J. Hortl. Sci.
Vol. 17(1) : 103-109, 2022

Original Research Paper

Response of Dashehari mango to different Zn levels on yield and pulp nutrient contents grown on sandy loam soils of Lucknow

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ABSTRACT

Dashehari is the leading mango variety grown in Indo-Gangetic plain. Its yield is affected severely by the micronutrient deficiencies. Zinc and boron are the two important micronutrients which limit the yield and quality of Dashehari mango in this region. Hence a field study was taken up to understand the responses of Dashehari mango to different levels of Zn. Results indicated yield enhancement with proper Zn supplementation through foliar sprays. Highest yield of 43.50±2.00 to 50.72±2.40 kg tree^{-1} was recorded with 1.0% $ZnSO_4$ application, followed by 42.27±1.26 (1.5% $ZnSO_4$) to 47.85±1.65 (0.75% $ZnSO_4$) kg tree^{-1}. TSS (19.63±0.25 to 20.27±0.40°Brix), acidity (0.150±0.01 to 0.200±0.02%) and ascorbic acid (29.46±2.29 to 35.17±1.32 mg per 100 g) variations were noted under the influence of various Zn treated fruits. Foliar spray application also caused nutrient richness in mango fruit pulp showing improvement in Zn concentration in fruit pulp from 1.17±0.10 to 1.73±0.10 mg kg^{-1}. Highest concentration of B, Cu, Fe and Mn were observed (3.13±0.018, 4.37±0.06, 7.87±0.06, 20.10±0.15 mg kg^{-1} respectively) with P and K concentrations of 0.026±0.0002& 0.28±0.001% respectively. Significant difference in leaf and soil Zn content was also recorded. The results indicated that yield and quality of Dashehari mango can be improved with foliar spray of Zn in sandy loam soil.

Keywords: Dashehari mango, pulp nutrient concentration, soil and foliar nutrient, yield and quality attribute and Zn levels.

INTRODUCTION

The response of fruit tree to externally applied mineral nutrients needs to be quantified to provide technology innovations to fruit growers as ready to use package of practices. This process might lead to nutrient richness in the end product i.e. fruit pup. This is very significant in case of sand, loamy sand, sandy loam soils having low water holding capacity, soil organic matter, nutrient reserve and microbial activity. Significant response of the tree to nutrient application depends on several attributes like tree physiology, soil response, weather interactions and varietal ability *etc.* Adak *et al.* (2021) scientifically explained that there is an urgent need for revisiting policy issues in terms of soil nutrition *vis-à-vis* productivity and profitability for subtropical zone. Soil nutrients play significant role in responding to the signal transduction to roots and from roots to sink. The source-sink continuum often either hastens or restricted by the pools of nutrients. Lower the nutrient pool, response to end product may be low. However, foliar application may improve the positive response through xylem-phloem pathways through leaf stomata. Adak *et al.* (2019) indicated that lower soil nutrient index is responsible for lower productivity of Dashehari mango in farmers' field in Maal area of Uttar Pradesh. This certainly had contributed to yield variations within the orchards. Similarly in apple orchards Aggelopoulou *et al.* (2010) described the spatial yield and quality variability within the apple orchards. Nutrient deficiency in the foliar part is one of the top most priority for any commercial or non-commercial orchards to indentify and its possible solutions for correction of nutrient limitations. Several nutrients were recorded to be deficient on long-term basis in orchards. Raja *et al.* (2005) inferred boron deficiency in mango and also suggested for possible remediation. Tehranifar and

Tabar (2009) observed that foliar application of K and B (1.5 and 3.0 g L^{-1}) leads to nutrient richness in pomegranate. Liu *et al.* (2021) emphasized potassium fertilization during fruit development for improving quality and potassium use efficiency of tomato in deficit irrigation regime. The quality of the produce is to be authenticated for which low cost near-infra-red spectroscopy technology could be employed (Yang *et al.,* 2021). Similarly, Davarynejad *et al.* (2009) recorded positiveness of foliar nutrition technology in enhancing the yield, quality and alternate bearing as well in pistachio fruit tree. The statistical significance of such response is to be recorded and multivariate interpretation should be done in order to understand the foliar chemical composition of essential nutrients (Raghupathi and Shilpashree, 2018) for development of technologies for corrections. On the present field study, trails were laid out to record the response of Zn levels on nutrient richness and productivity level on sandy loam soil at Lucknow, Uttar Pradesh.

MATERIAL AND METHODS

The field study was conducted on 9th and 10th year old mango cv Dashehari trees spaced at 10×10 m on sandy loam soil at Rehmankhera Farm, Lucknow, Uttar Pradesh during 2015-18. Seven treatments were replicated thrice in a randomized block design. Initial nutrient status of the experimental field was poor. The treatments applied were as T_1: control, T_2: 0.25% $ZnSO_4$, T_3: 0.50% $ZnSO_4$, T_4: 0.75% $ZnSO_4$ T_5: 1.0% $ZnSO_4$ T_6: 1.5% $ZnSO_4$ and T_7: 2.0% $ZnSO_4$. The foliar spray was done in the last week of September, before flowering (3rd week of February), at marble stage of fruit and second spray after 25 days interval. The $ZnSO_4$ was sourced as fertilizer (15%) and the volume of spray per tree was 10-liter volume of solution. Field layout and basin preparation was done as per recommended package of practices. Irrigation water was applied on critical stage wise and based on weather inputs. Tree protection measures were also taken care of. Soil samples were collected randomly from the selected trees. Leaf samples were taken from N-S and E-W directions within the canopy. Fruit samples were collected from different directions in the canopy to represent the overall performance of the tree. Fruits were harvested during 2nd week of June. Yield was reported kg $tree^{-1}$ basis. Quality components were analyzed as par Ranganna (1986). All standard procedures were followed for preparation of soil and leaf and pulp samples for chemical analysis. Leaf digestion and soil digestion was completed following laboratory protocol and micronutrients were analysed using AAS. Statistical analysis *viz*., significance, standard error of mean, standard error of difference and coefficient of variations were computed in OPSTAT (Sheoran *et al*., 1998).

RESULTS AND DISCUSSION

The study reveals the effectiveness of different Zn levels on the Dashehari mango grown on sandy loam soils in Indo-Gangetic plains under subtropical climate. The results showed significant response among mango trees treated with different foliar Zn levels (Table 1). Lowest $ZnSO_4$ application yield of 33.17±2.25 kg $tree^{-1}$ was noted. In general, yield improved up to 1%. Beyond that T_5, the response was not significant. Highest yield of 43.50±2.00 and 50.72±2.40 kg $tree^{-1}$ was noted. TSS of 19.90±0.31 (T_1) to 19.63±0.25 (T_5) and 19.67±0.21 (T_1) to 20.03±0.21°Brix (T_5) was estimated. Similarly, acidity of 0.158±0.03, 0.200±0.02 (T_5) to 0.175±0.03 to 0.158±0.01% (T_1) was recorded. Ascorbic acid content was ranging from 35.17±1.32 (T_5) to 30.58±3.50 mg per 100 g (T_1). Variable content of quality attributes suggested possible nutrient interaction in the mango trees. The enhanced nutrient concentration in fruit pulp was also recorded (Table 2). Lowest Zn concentration of 1.17±0.10 (T_1) to 1.73±0.10 (T_4), 1.60±0.06 mg kg^{-1} (T_5) was recorded. Cu concentration of 3.50±0.015 mg kg^{-1} (T_1) to 3.93±0.015 mg kg^{-1} (T_5), B concentration of 2.01± 0.09 mg kg^{-1} (T_1) to 3.13 ±0.18 mg kg^{-1} (T_5) followed by 2.56±0.12 mg kg^{-1} (T_4) were recorded. Non-significant response was observed in some mineral composition like Fe that varied between 16.20±0.15 to 20.10 ±0.15 mg kg^{-1}. A narrow range of 0.021 to 0.026% P and 0.26 to 0.28% K was observed. The observed results suggested strong response of Zn levels on fruit pulp Zn content.

The mineral contentions of leaf tissue showed Zn variations between 29.7±5.51 (T_1) to 52.0± 5.29 mg kg^{-1} (T_5), Cu content of 13.7±0.58 (T_1) to 19.7±1.53 mg kg^{-1} (T_4), B content of 32.367±3.11 (T_1) to 35.93±1.79 mg kg^{-1} (T_5) (Table 3). However, Fe and Mn contents were non-significant with a narrow range of 170.3±11.59 mg kg^{-1} to 206.7±10.26 mg kg^{-1} and 137.7±5.13 mg kg^{-1} to 158.0±8.72 mg kg^{-1} was observed. Similarly, P and K content were recorded as 0.147 to 0.159% and 0.936 to 1.022% respectively. Soil organic matter in general was low i.e. 0.316 to

Table 1. Effect of foliar application of Zn on fruit yield and quality of mango

Treatment	Fruit yield (kg /tree)		TSS (^{0} B)		Acidity (%)		Ascorbic acid (mg/100g)	
T_1	33.17±2.25	38.32±2.48	19.90±0.31	19.67±0.21	0.175±0.03	0.158±0.01	29.46±2.92	30.58±3.50
T_2	34.83±3.00	44.40±3.60	19.93±0.21	19.87±0.21	0.175±0.01	0.183±0.01	31.14±1.45	31.34±1.32
T_3	37.00±1.53	45.83±1.68	20.03±0.36	19.77±0.15	0.158±0.04	0.167±0.01	29.46±5.26	33.64±2.65
T_4	41.67±1.50	47.85±1.65	19.70±0.38	20.27±0.40	0.167±0.01	0.175±0.03	29.46±2.53	33.64±3.50
T_5	43.50±2.00	50.72±2.40	19.63±0.25	20.03±0.32	0.158±0.03	0.200±0.02	30.30±5.26	35.17±1.32
T_6	42.27±1.26	46.60±1.51	19.83±1.07	19.73±0.15	0.150±0.01	0.183±0.03	31.98±5.26	35.17±1.32
T_7	38.83±2.75	43.12±3.58	20.36±0.20	19.83±0.23	0.167±0.03	0.183±0.01	33.67±1.45	34.40±6.07
$CD_{0.05}$	2.944	3.546	NS	NS	NS	NS	NS	NS
SE(m)	0.945	1.138	0.299	0.151	0.009	0.013	1.982	1.721
SE(d)	1.336	1.610	0.423	0.214	0.013	0.018	2.803	2.434
CV(%)	4.224	4.355	2.603	1.316	9.776	12.16	11.152	8.921

SE(m) stands for standard error of mean and SE(d) stands for standard error of difference.
CV is the coefficient of variations; values in mean ± standard deviations

Table 2. Effect of foliar application of Zn on nutrient concentration of mango pulp

Treatment	P	K	Fe	Mn	Zn	Cu	B
	%		mg kg^{-1}				
T_1	0.023±0.0004	0.28±0.002	17.77±0.50	6.97±0.12	1.17±0.10	3.50±0.015	2.01±0.09
T_2	0.024±0.0003	0.26±0.005	18.17±0.26	7.73±0.10	1.60±0.06	4.17±0.21	2.59±0.21
T_3	0.026±0.0002	0.27±0.002	16.20±0.15	7.80±0.06	1.67±0.12	4.23±0.06	2.55±0.27
T_4	0.024±0.0005	0.26±0.006	18.57±0.30	7.77±0.12	1.73±0.10	4.37±0.06	2.56±0.12
T_5	0.021±0.0006	0.27±0.008	20.10±0.15	7.83±0.12	1.60±0.06	3.93±0.15	3.13±0.18
T_6	0.021±0.0001	0.28±0.001	17.03±0.15	7.87±0.06	1.53±0.06	3.37±0.21	2.02±0.10
T_7	0.023±0.0002	0.28±0.002	16.43±0.06	7.37±0.21	1.43±0.21	3.13±0.17	2.04±0.23
$CD_{0.05}$	NS	NS	NS	NS	0.21	0.3	NS
SE(m)	0.0001	0.002	0.147	0.069	0.068	0.097	0.108
SE(d)	0.0002	0.003	0.207	0.098	0.096	0.137	0.153
CV(%)	1.525	1.519	1.431	1.577	7.686	4.395	7.755

SE(m) stands for standard error of mean and SE(d) stands for standard error of difference.
CV is the coefficient of variations; values in mean ± standard deviations

0.385%, much lower than critical level of 0.50% (Table 4). Lower SOC content thus recommends for higher organic input remedies to sandy loam soil. Available K of 74.78±3.97 mg kg^{-1} (T_1) to 84.48±3.81 mg kg^{-1} (T_4) to 81.79±15.87 mg kg^{-1} (T_5) was estimated. Fe and Mn availability of 4.78 to 5.87 and 8.21 to 9.31 mg kg^{-1} was observed. Significant difference of Zn and Cu content of 0.52±0.08 mg kg^{-1} (T_1) to 0.93±0.25 mg kg^{-1} (T_5) and 0.43±0.15 (T_1) to 1.29±0.30 mg kg^{-1} (T_5) was evidenced (Table 4). Higher CV (%) of 20.78% (Zn) and 30.75% (Cu) was also noticed.

The observed yield differences in the mango orchards are accounted for different rate of Zn application. Tree nutrition was thus found responsible for obtaining satisfactory yields. Zeng *et al.* (2001) reported the possible soil and leaf K

Table 3. Effect of foliar application of Zn on nutrient concentration of mango leaf

Treatment	P	K	Fe	Mn	Zn	Cu	B
	%		mg kg^{-1}				
T_1	0.157±0.007	0.969±0.03	182.3±20.43	149.0±12.49	29.7±5.51	13.7±0.58	32.367±3.11
T_2	0.159±0.005	0.960±0.03	206.7±10.26	155.7±6.11	35.7±3.51	14.7±3.21	35.100±2.05
T_3	0.147±0.002	0.936±0.03	182.7±9.87	143.7±5.13	38.3±1.53	17.0±4.36	38.800±2.79
T_4	0.148±0.005	0.984±0.01	183.0±9.54	152.7±14.05	46.0±6.24	19.7±1.53	39.967±4.60
T_5	0.158±0.012	1.022±0.06	170.3±11.59	137.7±5.13	52.0±5.29	13.0±1.00	35.933±1.79
T_6	0.156±0.002	1.006±0.01	184.3±29.67	158.0±8.72	55.3±5.13	12.3±0.58	35.300±1.80
T_7	0.160±0.013	0.996±0.03	174.7±12.22	154.0±14.0	55.7±7.02	11.7±2.31	36.367±3.67
$CD_{0.05}$	NS	NS	NS	NS	9.9	4.5	NS
SE(m)	0.005	0.020	9.3	6.27	3.22	1.46	1.84
SE(d)	0.007	0.028	13.15	8.86	4.55	2.07	2.61
CV(%)	5.15	3.45	8.78	7.23	12.47	17.4	8.80

SE(m) stands for standard error of mean and SE(d) stands for standard error of difference.
CV is the coefficient of variations; values in mean ± standard deviations

Table 4. Effect of foliar application of Zn on soil nutrients after harvesting of mango

Treatment	SOC	P	K	Fe	Mn	Zn	Cu
	%		mg kg^{-1}				
T_1	0.316±0.02	0.179±0.03	74.78±3.97	4.78±0.31	8.21±0.35	0.52±0.08	0.43±0.15
T_2	0.370±0.05	0.211±0.02	71.41±4.26	5.37±0.78	9.31±0.51	0.68±0.15	0.72±0.14
T_3	0.385±0.07	0.184±0.02	81.96±2.93	5.13±0.46	8.42±1.05	0.55±0.09	0.62±0.14
T_4	0.370±0.07	0.213±0.03	84.48±3.81	5.87±0.51	8.86±0.77	0.84±0.15	0.92±0.25
T_5	0.375±0.06	0.173±0.03	81.79±5.95	5.14±0.66	8.95±1.00	0.93±0.25	1.29±0.30
T_6	0.331±0.04	0.199±0.02	79.75±3.65	5.62±0.68	8.94±1.04	0.61±0.10	1.19±0.23
T_7	0.375±0.02	0.208±0.03	80.64±4.22	5.66±0.23	8.93±1.04	0.78±0.08	0.83±0.52
$CD_{0.05}$	NS	NS	6.78	NS	NS	0.22	0.39
SE(m)	0.026	0.013	2.26	0.28	0.37	0.073	0.13
SE(d)	0.037	0.018	3.20	0.40	0.52	0.103	0.19
CV(%)	14.61	13.13	5.72	10.55	8.39	20.78	30.75

SE(m) stands for standard error of mean and SE(d) stands for standard error of difference.
CV is the coefficient of variations; values in mean ± standard deviations

concentration variations along with nut yield and quality in pistachio tree. Perry *et al.* (2010) exhibited the pear orchard tree characteristics and its variations with yield. The soil condition is always questionable for solute transport ability. Asghari *et al.* (2011) reported the effect of soil conditioners in a sandy loam soil in terms of physical quality and bromide transport while Yadav *et al.* (2011) recorded statistically significant improvement in Amrapali mango with nutrient transformation mechanisms. In fact, the fitness of soil for tree plantations with potential yield is always top most priority on long-term basis to sustain land productivity (Ganeshamurthy and Reddy, 2015). Recently, Vallentin *et al.* (2022) opined that the satellite remote sensing data could potentially be used for yield estimation and infrared spectroscopy could also be scientifically applied for quality assurances in mango and apple (Li *et al.,* 2021). The role of foliar spray of nutrients is beneficial in fruit trees as observed by Pal *et al.* (2018) in Arka Neelamani grape, Kumar *et al.* (2017) on guava, Hamze *et al.* (2018) on pistachio tree. Talang *et al.* (2017) found the effectiveness of calcium, boron and sorbitol on fruit-set, yield and quality in Himsagar mango. Adak *et al.* (2020) experimentally proved the beneficial effects of foliar nutrient technology on the yield performance, fruit quality and nutrient status of guava. In fact, the technological innovations should efficiently be disseminated to small and marginal growers for harnessing the benefits (Adak *et al.*, 2022). Since, soil properties also influence the yield performances, particularly organic carbon recognized as effective indicator, soil organic carbon stock should be estimated (Hinge *et al.,* 2018) and digital soil mapping of soil properties (Dharumarajan *et al.,* 2020), should also emphasized for future precision orchard management. Thus, the response recorded within the current trial showed 1% $ZnSO_4$ should be applied to mango trees for better statistically higher yield, quality component and nutrient richness. Beyond 1% $ZnSO_4$, economical benefit may not be availed.

CONCLUSION

Harvesting of optimum fruit yield from orchard is the sole objective of mango farmers. Fruit yield and fruit quality increased significantly with application of 1.0% $ZnSO_4$ over control. In the current study yield of 50.72 kg tree^{-1} indicated that there is enormous scope to increase the yield of mango in this region through zinc application through foliar sprays. The study recommends foliar spray of 1.0% $ZnSO_4$ for mango in Indo-Gangetic plain region for higher yields and improvement of fruit quality. Study further shows the scope for improvement in soil management to get a desirable potential yield.

ACKNOWLEDGEMENT

ICAR networking project on "Micronutrient management in Horticultural crops for enhancing Yield and quality" is duly acknowledged for financial assistance. Director, ICAR-CISH, Lucknow is also kindly acknowledged for smooth functioning of field trials and other staff for cooperation in laboratory and fields.

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(Received: 23.01.2022; Revised: 25.03.2022, Accepted: 30.03.2022)