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Effect of Foliar Application of Nutrients on Leaf Mineral Composition and Yield of Ber (*Ziziphus mauritiana* Lamk.) under Arid Conditions

R.P.S. Dalal*, Navjot, Anirudh Thakur and J.S. Brar

Punjab Agricultural University, Regional Station, Bathinda 151 001, India

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Abstract: Foliar application of urea (2%) and zinc sulphate (0.5%) at peak flowering, peanut size of fruit and second growth phase significantly increased the fruit yield over control. Effects of potassium sulphate and borax were not significant. The maximum fruit yield (71.33 kg tree^{-1}) was observed with urea and minimum (52.19 kg tree^{-1}) in the control. N, Cu and Mn contents increased and P, K, and Fe contents decreased with urea spray, whereas, reverse was observed with potassium sulphate spray. Zinc sulphate and borax spray showed positive relationship with Zn and Mn uptake, but inverse relationship with Cu uptake. A significantly positive correlation was observed between yield and N and Mn contents, whereas, negative correlation was observed between yield and P content in leaves.

Key words: *Ziziphus mauritiana,* foliar nutrition, mineral composition, ber yield.

Ber (*Ziziphus mauritiana* Lamk.) is an important arid zone fruit crop grown mostly on degraded lands, which are poor in fertility. Plants some times grow at rates faster than the ability of their roots to supply mineral nutrients to the leaves and/ or developing fruits. Hence, the need arises for better understanding of nutritional requirement as the nutrients play an important role in improving quality and yield of fruits.

Foliar application of nutrients has certain advantages over soil application. Foliar applications are highly effective with rapid plant response and also useful to maintain their optimum concentration in the plant during growth and fruit development. But very scanty information is available on foliage nutritional aspects, which can be valuable in making judicious fertilizer recommendation for profitable production of ber. Old ber plantation depletes micronutrients, especially Zn, Fe and S to a great extent resulting in deficiency of these nutrients (Singh *et al*., 1997). The experimental orchard was found deficient in nitrogen, phosphorus and micronutrients. However, the plants did not show the deficiency symptoms of nutrients in spite of their deficiency in the soil. In order to make a precise fertilizer recommendation, it is necessary to know the chemical composition of the leaves (Smith, 1962). Therefore, the present investigation was carried out to study the influence of foliar sprays of urea, potassium suphate, zinc sulphate and borax on fruit yield and to know the concentration of nutrients and correlation between yield and mineral nutrition.

*E-mail: dalal08@rediffmail.com

Materials and Methods

The present investigation was carried out during the year 2007-2008 at the experimental orchard of PAU, Regional Station, Bathinda, on 15-year-old ber trees of cv. Umran planted 10 x10 m apart. The soil of the experimental site was sandy loam with EC: 0.24, OC: 0.32, pH: 8.30, available N: 104 kg ha^{-1}, P: 11.8 kg ha^{-1} and K: 476 kg ha^{-1}. Ber orchards are poorly fertilized, and due to continuous mining for a longer period the orchard may be deficit in macronutrients. However, the deficiency symptoms on leaves were not observed. Aqueous solution (non-neutralized) of different nutrients viz. urea (2.0%) containing 46.8% N, K_2SO_4 (1.5%) containing 48% K_2O, $ZnSO_4$ (0.5%) containing 21% Zn and Borax (0.5%) containing 11% B were sprayed on foliage thrice, along with control (water spray) using teepol as surfactant. The first spray was given at full bloom (20th September), 2nd at peanut size of fruit (1st November) and 3rd spray with the onset of 2nd growth phase (20th January) on the same plants. Uniform cultural practices and standard plant protection measures were adopted as per the package of PAU, Ludhiana, throughout the experimental period. The experiment was laid out in randomized block design with four replications by taking one tree of uniform size in respect of canopy and trunk diameters per replication. Fruits were picked thrice from each replication at various intervals and weighed separately and added to record total fruit yield per tree. The recently matured 50 leaves of 5-7 month age were collected from the middle portion of the current season shoots three weeks after last spray for leaf nutrient analysis as

per the procedure given by Ahlawat *et al.* (1983). The collected leaves were washed with running tap water followed by distilled water and dried in oven at 70°C for 48 hours, ground and digested in di-acid mixture of H_2SO_4:$HClO_4$ (4:1) for N, P, K and di-acid mixture of nitric acid:perchloric acid (4:1) for micronutrients. N was estimated using Nesseler's reagent and P by the Vanadomolybdophosphoric yellow color method as per standard procedure (Jackson, 1967), whereas K by the flame photometer (Piper, 1966). Micronutrients viz. Zn, Fe, Cu, Mn and B were analyzed by the atomic absorption spectrophotometer (Lindsay and Norvell, 1978).

Results and Discussion

Fruit yield

Foliar application of urea and $ZnSO_4$ increased the fruit yield significantly over K_2SO_4 and unsprayed control (Table 1). The maximum fruit yield 71.33 kg tree^{-1} was observed with urea (2%) spray, which was at par with $ZnSO_4$ (0.5%) 65.81 kg tree^{-1} and was minimum (52.19 kg tree^{-1}) in control. However, K_2SO_4 and borax also increased the yield, but effects were not significant. Increase in the yield due to urea and $ZnSO_4$ spray might be due to increased fruit retention. Foliar sprays of urea accelerate the synthesis of polyamines through the arginine biosynthetic pathway. Polyamines are necessary for fruit set and growth (Sagee and Lovat, 1988). In addition, these have beneficial effects in increasing the food reserves that help in better nourishing the fruits till ripening (Chauhan and Gupta, 1985). $ZnSO_4$ helps in the synthesis of tryptophane, a precursor of auxin, and zinc might have regulated the cell wall permeability thereby allowing more mobilization of water and photo-synthates in fruits attributed to greater fruit size and increase in yield. However, boron increases pollen germination, pollen tube growth and ultimately stimulates fertilization process. K_2SO_4 helps in sugar transport to fruit, but these nutrients could not attain the level of significance. Similar results were earlier reported by Jeyabhaskaran and Pandey (2008) with foliar application of boron in banana.

Macronutrients

Urea spray increased the leaf N (2.64%), which was significantly higher over the other treatments being otherwise at par, and minimum (2.18%) in K_2SO_4 (Table 1). Phosphorus and potassium contents increased significantly with K_2SO_4 and decreased with urea and $ZnSO_4$ sprays. Reduced P and K with foliar sprays of 2% urea may be due to luxuriant growth and yield leading to high biomass production resulting in a dilution effect. In control, the nitrogen was found in lower range and P and K in sufficient ranges as compared to normal concentration range (N: 2.50%, P: 0.25% and K: 1.00%). Ber orchards are poorly fertilized and due to continuous nutrient mining for a longer period the orchard may be deficit in macronutrients. Secondly, less depletion of nutrients due to low requirement and uptake by ber plants, soil may be sufficient in micronutrients. This might be due to the absorption of good amount of nitrogen by the leaves and synergistic effect between N and Zn, and antagonistic effect between N:P and N:K (Singh and Ahlawat, 1995). The maximum P (0.272%) and K (1.16%) contents were observed with K_2SO_4 and minimum (0.203 and 0.85%) with urea spray, respectively. Boron spray was observed at par with control in N, P, and K contents. More leaf P and K contents have been observed in N deficient ber leaves as compared to normal N content (Raghupathi and Bhargava, 1996).

Micronutrients

Copper and manganese contents increased with urea and decreased with potassium sulphate spray. The maximum copper and manganese (19.00 and 41.12 ppm) were observed with urea and minimum (14.33 and 19.54 ppm) with potassium sulphate spray, respectively. It is well known that ammonical nitrogen in the plants increases the manganese and copper contents and reduces the ferrous level. Zinc sulphate and boron sprays were found to increase

Table 1. Effect of foliar sprays of different nutrients on leaf mineral composition of ber

Treatments	Yield (kg tree^{-1})	Nitrogen (%)	Phosphorus (%)	Potassium (%)	Zinc (ppm)	Iron (ppm)	Copper (ppm)	Manganese (ppm)	Boron (ppm)
Urea (2%)	71.33	2.64	0.203	0.85	47.24	138.09	19.00	41.12	68.33
Potassium sulphate (1%)	56.30	2.18	0.272	1.16	43.33	158.12	4.33	19.54	69.30
Zinc sulphate (0.5%)	65.81	2.37	0.228	0.91	180.26	184.26	5.11	36.03	67.82
Borax (0.5%)	60.59	2.25	0.250	1.00	57.53	185.62	9.00	26.18	71.16
Control	52.19	2.23	0.252	1.00	43.02	162.00	14.16	33.06	63.57
CD (5%)	8.61	0.16	0.012	0.17	14.38	27.47	1.75	7.60	NS

the zinc and iron contents and reduce the copper content. In the present study, the plants did not show any visual deficiency symptoms, though, the leaf micronutrient contents except Zinc, were found lower than the earlier reports of Khanduja and Garg (1984) who suggested the sufficient range (Zn: 44 ppm, Fe: 369 ppm, Cu: 18 ppm and Mn: 48 ppm) in ber. This means that micronutrients requirement may vary with growing condition, growth stages and management practices. Similar results were earlier reported by Jeyabhaskaran and Pandey (2008) in banana. The maximum zinc (180.26 ppm) was observed with $ZnSO_4$ and maximum Iron (185.62 and 184.32 ppm) was found with borax and $ZnSO_4$ sprays, respectively. Increase in the leaf zinc, iron and manganese contents with foliar application of $ZnSO_4$ has been earlier reported by Wali and Sharma (1997) in kinnow and Jeyabhaskaran and Pandey (2008) in banana. Boron content of the leaves was not affected significantly by any of the treatments, however, the maximum boron content (71.16 ppm) was observed with borax and minimum (63.57 ppm) was in control. This may be due to the more biomass production which counter balances the content of this element, i.e. dilution effect. Raghupati and Bhargava (1996) reported more micronutrient in artificially induced macronutrients deficiency in ber leaves and effect was more pronounced in nitrogen and phosphorus deficient plants. The possible reason for increase in micronutrients might be due to the fact that foliar application of nutrients may be responsible for increase in leaf area and other growth parameters thus increasing the levels of photosynthates, which exert pressure for more absorption of nutrients from the soil.

Correlation studies

The correlation coefficient between yield and leaf mineral composition indicates that there was a positive, but nonsignificant association between yield and zinc, copper and boron contents and negative in case of potassium and ferrous contents (Table 2). However, positive correlation coefficient (r=0.64 and r=0.53) was significant between yield and N and Mn contents, respectively. On the other hand, a significant negative correlation coefficient (r=-0.76) was observed between yield and P content. The negative correlation coefficient of P, K and Fe with yield suggest that rate of biomass production had countered balance the contents of these elements i.e. dilution effect. These results are in conformity with those of Patel *et al.* (1993) in ber and Dhillon *et al.* (2011) in pear.

Table 2. Correlation studies between nutrient status of foliage and yield in ber

Correlation coefficient between	r- value
Leaf nitrogen (%) and yield	0.64*
Leaf phosphorus (%) and yield	-0.76**
Leaf potassium (%) and yield	-0.52 NS
Leaf zinc (ppm) and yield	0.26 NS
Leaf iron (ppm) and yield	-0.31 NS
Leaf copper (ppm) and yield	0.31 NS
Leaf manganese (ppm) and yield	0.53*
Leaf boron (ppm) and yield	0.04 NS

NS: Not significant; *Significant at 5%; **Significant at 1%.

Foliar application of urea and zinc sulphate significantly increased the fruit yield, whereas potassium sulphate and borax could not attain the level of significance. Foliar application of nutrients might also be responsible for increase in leaf area and other growth parameters thus, increasing the level of photosynthates in plants and utilization of these photosynthates in developing fruits, which resulted in increased yield (Upadhyay and Badyal, 2008). Zn, Cu and Mn have positive association, whereas P, K and Fe have negative association with yield. It is inferred that correlation of yield with the different leaf nutrients is mediated through urea sprays. It is evident from the present study that increase in leaf N, Zn, Cu and Mn contents with urea spray showed the positive correlation and decrease in P, K and Zn contents showed negative correlation with yield. Urea spray showed inverse relationship or antagonistic effect in P, K and Fe uptake and positive relationship in copper and manganese uptake, whereas, K_2SO_4 and borax showed inverse relationship in Cu and Mn uptake. $ZnSO_4$ and borax showed positive influence in Zn, Fe and Mn uptake but inverse relationship in Cu uptake.

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