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Physico-Chemical Attributes of Ber Fruits as Influenced by Phosphorus and Zinc Applications

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Abstract

The experiment was conducted to assess the optimum dose of phosphorus and zinc sulfate for improving the fruit quality of ber cv Umran. Soil application of 400 g P_2O_5 per plant produced ber fruits with maximum fruit weight, fruit size (length and breadth), pulp content and pulp/stone ratio. However, stone weight and juice content were not affected significantly by different phosphorus and zinc sulfate treatments. Maximum TSS, total sugars, reducing and non-reducing sugars, ascorbic acid, TSS/acid ratio and minimum acidity were also recorded with the application of 400 g P_2O_5 per plant. Fruit quality was also improved by zinc sulfate application and optimum dose for better fruit quality was 200 g zinc sulfate per plant. Application of 400 g P_2O_5 in combination with 200 g zinc sulfate per plant produced maximum fruit weight.
Key words : Phosphorus, Zinc sulfate, Physico-chemical attributes, Ber fruits.

Among different cultivars of ber (*Ziziphus mauritiana* Lamk.) grown in northern part of India, Umran ranks first in area and yield potential due to its large fruit size, attractive color and superb eating quality. Its fruits ripen from mid-March to April when other fruits are scarce in the market and thus fetches good price. The general opinion of the ber fruit growers is that ber can grow successfully in adverse soil and climatic conditions without proper care and fertilization. According to a survey of ber orchards, the soils of Haryana are low in nitrogen, medium in phosphorus, high in potassium and about 70% of these soils are also deficient in available zinc (1). Judicious fertilization is key to successful cultivation of ber. Balanced supply of nutrients is essential for obtaining high yields of quality fruits in addition to maintaining trees in healthy and productive conditions for their optimum span of life. Yet due attention has not been paid on the nutritional aspects of ber and no recommendation of phosphorus and zinc exists for this crop under Haryana conditions. Hence, the experiment was planned to study the effect of soil application of different levels of phosphorus and zinc, alone and in combinations, on fruit quality of ber cv Umran.

Methods

The experiment was carried out at the experimental orchard of the Department of Horticulture, CCS Haryana Agricultural University, Hisar. The soil of the experimental orchard was low in nitrogen, phosphorus, zinc and high in potassium having a pH of 8.2. There were sixteen combinations of four levels each of phosphorus (0, 200, 400 and 600 g P_2O_5/plant) and zinc (0, 100, 200 and 300 g zinc sulfate/plant). The experiment, designed in factorial randomized block, had three replications for each treatment. All the forty-eight plants selected were of uniform size and vigor and these plants were kept under uniform conditions of orchard management as per recommended cultural practices during the studies. Single super phospthate and zinc sulfate were used as the source of phosphorus and zinc, respectively and full dose of single super phosphate and zinc sulfate were applied in the month of July every year. Physical attributes of quality parameters like fruit size (length and breadth), fruit

Table 1. Effect of soil application of phosphorus and zinc on vegetative characters in ber cv Umran.

Treatments	Fruit size (cm) Length	Fruit size (cm) Breadth	Fruit weight (g)	Stone weight (g)	Pulp content (%)	Pulp/stone ratio	Juice content
P_0 (0 g P_2O_5)	3.81	3.04	19.3	1.07	94.5	17.2	3.68
P_1 (200 g P_2O_5)	3.90	3.09	20.2	1.08	94.6	17.8	3.68
P_2 (400 g P_2O_5)	4.03	3.13	21.6	1.09	94.9	18.6	3.71
P_3 (600 g P_2O_5)	4.01	3.11	21.6	1.11	95.0	18.6	3.80
CD at 5%	0.06	0.03	0.5	NS	0.2	0.5	NS
Z_0 (0 g $ZnSO_4$)	3.69	3.00	18.0	1.07	94.1	15.9	3.67
Z_1 (100 g $ZnSO_4$)	3.94	3.07	20.2	1.07	94.7	18.0	3.74
Z_2 (200 g $ZnSO_4$)	4.08	3.16	22.4	1.12	95.1	19.2	3.73
Z_3 (300 g $ZnSO_4$)	4.03	3.14	22.0	1.11	95.0	19.0	3.74
CD at 5%	0.06	0.03	0.5	NS	0.2	0.5	NS

weight, stone weight, pulp content, and juice content were recorded on ten randomly selected fruits, whereas, chemical parameters like TSS, acidity, ascorbic acid and sugars were estimated as per standard prescribed methods. The data of two years, recorded on different parameters, were pooled and statistically analyzed.

Results and Discussion

Physical attributes of ber fruit quality like fruit size (length and breadth), fruit weight, pulp content and pulp/stone ratio increased appreciably by different levels of phosphorus, however, the stone weight and juice content were not affected by different treatments (Table 1). All the three levels of phosphorus (200, 400 and 600 g P_2O_5/plant) significantly increased the fruit length and breadth over control. Maximum fruit length (4.03 cm) and fruit breadth (3.12 cm) were recorded from the trees receiving 400 g P_2O_5 per plant which was statistically at par with 600 g P_2O_5 per plant treatment, whereas, minimum fruit length (3.81 cm) and fruit breadth (3.04 cm) were recorded in no phosphorus treatment. The phosphorus treatments upto 400 g P_2O_5 per plant significantly increased the fruit weight over preceding phosphorus levels. The difference between the higher levels of P_2O_5 (400 and 600 g/plant) was non-significant but these treatments increased the fruit weight significantly more than all other treatments. Table 1 further reveals that there was a significant increase in pulp content with the increasing levels of phosphorus. Maximum value

Table 2. Effect of soil application of phosphorus and zinc on vegetative characters in ber cv Umran.

Treatments	TSS (%)	Acidity (%)	TSS/acid ratio	Ascorbic acid (mg/100 g pulp)	Total sugars (%)	Reducing sugars (%)	Non-reducing sugars (%)
P_0 (0 g P_2O_5)	16.9	0.278	61.2	89.0	9.35	4.54	4.90
P_1 (200g P_2O_5)	17.6	0.259	69.1	93.4	9.75	4.67	5.08
P_2 (400g P_2O_5)	18.1	0.237	78.4	103.0	10.48	4.89	5.60
P_3 (600g P_2O_5)	18.1	0.243	75.9	101.9	10.38	4.95	5.43
CD at 5%	0.4	0.013	3.5	2.1	0.28	0.15	0.28
Z_0 (0 g $ZnSO_4$)	16.9	0.279	61.3	88.0	9.43	4.51	4.96
Z_1 (100 g $ZnSO_4$)	17.7	0.257	69.9	97.2	9.94	4.82	5.17
Z_2 (200 g $ZnSO_4$)	18.2	0.241	76.8	101.7	10.31	4.88	5.43
Z_3 (300 g $ZnSO_4$)	18.1	0.241	76.5	100.3	10.28	4.84	5.44
CD at 5%	0.4	0.013	3.5	2.1	0.28	0.15	0.28

(95.0%) was recorded with 600 g P_2O_5 per plant and minimum (94.5%) under control, however, the higher levels of phosphorus (400 and 600 g P_2O_5/plant) were statistically at par. The increase in fruit weight, fruit size and pulp content by phosphorus application might be due to increased growth, better root development and increased cell division resulting in more photosynthates and increased absorption of water and nutrients from soil. These results are similar to the earlier findings with 500 g P_2O_5 per tree in ber (2) and with 750 g P_2O_5 per vine in grapes (3).

All zinc treatments significantly increased the fruit length and fruit breadth over control. The higher levels of zinc sulfate i.e. 200 and 300 g per plant were at par. The maximum fruit length (4.09 cm) and fruit breadth (3.16 cm) were registered from the trees receiving 200 g zinc sulfate per plant and minimum (3.69 and 3.00 cm) from control, respectively. The data further revealed that the zinc treatments significantly increased the fruit weight over control. The maximum fruit weight (22.4 g) was recorded with 200 g zinc sulfate per plant, which was at par with 300 g zinc sulfate treatment but significantly higher than all the other zinc treatments, whereas it was minimum (18.0 g) in control. The interaction between phosphorus and zinc was also observed as significant in respect of fruit weight (Fig. 1). The maximum fruit weight (24.0 g) was recorded with 400 g P_2O_5 and 200 g zinc sulfate per

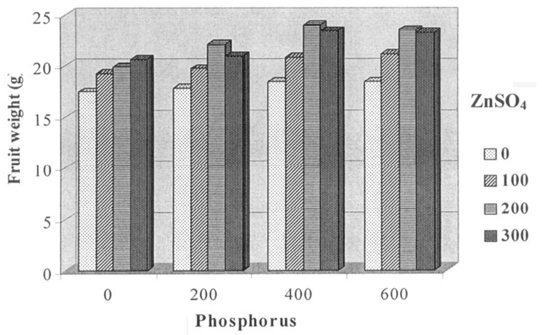

Figure 1. Effect of phosphorus and zinc on fruit weight of ber.

plant and minimum (17.4 g) in control.

The zinc sulfate application upto 200 g per plant also increased the pulp content significantly. It was also observed that various zinc treatments could not affect the stone weight and juice content of ber fruits significantly. The possible reason for enhancement in size and weight of fruits with soil application of zinc sulfate might be due to the fact that zinc promoted synthesis of tryptophan which serves as a precursor for auxin synthesis resulting in production of higher metabolites. The results of the present investigation are in conformity with the findings in guava (4) and in grapes (5).

Soil application of phosphorus and zinc sulfate significantly improved the chemical attributes of ber fruit quality (Table 2). Increasing levels of phosphorus significantly increased the total soluble solids, however, the 400 and 600 g P_2O_5 per plant treatments were ar par. The maximum total soluble solids (18.1%) was recorded with 400 g P_2O_5 and 600 g P_2O_5 per plant, whereas, it was minimum (16.9%) under control. All the three levels of phosphorus (200, 400 and 600 g P_2O_5/plant) significantly reduced the acidity over control. Minimum acidity (0.237%) was recorded in the 400 g P_2O_5 per plant treatment, which was significantly lower than other treatments except 600 g P_2O_5 (0.243%). However, the maximum acidity (0.278%) was registered under control. Further, among phosphorus treatments 400 g P_2O_5 per plant resulted in maximum TSS/acid ratio of 78.4, which was significantly higher than the lower dose of phosphorus as well as control (61.2) but at par with higher dose. The plants receiving 400 g P_2O_5 produced the fruits with maximum ascorbic acid content (103.0 mg/100 g pulp), which was statistically at par with 600 g P_2O_5 (101.9 mg/100 g pulp) but significantly higher than all the other phosphorus treatments including control (89.0 mg/100 g pulp). The three levels of P_2O_5 (200, 400 and 600 g/plant) increased the total, reducing and non-reducing sugars significantly over control. Maximum total sugar (10.48%) and non-reducing sugar (5.60%) contents were recorded in the fruits obtained from the trees receiving 400 g P_2O_5 and minimum (9.35 and 4.90%, respectively) in control, whereas, reducing sugar content was recorded maximum (4.95%) under 600 g P_2O_5 per plant treatment, however, the differences between 600 g and 400 g P_2O_5 treatments were non-significant. Increase in TSS and sugar content with phosphorus application might be due to increased vegetative growth and photosynthetic rate as a result of which fruits accumulated more sugars. Higher ascorbic acid content might be due to catalytic activity of several enzymes which participate in the biosynthesis of ascorbic acid. Secondly, phosphorus is an essential constituent of several enzymes which have their important role in energy transfer, carbohydrate and fat metabolism and respiration resulting in quality improvement of the produce (6). Phosphorus application decreased the acidity which might be due to the increase in total soluble solids. These results are in consonance with earlier findings in ber (2), in orange (7, 8) and in litchi (9).

Total soluble solids were significantly improved by the increasing levels of zinc upto 200 g zinc sulfate per plant treatment, thereafter, there was a slight decrease. The maximum total soluble solids (18.2%) were obtained from the trees receiving 200 g zinc sulfate which was statistically at par with 300 g zinc sulfate treatment (18.1%) and minimum (16.9%) in control. The acidity was observed minimum (0.241%) with the application of 200 g and 300 g zinc sulfate per plant as compared to 0.279% under control. It was also evident that zinc treatments significantly increased the TSS/acid ratio over control. The differences between the higher two doses of zinc sulfate (200 and 300 g/plant) were not significant but these treatments gave significantly higher TSS/acid ratio over all other zinc treatments. Maximum ascorbic acid content of 101.7 mg per 100 g pulp was registered with 200 g zinc sulfate per plant, which was significantly higher than lower dose and control, but statistically at par with higher dose of zinc sulfate. The minimum value of 88.0 mg per 100 g pulp was recorded under control. It was also clear from the data that total sugar content of fruits was significantly improved by different zinc treatments. Maximum total sugar content (10.31%) was obtained from the fruits of the trees supplied with 200 g zinc sulfate. The higher two levels of zinc sulfate (200 and 300 g/plant) were statistically at par, whereas, minimum values (9.43%) were recorded under control. Similar trend was also observed for reducing and non-reducing sugar contents of ber fruits. This increase in TSS, sugars and ascorbic acid content of ber fruits by soil application of zinc sulfate might be due to increased auxin synthesis, increased availability and translocation of metabolites towards the developing fruits. Zinc also acts as a catalyst in the oxidation and reduction processes and is of great importance in the sugar metabolism (10). Zinc sulfate application increased the concentration of chlorophyll *a* and *b*, net photosynthetic productivity and carotenoids, increased activity of peroxidase and increased concentration of Fe and P, leading to increased accumulation of sugars in fruits (11). The decrease in acidity by zinc sulfate application might be due to accelerated conversion of organic acids into sugars during the fruits maturity. These results are in conformity with those in guava (4) and in grapes (5).

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