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Response of Ber to Nutrient Management in Relation to Yield and Physico-chemical Composition of Fruits under Semi-arid Condition

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Abstract: A field experiment was conducted on response of nitrogen, phosphorus and zinc nutrition on yield and physico-chemical composition of ber fruits under semi-arid condition of western Rajasthan. The highest fruit yield, dry matter, pulp:stone ratio, TSS, ascorbic acid, reducing sugar, non-reducing sugar, and total sugars were recorded in soil applications of 500 g each of nitrogen and phosphorus and 0.6% zinc sulphate as foliar application. The interaction among nitrogen, phosphorus and zinc was significant with respect to yield, which was maximum (42.12 kg plant^{-1}) under 500 g each of N, P and 0.6% zinc sulphate.

Key words: Ber, nitrogen, phosphorus, zinc sulphate, yield, physico-chemical quality parameters.

The ber (*Ziziphus mauritiana* Lamk.), known as the king of arid zone fruits is rich in vitamin C and sugar and fair amount of minerals. Its cultivation even on marginal and poor soils with limited irrigation water provides some income. However, for taking commercial production optimum doses of primary and secondary nutrients need to be standardized. These nutrients together with other factors, determine the yield and quality of fruits. Ber is mainly grown on marginal arid lands where there is a lack of awareness of nutrient management, which is essential to enhance yield and quality of fruits. Keeping the above scenario in view, the present investigation was undertaken to study the influence of nitrogen, phosphorus and zinc applications on the yield and physico-chemical quality parameters of ber fruits.

Materials and Methods

The investigation was carried out on 15-year-old, uniform plants of ber cv. Gola at Krishi Vigyan Kendra, Pali, under Central Arid Zone Research Institute, during 2004-05 and 2005-06. The treatments consisted of three levels each of nitrogen (250, 500 and 750 g plant^{-1} year^{-1}), phosphorus (200, 350 and 500 g plant^{-1} year^{-1}) and zinc sulphate (0.4, 0.6 and 0.8%) making twenty seven treatment combinations in addition to control. The experiment was laid out in factorial RBD with three replications. Fifty per cent dose of nitrogen and full dose of phosphorus were applied in basin with the onset of monsoon and remaining dose of nitrogen was applied in November after fruit set. The zinc sulphate was applied as foliar spray thrice along with equal dose of lime for neutralization and teepol as a surfactant in the 1st week of August, September and October. The soil of the experimental site was silty loam with 135.98 kg ha^{-1} available nitrogen, 18.22 kg ha^{-1} phosphorus, 256.15 kg ha^{-1} potassium, and Zinc (0.18 ppm) having pH 8.3.

The other cultural practices were applied uniformly. The fruits were harvested at color turning stage in five pickings and the yield was recorded accordingly. A sample of 500 g fruits was collected randomly from second picking from each treatment for taking observations on physico-chemical characteristics viz., moisture (%), dry matter (%), pulp content (%), pulp:stone ratio, TSS (°Brix), ascorbic acid (mg 100 g^{-1} pulp), reducing sugar (%), non-reducing sugar (%) and total sugar (%). The fruit pulp was dehydrated at 60°C up to constant weight to record total dry matter and moisture content. Total soluble solids of the fruits were measured with the help of 'Erma' hand refractometer corrected at 20°C temperature. Ascorbic acid, reducing sugar, non-reducing sugar and total sugar contents were determined by AOAC methods (1990). The data for both the years were pooled and analyzed statistically following Gomez and Gomez (1984).

Results and Discussion

The data revealed that nitrogen, phosphorus and zinc sulphate significantly influenced the yield and physico-chemical parameters of ber fruits except non-reducing sugars (Table 1). The highest fruit yield (37.82 kg plant^{-1}), TSS (16.75°Brix),

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Table 1. Effect of different nutrients on yield and physico-chemical characteristics of ber fruits

Treatments	TSS (^{0}Brix)	Ascorbic acid (mg/100 g pulp)	Reducing sugar (%)	Non-reducing sugar (%)	Total sugars (%)	Fruit yield (kg tree^{-1})
Control	14.41	65.39	3.75	4.55	8.56	26.81
Nitrogen (g plant^{-1})						
250	15.82	80.50	4.85	5.23	10.23	34.48
500	16.75	87.53	5.30	5.49	10.71	37.82
750	16.67	86.38	5.17	5.21	10.15	37.62
SEm±	0.09	1.03	0.08	0.11	0.09	0.27
CD (P=0.05)	0.25	2.89	0.21	NS	0.26	0.76
Phosphorus (g plant^{-1})						
200	16.27	82.19	4.89	5.24	10.04	35.41
350	16.29	85.29	5.08	5.32	10.48	36.46
500	16.69	86.94	5.34	5.36	10.57	38.05
SEm±	0.09	1.03	0.08	0.11	0.09	0.27
CD (P=0.05)	0.25	2.89	0.21	NS	0.26	0.76
$ZnSO_4$ (%)						
0.4	16.14	81.73	4.88	5.28	10.16	35.63
0.6	16.65	87.30	5.33	5.39	10.66	37.42
0.8%	16.45	85.38	5.10	5.26	10.27	36.88
SEm±	0.09	1.03	0.08	0.11	0.09	0.27
CD (P=0.05)	0.25	2.89	0.21	NS	0.26	0.76

ascorbic acid (87.53 mg 100 g^{-1} pulp), reducing sugar (5.30%), non-reducing sugar (5.49%) and total sugar (10.71%) were recorded in plants receiving 500 g nitrogen. Similarly foliar application of 0.6% zinc sulphate had best response as reflected in highest fruit yield (37.42 kg plant^{-1}) and quality parameters such as TSS (16.65°Brix), ascorbic acid (87.30 mg 100 g^{-1} pulp), reducing sugar (5.33%) and total sugar (10.66%). In case of phosphorus the highest yield (38.05 kg plant^{-1}) as well as highest values of qualitative characters such as TSS (16.69°Brix), ascorbic acid (6.94 mg 100 g^{-1} pulp), reducing sugar (5.34%) and total sugar (10.57%) were recorded with application of 500 g P_2O_5 plant^{-1}.

Table 2. Effect of N, P and Zn on physico-chemical parameters of ber fruits

Treatments	Moisture (%)	Dry matter (%)	Pulp (%)	Stone content (%)	Pulp stone ratio
Control	82.21	17.79	85.40	14.60	5.86
Nitrogen (g plant^{-1})					
250	79.68	20.31	90.34	9.64	9.58
500	78.71	21.26	91.27	8.73	10.80
750	78.56	21.36	91.20	8.77	10.56
SEm±	0.16	0.16	0.15	0.15	0.20
CD (P=0.05)	0.46	0.45	0.43	0.42	0.56
Phosphorus (g plant^{-1})					
200	79.42	20.53	90.50	9.48	9.80
350	79.03	20.92	90.74	9.23	9.99
500	78.51	21.48	91.57	8.47	11.14
SEm±	0.16	0.16	0.15	0.15	0.20
CD (P=0.05)	0.46	0.45	0.43	0.42	0.56
$ZnSO_4$ (%)					
0.4	79.46	20.48	90.46	9.50	9.73
0.6	78.74	21.25	91.28	8.72	10.77
0.8%	78.76	21.19	91.08	8.92	10.43
SEm±	0.16	0.16	0.15	0.15	0.20
CD (P=0.05)	0.46	0.45	0.43	0.42	0.56

Table 3. Interaction effects of N, P and $ZnSO_4$ on yield of ber fruits (kg $plant^{-1}$)

Nitrogen (g $plant^{-1}$)	Phosphorus (g $plant^{-1}$)								
	200			350			500		
	$ZnSO_4$ (%)			$ZnSO_4$ (%)			$ZnSO_4$ (%)		
	0.4	0.6	0.8	0.4	0.6	0.8	0.4	0.6	0.8
Control	26.81	26.81	26.81	26.81	26.81	26.81	26.81	26.81	26.81
250	31.97	33.63	34.29	32.73	35.97	34.73	34.94	36.01	36.03
500	35.57	36.55	36.28	36.64	36.92	37.82	39.15	42.12	39.32
750	37.68	37.20	35.53	35.78	39.55	38.02	36.20	38.80	39.87

CD (P=0.05) NxPxZn = 2.28

The physical parameters of fruits were also significantly influenced by the application of different nutrient does (Table 2). The dry matter and pulp content were increased with increasing levels of nitrogen, while moisture and stone contents decreased. The pulp to stone ratio was highest (10.80) in 500 g nitrogen per plant, while dry matter (21.36%) was highest in 750 g nitrogen per plant. The lowest moisture content (78.56%) was recorded in 750 g N per plant, while minimum stone content (8.73%) was recorded in 500 g N per tree. The maximum values of moisture and seed content (82.21% and 14.60%, respectively) were in control.

Nitrogen, being the chief constituent of proteins, enzymes and chlorophylls, is involved in all the processes associated with photosynthesis and growth and helps assimilating more food resulting into larger fruits and higher yield. It has been reported that nitrogen stimulates number of enzymes (Singh *et al*., 1986) and is involved in biosynthesis of ascorbic acid in fruits (Singh *et al*., 1981). The increase in reducing sugar and total sugar contents in fruits are directly related to the synthesis of protein through amino acids and amino sugars. The application of nitrogen and phosphorus significantly influenced the reducing and total sugar contents of ber fruits because both the nutrients are actively involved in photosynthesis (Lal *et al*., 2001) and amino acid formation in plants (Singh *et al*., 1985). Similar observations were also made by Prasad and Bankar (2002) in ber and Kumar *et al.* (1996) in guava.

The significant influence of phosphorus on yield and physico-chemical composition of fruits is due to its role in the plant metabolism, which might influence the ascorbic acid and TSS content of fruits as reported long back by Teaotia *et al.* (1972) and Singh and Rajput (1977). The effect of phosphorus with respect to sugars may be attributed to enhanced metabolic and physiological activities of plant, which led to improved yield and quality of fruits (Lal *et al.,* 2003). These results are also in close agreement with the findings of Teaotia *et al.* (1972) and Koj *et al.* (1989) in guava.

The foliar application of zinc significantly influenced dry matter, pulp, pulp:stone ratio, ascorbic acid, reducing sugar, total sugar and fruit yield, while moisture and stone content were significantly decreased. The maximum dry matter content (21.25%), pulp (91.28%), pulp:stone ratio (10.77), ascorbic acid (87.30 mg 100 g^{-1}), reducing sugar (5.33%), total sugars (10.66%) and fruit yield (37.42 kg $plant^{-1}$) were observed with 0.6% $ZnSO_4$ (Table 1 and 2). The improved quality of ber fruits as evidenced by higher TSS and ascorbic acid content due to zinc application may be attributed to activation of enzymes, viz. carbonic anhydrase and number of dehydrogenases and RNA and protein synthesis (Pamila *et al*., 1992). Zinc is also essential for evolution and utilization of CO_2, carbohydrates, protein metabolism, synthesis of RNA and auxins (Pandey and Sinha, 1978).

The increase in sugar content of fruits might be attributed to the action of zinc on zymohexose, a metal protein, which is blocked by formation of complex cystein. The blocked enzyme is reactivated with zinc. Its presence, however, is of great importance for sugar metabolism (Levitt, 1972).

The interaction of N x P x Zn had significant influence only on fruit yield of ber (Table 3).The maximum yield of fruits (42.12 kg $plant^{-1}$) was recorded with the application of 500 g each of N and P_2O_5 per plant as soil application and 0.6% $ZnSO_4$ as foliar spray as compared to the minimum (26.81 kg $plant^{-1}$) under control. This is in close agreement with the earlier reports of Kumar and Tung (1981) and Chaudhary and Singh (1990).

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