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EFFECT OF PRE-HARVEST SPRAY OF GROWTH REGULATORS AND UREA ON GROWTH, YIELD AND QUALITY OF BER UNDER MALWA PLATEAU CONDITIONS

BALIRAM KAROLE AND *RAJESH TIWARI

Department of Fruit Science, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Campus, College of Horticulture, Mandsaur (M.P.) - 458 001

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ABSTRACT

The experiment was conducted at K.N.K. College of Horticulture, Mandsaur (M.P.) on six years old ber trees cv. Gola during 2013-14 to study the effect of pre-harvest spray of growth regulators and urea on growth, yield and quality of ber (Zizyphus mauritiana Lamk.). Results revealed that the maximum leaf length (1.70 cm), leaf width (1.49 cm) and leaves/shoot (390.67), fruit retention 49.28% and minimum fruit drop 51.72% were recorded with the pre-harvest foliar application of NAA 60 ppm+GA_3 30 ppm+2.0% urea followed by NAA 40 ppm+GA_3 20 ppm+1.5% urea. Physical parameters viz. fruit length (3.58 cm) and diameter (3.31 cm) at harvest, fruit volume (24.46 ml), pulp thickness (1.21 cm) and yield parameters viz. fruit weight (20.08 g), fruits/tree (1366.67), yield/tree (31.75 kg) were recorded with pre-harvest foliar application of NAA 60 ppm + GA_3 30 ppm + 2.0% urea followed by NAA 40 ppm + GA_3 20 ppm + 1.5% urea. The chemical parameters viz. total soluble solids (19.68 ^{0}Brix), reducing sugar (5.42%), non-reducing sugar (4.57%) and chlorophyll content (71.0 Spad Value) were recorded with pre-harvest foliar application of NAA 60 ppm + GA_3 30 ppm + 2.0% urea followed by NAA 40 ppm + GA_3 20 ppm + 1.5% urea, as compared to other treatments in ber plants. The minimum values for different parameters of ber viz. leaf length (0.48 cm), leaf width (0.40 cm) and number of leaves/shoot (220.33), fruit retention 37.50%, fruit length (3.26 cm) and diameter (2.91 cm) at harvest, fruit volume (17.2 ml), pulp thickness (0.90 cm), fruit weight (15.0 g), fruits/tree (1301.67), yield/tree (19.56 kg), reducing sugar (4.45%), non-reducing sugar (3.50%) & chlorophyll content (54.76 Spad Value) were recorded under control.

Key words: Foliar feeding, growth regulators, quality, yield, *ber*.

INTRODUCTION

Ber (Zizyphus mauritiana Lamk.), the Poor man's apple, is an important drought hardy fruit crop, which can be grown under hostile agro-climatic conditions of the arid region. Since, it is hardy and salt tolerant, the tree can be grown even in marginal lands. Its fruit contains 14-16 % sugars, 150 mg vitamin-C per 100 g of pulp, besides other minerals. Ber grows in wild and cultivated forms in India. Plant hormones play a key role in ber production by influencing directly or indirectly various processes i.e. germination, rooting, growth, flowering and productivity of ber. Plant hormone also influence the size, appearance and quality parameters of fruits by indirectly affecting the crop growth and development or directly by synchronizing flowering, improving fruit set and decreasing fruit drop. Plant growth regulators play a significant role in many physiological phenomena. They are using in vegetative propagation, regulation of flowering, thinning of flower and fruit, artificial induction of seedlessness, improvement of fruit set and size and prevention of pre-harvest fruit drop. Plant growth regulators also plays major role in the development of fruits. They act as metabolic sink for the diversion of metabolites from one part to other of the plant specially towards developing fruits. The pre-harvest sprays of PGR's are using to control fruit drop and to improve fruits retention percentage. Spraying urea significantly increased shoots length, number of leaves per shoot and leaf area higher than control in ber (Katiyar *et al.* 2009). NAA is an important growth regulator of auxin group, which helps to reduce fruit drop and to improve fruit set and quality specially TSS. Gibberellic acid is an important growth regulator of gibberellins group and used to improve fruit size and quality viz. to increase the juice percentage and TSS. GA3 use improved sugar content, inducing flowering, delaying in maturity and producing seedlessness. Spraying urea, NAA and GA3 significantly increased shoot length, number of leaves per shoot and leaf area higher than control (Godara et al., 2001). Nitrogen and Potassium content in leaves significantly increased by urea. Keeping the

**Correspondent authors E-mail: rt_jnkvv@yahoo.com, RVSKVV, Gwalior (M.P.)-474002*

above facts in mind, the study was conducted to assess the effects of growth regulators and urea on growth, yield and yield attributing characters of ber as well as economics of the treatments.

MATERIAL AND METHODS

The experiment was conducted at K.N.K. College of Horticulture, Mandsaur (M.P.) on six years old ber tree cv. Gola during 2013-14. Mandsaur is situated at 23.450 to 24.130 N latitude and 74.440 to 75.180 E longitudes at an altitude of 435 m MSL. It has a sub-tropical climate with hot summer and cool winter. The temperature rises up to 460C during summer and falls to 3.60C during winter with an occasional occurrence of frost. The average annual rainfall is 800 mm, most of which occurred during July to September, winter and summer rains are uncommon. The meteorological data such as maximum and minimum temperature (37.70C to 7.70C), relative humidity (88.00%) and rainfall (723mm) were recorded during the experimental period.The treatments namely T0-Control, T1-20 ppm NAA, T2-40 ppm NAA, T3-60 ppm NAA,T4-10 ppm GA3, T5-20 ppm GA3, T6-30 ppm GA3, T7-1.0% urea, T8-1.5% urea, T9-2.0% urea, T10-20 ppm NAA + 10 ppm GA3 + 1.0% urea, T11-40 ppm NAA + 20 ppm GA3 + 1.5% urea and T12-60 ppm NAA + 30 ppm GA3 + 2.0% urea were tested in randomized block design. First foliar spray of growth regulator on crop was done on 11th October 2013 and same spray is repeated after 30 days. The observation on leaf length, width and leaves per shoot were recorded. For recording reproductive parameters of ber viz. fruit drop and fruit retention per cent, four branches are randomly selected and tagged on the plant and the number of flowers were counted at full bloom separately on each branch after that number of fruits were counted. The fruit drop was calculated by the following equation:

$$\text{Fruit drop\%} = \frac{\text{(Total number of fruit set - Total number of fruits at harvest time)}}{\text{Total number of fruit set}} \times 100$$

The fruit retention % at maturity was calculated as: Number of fruits at harvest/ Initial number of fruit set x 100

Four healthy fruits were selected randomly from each tree at full maturity to determine of chemical parameters. Hand refractometer was used for determination of T.S.S. in ^{0}Brix. Acidity was estimated by simple acid–alkali titration method (A.O.A.C. 1970). Sugars in fruit juice were estimated by the method as suggested by Nelson (1944). Chlorophyll content in leaves was estimated by using instrument SPAD chlorophyll meter by simple clamping the meter over leafy tissue.

RESULTS AND DISCUSSION

The morphological parameters of plant were significantly influenced by the plant growth regulators and urea (Table 1). Maximum values for leaf length (1.70 cm), leaf width (1.49 cm) and leaves/shoot were recorded with foliar application of 60 ppm NAA + 30 ppm GA_3 + 2.0% urea followed by 40 ppm NAA + 20 ppm GA_3 + 1.5% urea whereas minimum in control . The increase in vegetative growth of the ber plant by growth regulators and urea may be attributed to the association of nitrogen in the synthesis of protoplasm and in the primary manufacture of amino acids and increased auxin activities. As a result, meristematic activities increased which in turn increase the vegetative growth. Similar results have also been reported by Sharma *et al.* (2011) in ber. Application of the plant growth regulators and urea significantly influenced the reproductive parameters. Maximum fruit retention (49.48 %) and minimum fruit drop (50.72%) were recorded with foliar application of 60 ppm NAA + 30 ppm GA_3 + 2.0% urea followed by 40 ppm NAA + 20 ppm GA_3 + 1.5% urea whereas minimum in control. The optimum dose of nutrient (urea) accelerates the metabolic activities of the plant and increases the vegetative growth, more photosynthesis and ultimately leads to increase flowering, maximum fruit setting and maximum fruit retention per cent. Similar results were reported by Uma Shankar *et al.* (2002) in guava. Reduction in fruit drop with foliar application of growth regulators may be attributed to correcting the deficiency of endogenous auxin which prevents the formation of abscission layer possibly through the inhibition of enzymatic activity such as pectinase, cellulose and also polygalactauronase in ber.

Table 1: Effect of pre-harvest spray of growth regulators and urea on leaf and reproductive parameters of ber

Treatment	Leaf length (cm)	Leaf width (cm)	Leaves/ shoot	Fruit drop (%)	Fruit retention (%)
Control	0.48	0.40	220.33	62.50	37.50
NAA 20 ppm	0.51	0.68	230.25	61.08	38.92
NAA 40 ppm	0.84	0.90	270.17	58.55	41.45
NAA 60 ppm	1.01	0.95	290.67	56.84	43.16
GA_3 10 ppm	0.76	0.74	250.33	60.44	39.56
GA_3 20 ppm	1.10	1.10	310.25	56.48	43.52
GA_3 30 ppm	1.25	1.15	320.42	55.27	44.73
Urea 1.0 %	0.80	0.80	240.33	59.92	40.08
Urea 1.5 %	1.30	1.20	336.70	55.61	44.39
Urea 2.0 %	1.30	1.30	340.42	52.26	47.74
NAA 20 ppm+GA_3 10 ppm+urea 1.0 %	1.40	1.37	360.25	51.32	48.68
NAA 40 ppm+GA_3 20 ppm+urea 1.5 %	1.65	1.40	373.58	51.27	48.73
NAA 60 ppm+GA_3 30 ppm+urea 2.0 %	1.70	1.49	390.67	50.72	49.28
S. Em. ±	0.16	0.05	8.90	0.83	0.18
CD (p=0.05)	0.48	0.15	25.97	2.43	0.52

The physical characteristics of fruit are an expression of a plant's vegetative activity which were also significantly influenced by various plant growth regulators and urea (Table 2). The maximum values for fruit length (3.58 cm), diameter (3.31 cm), volume of fruit (24.46 ml), pulp thickness (1.21 cm) were recorded with foliar application of 60 ppm NAA + 30 ppm GA_3 + 2.0% urea followed by 40 ppm NAA + 20 ppm GA_3 + 1.5% urea whereas minimum in control. The increase in fruit length and diameter by foliar application of plant growth regulators and urea might be due to optimum supply of plant nutrients and growth hormones in right amount during the entire crop growth period causing vigorous vegetative development of the plants and ultimately production of more photosynthates. The nutrient combinations accelerate the metabolic activities of the plant. Nitrogen positively influences the vegetative growth of the plant, manufacturing greater amount of food materials and the same when translocated into the fruit bearing areas leading to enhancement in weight and size of the fruits (Sharma *et al.* 2011). Jain and Dashora (2010) also reported an increase in fruit size with NAA in guava.

Table 2: Effect of pre-harvest spray of growth regulators and urea on physical and yield parameters of ber

Treatment	Fruit volume (ml)	Fruit length (cm)	Fruit diameter (cm)	Pulp thickness (cm)	Fruit weight (g)	Fruits/ tree	Yield/ tree (kg)
Control	17.2	3.26	2.91	0.90	15.0	1301.67	19.56
NAA 20 ppm	18.1	3.38	2.91	0.93	16.4	1304.00	21.38
NAA 40 ppm	20.1	3.41	3.04	1.01	18.1	1315.33	23.84
NAA 60 ppm	21.5	3.41	3.08	1.01	19.5	1316.67	25.68
GA_3 10 ppm	18.7	3.38	2.93	0.95	16.7	1305.33	21.82
GA_3 20 ppm	21.85	3.42	3.08	1.06	19.8	1321.67	26.27
GA_3 30 ppm	22.4	3.49	3.17	1.10	20.4	1325.00	27.09
Urea 1.0 %	19.7	3.39	3.02	0.99	17.7	1313.33	23.32
Urea 1.5 %	22.2	3.50	3.21	1.13	20.5	1337.67	27.46
Urea 2.0 %	23.3	3.51	3.22	1.14	21.4	1340.67	28.69
NAA 20 ppm+GA_3 10 ppm+urea 1.0 %	23.4	3.55	3.23	1.17	21.5	1345.00	29.02
NAA 40 ppm+GA_3 20 ppm+urea 1.5 %	23.8	3.55	3.27	1.18	21.9	1355.67	29.58
NAA 60 ppm+GA_3 30 ppm+urea 2.0 %	24.4	3.58	3.31	1.21	22.0	1366.67	31.75
S. Em. ±	0.17	0.04	0.06	0.01	0.65	3.00	0.57
CD (p=0.05)	0.52	0.10	0.18	0.03	1.90	0.76	1.69

The increase in fruit size due to accelerated rate of cell division and cell enlargement and more intercellular space with the application of higher concentration of growth substances like NAA. The maximum average fruit weight (20.08 g) maximum fruits per tree (1366.67) and highest yield per tree (31.75 kg) were recorded with foliar application of 60 ppm NAA + 30 ppm GA_3 + 2.0% urea followed by 40 ppm NAA + 20 ppm GA_3 + 1.5% urea whereas minimum in control. It is well known that nitrogen is the constituent of proteins, enzymes and chlorophyll and involves in all the processes associated with photosynthesis and growth, hence increase in weight and yield due to nitrogen application is obvious. These co-enzymes are beneficial in increasing size of fruits and ultimately weight of the fruit. Gill and Bal (2013) also reported similar results in ber. Increase in fruit weight may be attributed to the strengthening of middle lamella and consequently cell wall, which later may have increase the free passage of solutes to the fruits. The NAA plays an effective role in increasing fruit weight. Ultimately these produced more number of leaves and flowers buds. This might have lead to more length and diameter of fruit and also larger weight of individual fruit. There was a positive and significant correlation between the length of fruit and weight of fruit and the diameter of fruit with weight of fruit. The increase in fruit yield might be due to reduction in the fruit drop and increase fruit weight with these treatments. These results are in accordance with the findings of Bhati and Yadav (2003) in ber.

Table 3: Effect of pre-harvest spray of growth regulators and urea on chemical parameters of ber

Treatment	Acidity (%)	TSS (%)	Reducing Sugar (%)	Non-Reducing Sugar (%)	Chlorophyll content (Spad value)
Control	0.22	14.92	4.45	3.50	54.76
NAA 20 ppm	0.22	14.33	4.62	3.98	55.38
NAA 40 ppm	0.16	16.00	4.82	3.97	60.97
NAA 60 ppm	0.15	16.50	4.86	4.03	61.45
GA_3 10 ppm	0.19	15.54	4.71	3.94	58.28
GA_3 20 ppm	0.15	16.77	4.89	4.14	62.12
GA_3 30 ppm	0.15	16.96	4.92	4.24	63.47
Urea 1.0 %	0.17	15.87	4.79	3.90	58.28
Urea 1.5 %	0.15	17.10	4.95	4.40	63.59
Urea 2.0 %	0.14	17.62	4.98	4.47	64.30
NAA 20 ppm+GA_3 10 ppm+urea 1.0 %	0.14	18.02	4.99	4.57	65.01
NAA 40 ppm+GA_3 20 ppm+urea 1.5 %	0.13	18.37	5.06	4.54	68.29
NAA 60 ppm+GA_3 30 ppm+urea 2.0 %	0.12	19.68	5.42	4.45	71.00
S. Em. ±	0.01	0.42	0.12	0.06	1.79
CD(p=0.05)	0.02	1.23	0.35	0.18	5.21

Application of plant growth regulators and urea not only increased the yield but also improved the fruit quality (Table 3). The minimum acidity (0.12%) and maximum total soluble solids (19.68 ^{0}Brix), reducing sugar (5.42%), non-reducing sugar (4.57%) and chlorophyll content (71.0 Spade value) were recorded with 60 ppm NAA + 30 ppm GA_3 + 2.0% urea and minimum in control except TSS. GA_3 at higher concentration augmented TSS content of the fruit. Which may be due to diversion of more solids towards developing fruits and might also enhance the conversion of complex polysaccharide into simple sugars? These results are in conformity with the results reported by Gill and Bal (2013) in ber. Increase in sugar content may be due to the higher concentration of GA_3 which promotes hydrolysis of starch into sugar. The higher percentage of total sugar, reducing and non-reducing sugar pectin might have been due to efficient translocation of photosynthates to the fruits by regulation of GA_3. These results are in conformity with the findings of Ram *et al.* (2005) in ber. The growth regulators and urea decrease the acidity of fruits might be due to that acids under the influence of growth regulators might have either fastly been converted into sugars and their derivatives by reactions involving reverse glycolytic pathways or might have been used in respiration or both. The data clearly indicate that the combination of 60 ppm NAA + 30 ppm GA_3 + 2.0% urea registered minimum acidity (0.12%) over the control which retained

highest acidity. Simlar trend was also observed by Kher *et al.* (2005) in guava. TSS contents increased with the use of various growth regulators. This has been reported to divert more solids towards developing fruits and might also have enhanced the conversion of polysaccharide into simple sugars. The increase in TSS contents of fruits might be explained on the basis of that GA_3 has stimulated the functioning of number of enzymes in the physiological process. The increase in TSS of treated fruit juice might be due to the increase in mobilization of carbohydrates from the source to sink (fruits) by auxin and gibberellins treatments. This may be attributed to the fact that application of NAA might have increased a'-amylase activity and thus there was conversion of starch into sugars and hence improved total soluble solids content. These results are in agreement with the findings of Bhati and Yadav (2003) in ber.

The results of present experiment conducted on 6 years old ber cv. Gola plants showed that foliar application of 60 ppm NAA + 30 ppm GA_3 + 2.0 % urea was found most optimum dose of plant growth regulators and Urea under agro-climatic conditions of Malwa plateau for obtaining maximum vegetative growth and yield, improving the reproductive parameters, physical characteristics and quality of the fruits.

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