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Full Research Article

Effect of Certain Nutrients on Fruit Set, Fruit Retention, Physical Characters and Yield of Ber Fruit *(Zizyphus mauritiana* Lamk). cv. Banarasi Karaka

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Abstract

The present investigation was undertaken on the effect of certain nutrients on fruit setting, fruit retention, physical characters and yield of ber fruit (*Zizyphus mauritiana* Lamk). c.v. Banarasi Karaka at main experiment station, Department of Horticulture, Narendra Deva University of Agriculture and Technology Kumarganj, Faizabad (U.P.) during the years 2008–2009. Plants received uniform cultural operations throughout the experimental period. Treatments included control, Ferrous sulphate ($FeSO_4$) @ 0.3%, Ferrous sulphate @ 0.6%, Potassium sulphate (K_2SO_4) @ 1.0%, Potassium sulphate @ 2.0%, borax ($Na_2B_4O_7$ $10H_2O$) @ 0.5%, borax @ 1.0%, ($FeSO_4$ @ 0.3%+K_2SO_4 @ 1.0%+borax @ 0.5%, ($FeSO_4$ @ 0.6%+K_2SO_4 @ 2.0%+borax @ 1.0%. The nutrients were sprayed as aqueous solutions using Tween-20 as a surfactant. First spray was done in month of September just before flowering and second spray was done after fruit setting. The results were found that the foliar spray of $FeSO_4$ @ 0.6%, along with K_2SO_4 @ 2%, and borax @ 1.0%, proved most effective in recording maximum initial fruit setting, fruit retention, minimum fruit drop, and maximum length and breath, stone weight of fruit, pulp stone ratio and weight of fruit which contributed to maximum yield. The better fruit quality parameters viz. % of TSS, sugar, ascorbic acid, lowest acidity was also recorded with the application of the same treatment.

1. Introduction

The ber, Chinese date or Chinese fig (*Zizyphus mauritiana* Lamk.) is an ancient fruit tree of India and China. In fact, it was one of the prominent fruits on which sages in ancient India lived during Vedic ages. There is a reference to ber in *Yajur Veda*, written not later than 1000 B.C. It is said to be indigenous to the area stretching from India to the South Western Asia up to Malaya. The Indian Ber (*Zizyphus mauritiana* Lamk.) belongs to family *Rhamnaceae* and genus *Zizyphus*. It is a tetraploid (2n=48) in nature. It is cultivated widely for its resistance to grow in drought and diversified soil and climatic conditions, and is known as "King of Arid Fruits". It requires less care and even in neglected condition. However, produces sufficient fruits and can be successfully grown under the most unfavourable conditions of the soil, water and climate. It grows even on the marginal soil and various kinds of wasteland situations such as sodic saline soil, ravines, arid semi-arid region including platen area of Bundelkhand and South India. The ripe ber fruits have high nutritive value, conventionally it is considered a "poor man's fruit". It is richer than apple in protein, phosphorus, calcium and vitamin 'C' (Bakshi and Singh, 1974).

Nutrients play a important role in many physiological phenomena like vegetative propagation, induction of seedlessness increase fruit set prevention of pre-harvest fruit drop, regulation of flowering, fruit size, thinning of flower and fruits. Various types of nutrients like Fe, K, borax, Zn, Ca. Fe and borax are used for improving the flowering, fruit set, size and quality of fruit as well as yield in many tree crops. Borax has been mainly used for manipulating many physiological events and is commercially used to improve the quality of fruit in crops like grapes, citrus, cherries and apples. Tomar et al. (1999) observed significantly higher fruit yield with the foliar application of Urea (1, 2 and 3%), Zinc sulphate and borax @ 0.5 and 1% as compared to water spray (control) in ber cv. Umran. Singh and Vashistha (1997) advocated that application of 0.5% borax @ $Na_2B_4O_7$. $10H_2O$ and 0.5% zinc sulphate was obtained most effective to minimize fruit drop

percentage in ber cv. Seb.

The ber cultivar Banarasi Karaka fruits are perishable in nature and stored for longer period under normal conditions and can be easily transported to distant places. It therefore, being sold in the market. During peak season there is glut in the market and hence the prices go down. Some nutrients sparing have been reported to increase the shelf-life of various fruits besides improving their quality yield. Potassium sulphate (K_2So_4) borax ($Na_2B_4O_7.10H_2O$) and Ferrous sulphate ($FeSo_4$) are being used in certain fruit crops to improve their quality, yield and maturity as well as storage life. Long storage life along with high quality ber cultivar Banarasi Karaka fruits are needed for enriching human diet and increasing availability for internal as well as external trade.

2. Materials and Methods

The present experiment was conducted at main experiment station, Department of Horticulture, NDUA&T, Kumarganj, Faizabad during the year 2008–2009. To find out Effect of certain nutrients on fruit set, fruit retention, physical characters and yield of ber fruit *(Zizyphus mauritiana* Lamk*)*. cv. Banarasi Karaka. Twenty-five year old plants of ber cultivar Banarasi Karaka, uniform in vigour and productivity were taken as experimental material. The nutrients used in the experiment were $FeSO_4$ @ 0.3% and 1.0%, K_2SO_4 @ 1.0% and 2.0%, borax @ 0.5 and 1.0%, $FeSO_4$ @ 0.3% along with K_2SO_4 @ 1.0%+borax @ 0.5% and $FeSO_4$ @ 0.6% along with K_2SO_4 @ 2.0%, borax @1.0%, with one control treatment. Total number of plant 27, in three replications. The nutrients were sprayed as aqueous solutions using Tween-20 as a surfactant. First spray was done in month of September Just before flowering and second spray was done after fruit setting (10 days). Total soluble solids (TSS) of ripe fruits was estimated by Digital model pocket refractometer of 0 to 53% range at 20 °C. The total titratable acidity was determined by titrating five-milliliter fruit juice against N/10 Sodium hydroxide (NaOH) to pH 8.1, using phenolphthalein indicator. The titratable acidity results represented citric acid content expressed as a percentage. (AOAC, 1990). The ascorbic acid of guava fruit was determined by diluting the known volume of juice with 3% metaphosphoric acid and titrating with 2, 6 dichlorophenol indophenols dye solution. The result was expressed as mg of ascorbic acid 100 g^{-1} of fruit juice (AOAC, 1990).

2.1. Statistical analysis

The data generated were subjected to analysis of variance (ANOVA) and separation of means was obtained using Randomized Block Design (RBD), according to the methods described by Gomez and Gomez (1984).

3. Results and Discussion

Initial fruit set, fruit retention and fruit drop percentage was influenced significantly by different nutrients as compared to control (Table 1). The maximum fruit set (58.57%), fruit retention (42.58%) and minimum fruit drop (57.42%) was recorded by the foliar application of ferrous sulphate ($FeSO_4$)+potassium sulphate (K_2SO_4)+borax @ 0.6%+2.0%+1.0% (T_9), followed by its lower concentration T_8. Higher fruit set, fruit retention and minimum fruit drop with these chemicals was might be due to stimulating effects of these treatments on the process of fertilization and hormonal metabolism. Borax known to be an activator of the enzyme tryptophan synthetage (Brahmachari and Kumar, 1997). Increased fruit retention under borax sprays is suggestive of inference that the treatments have in one way or other

Table 1: Effect of foliar spray of nutrients on initial fruit set, fruit retention and fruit drop in ber cv. Banarasi Karaka

Treatments	Initial fruit set (%)	Fruit retention (%)	Fruit drop (%)	Length of fruit (cm)	Breadth of fruit (cm)	Stone weight of fruit (g)	Pulp stone ratio
T_1 (Control)	46.83	30.19	69.81	3.13	2.48	1.13	11.50
T_2 ($FeSO_4$ @ 0.3%)	49.00	32.82	67.18	3.59	2.63	1.14	12.25
T_3 ($FeSO_4$ @ 0.6%)	54.77	34.70	65.30	4.06	2.88	1.14	13.66
T_4 (K_2SO_4 @ 1.0%)	47.73	32.46	67.54	3.41	2.76	1.13	13.62
T_5 (K_2SO_4 @ 2.0%)	47.70	35.36	64.64	3.66	2.89	1.14	13.56
T_6 (Borax @ 0.5%)	48.53	37.37	62.63	4.10	2.67	1.14	14.07
T_7 (Borax @ 1.0%)	51.40	40.83	59.17	4.17	2.89	1.14	13.67
T_8 ($FeSO_4$ @ 0.3%+K_2SO_4 @ 1.0%+Borax @ 0.5%)	55.53	38.41	61.59	4.04	2.92	1.15	13.99
T_9 ($FeSO_4$ @ 0.6%+K_2SO_4 @ 2.0%+Borax @ 1.0%)	58.57	42.58	57.42	4.39	3.12	1.15	16.73
SEm±	0.46	0.81	0.81	0.11	0.05	0.006	0.30
CD (*p*=0.05)	1.38	2.43	2.43	0.33	0.17	0.01	0.091

influenced the auxin balance to prevent fruit drop. (Sharma et al., 1991). The beneficial effect of borax in increasing fruit retention percentage may be due to its role in improving the plant vigour thereby increasing food reserves Ali et al. (1991). It is also regulators carbohydrates metabolism specially pentose phosphate Shunt (Singh et al., 2005).

Fruit length and breadth was influenced significantly by different nutrient sprays as compare to control. The fruit length (4.39 cm) and breadth (3.12 cm) was found maximum with foliar application ferrous sulphate+potassium sulphate+borax sulphate @ 0.6%+2.0%+1.0% (T_9). Borax increases the efficiency of metabolic process of trees. Adequate amount of borax improved the auxin content and it also acted as catalyst in oxidation process. The beneficial effect of growth stimulating compounds thereby increases the availability of photosynthetes. Response of ferrous sulphate along with borax and potassium with the findings of Meena et al. (2008).

Fruit weight and volume was influenced significantly by different nutrient spraying as compare to control (Table 2). Significantly maximum fruit weight (20.39 g) and volume (19.76 cm^3) was recorded with foliar application of ferrous sulphate+potassium sulphate+borax @ 0.6%+2.0%+1.0% (T_9). Increased in weight and volume of fruits by boron application might be due to rapid cell division translocation of sugar and higher pulp content. The increment in fruit weight by potassium sulphate and boron spray may be due to the accumulation of more food material in fruit trees. Meena et al. (2008) also reported favourable effects of potassium, boron and ferrous sulphate on various constituents of fruits.

The improvement in fruit weight was observed with foliar application potassium sulphate, borax, ferrous sulphate in fruit crops like guava and grape by Kumar et al. (1988); Sharma et al. (1991). The specific gravity and stone weight were not affected by different treatments in ber. The effects were non-significant because the increase in weight and volume of fruits was in the same proportion under different treatments. However, appreciable increase in the specific gravity was recorded with spray of ferrous sulphate (0.5) by control. The maximum stone weight (1.5) was obtained with foliar application of ferrous sulphate @ 0.6%+potassium sulphate @ 2.0%+borax @ 1.0%, followed by its lower concentration. Specific gravity of fruit in ber cv. Banarasi Karaka, decreased harvest. These results are in agreement with Pandey et al. (1990); Sarangi et al. (1992).

Significant variations were recorded with respect to pulp: stone ratio with the application of different concentration of nutrients. The increase in pulp percentage may be due to more absorption of water, nutrient and increase the volume of inter cellular spaces in the pulp. The maximum pulp: stone ration (16.73) was found by the combined foliar application of ferrous sulphate @ 0.6%+potassium sulphate @ 2.0% and borax @ 1.0%. These results are in conformity with findings of Yadav et al. (2004); Meena et al. (2008). Fruit yield plant^{-1} was influenced significantly by different nutrient spraying as compared to control. The maximum yield (70.00 kg) was recorded with foliar application of ferrous sulphate @ 0.6%+borax @ 1.0%+potassium sulphate @ 2.0% followed by borax 1.0%. Yandagni et al. (1976) reported that boron application increase the rate of photosynthesis and activity of carbohydrate in leaves. Potassium increases the efficiency of metabolic process of trees. These results are enclose confirmation to findings of Ingle et al. (1993); Pawar et al. (1994); Chaitanya et al. (1997); Woycik et al. (1999).

TSS content of ber fruit was significantly influenced by different nutrient spray. The maximum T.S.S. content (14.13%) was recorded with T_9. The borax also stimulates the functioning of number of enzymes in the physiological process which probably cause an increase in T.S.S. content

Table 2: Effect of foliar spray of nutrients on fruit weight, fruit volume and specific gravity of ber fruit cv. Banarasi Karaka

Treatments	Fruit weight (g)	Fruit volume (cm^3)	Specific gravity of fruit	Fruit yield (Kg Tree^{-1})
T_1 (Control)	14.12	13.19	1.07	53.00
T_2 ($FeSO_4$ @ 0.3%)	15.10	14.75	1.02	55.00
T_3 ($FeSO_4$ @ 0.6%)	16.72	15.35	1.09	63.00
T_4 (K_2SO_4 @ 1.0%)	16.54	15.48	1.07	65.00
T_5 (K_2SO_4 @ 2.0%)	16.60	15.85	1.05	67.00
T_6 (Borax @ 0.5%)	17.19	16.25	1.06	65.00
T_7 (Borax @ 1.0%)	16.73	16.22	1.04	75.00
T_8 ($FeSO_4$ @ 0.3%+K_2SO_4 @ 1.0%+Borax @ 0.5%)	17.24	17.04	1.01	74.00
T_9 ($FeSO_4$ @ 0.6%+K_2SO_4 @ 2.0%+Borax @ 1.0%)	20.39	19.76	1.03	77.00
SEm±	0.172	0.279	0.019	1.05
CD (p=0.05)	0.516	0.838	0.057	3.16

(Table 3). Under the influence of potassium sulphate the acids have either been converted into sugar and their derivative by the reaction involving reversal of glycolytic path way or might be used in respiration or both. The above findings are in agreement with Brahmachari and Kumar (1997); Stamper et al. (1999). Different treatments significantly influenced the acidity percentage in ber cv. Banarasi Karaka. The minimum acidity per cent (0.15) was recorded by the foliar application of ferrous sulphate @ 0.6%, along with potassium sulphate @ 2.0% and borax @ 1.0% followed by borax @ 0.5% and potassium sulphate @ 1.0%. Acidity content of fruit decreased with increase in concentration of borax which might be due to increased TSS and reduced acidity. In potassium sulphate treated fruits might be due to early ripening induced by this treatment in which degradation of acids may occurred. The acids under the influence of nutrient spray might have either been fastly converted into sugar and their derivative by the reaction involving reversal of glycoltic path way. The above findings are in the line with the findings of Meena et al. (2008); Singh et al. (2007). Ascorbic acid content was significantly influenced by different nutrient spraying. Maximum ascorbic acids (75.68 mg 100 g^{-1} Pulp) was recorded by the foliar application of ferrous sulphate @ 0.6%+borax @ 1.0 %+potassium sulphate @ 2.0% followed by potassium sulphate @ 2.0% and borax @ 1.0%. borax also stimulate the functioning of number of enzymes in the physiological process which probably increases the ascorbic acid content of ber fruit. The adequate of Iron is also acted as catalyst in oxidation process. These findings are in agreement with the findings of Singh et al. (2005); Singh et al. (2002); Singh and Vashistha (1997). Different treatment significantly increase the reducing, non-reducing and total sugar content of ber fruit in comparison to control, The maximum reducing, non-reducing and total sugar (i.e. 4.5, 5.13 and 9.64% respectively) were recorded by the foliar application of ferrous sulphate @ 0.6%+borax @ 1.0%+potassium sulphate @ 2.0% followed by potassium sulphate @ 2.0%. This improvement in sugar content of fruit potassium spray was helpful in the process of photosynthesis which ultimately lead to the accumulation of carbohydrates which help in increasing the sugar content of fruits. Boron prove to be very effective in translocation of more sugar in fruits. These findings are in complete conformity with those of Brahmachari and Kumar (1997); Chaitanya et al. (1997); Hasan Jana (2000); Singh and Vishistha (1997); Stamper et al. (1999).

Table 3: Effect of foliar spray of nutrients on fruit quality of ber fruit cv. Banarasi Karaka

Treatments	TSS (°Brix)	Acidity (%)	Ascorbic acid (mg 100 g $pulp^{-1}$)	Reducing sugar (%)	Non-reducing sugar (%)	Total sugars (%)
T_1 (Control)	10.75	0.23	63.80	3.63	4.32	7.95
T_2 ($FeSO_4$ @ 0.3%)	11.96	0.21	65.27	3.98	4.63	8.61
T_3 ($FeSO_4$ @ 0.6%)	12.47	0.20	67.17	4.05	4.78	8.83
T_4 (K_2SO_4 @ 1.0%)	13.37	0.18	66.89	4.05	4.64	8.70
T_5 (K_2SO_4 @ 2.0%)	12.72	0.22	69.01	4.27	4.94	9.21
T_6 (Borax @ 0.5%)	12.81	0.17	67.03	4.09	4.78	8.87
T_7 (Borax @ 1.0%)	13.09	0.18	69.33	4.33	4.84	9.18
T_8 ($FeSO_4$ @ 0.3%+K_2SO_4 @ 1.0%+Borax @ 0.5%)	13.30	0.16	71.58	4.26	4.93	9.19
T_9 ($FeSO_4$ @ 0.6%+K_2SO_4 @ 2.0%+Borax @ 1.0%)	14.13	0.15	75.68	4.51	5.13	9.64
SEm±	0.310	0.009	0.304	0.025	0.028	0.050
CD (p=0.05)	0.931	0.028	0.910	0.074	0.085	0.151

4. Conclusion

Combined foliar application of $FeSo_4$ @ 0.6%, along with K_2SO_4 borax @ 1.0%, before flowering and after fruit setting resulted in higher improvement of the initial fruit setting, fruit retention, minimum fruit drop and maximum length and breath, stone weight of fruit, pulp stone ratio, fruit of weight and better quality. Increase in yield was also maximum with the application of the same treatment.

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