	20.43	129.82	13.10	93870	2.44
SEm ±	0.34	2.15	0.23	1540	0.050
CD (P=0.05)	0.97	6.13	0.65	4389	0.142
Cultivars					
C_1 (Gola)	21.17	111.58	12.82	87629	2.83
C_2 (Kaithli)	17.59	129.71	11.80	75475	2.44
C_3 (Umran)	20.11	142.20	12.55	126244	4.07
SEm ±	0.52	3.29	0.35	2353	0.076
CD (P=0.05)	1.48	9.36	1.00	6705	0.216

C = Cultivars P = Plant growth regulators

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